

HYDROGRAPHIC SURVEYING VESSEL AND SYSTEM

TECHNICAL FIELD

[0001] The disclosure relates to a hydrographic surveying vessel. In particular, this disclosure relates to a hydrographic surveying vessel with an acoustic wave generator.

[0002] This disclosure also relates to a hydrographic surveying system. In particular, this disclosure relates to a hydrographic surveying system including a hydrographic surveying vessel that is operably connected to a towing vessel.

[0003] This disclosure also relates to a hydrographic surveying vessel comprising a marine manoeuvring system that is configured to controllably influence a heading of the hydrographic surveying vessel.

BACKGROUND

[0004] Hydrographic surveying vessels are specialised ships that are equipped with sensor systems that enable marine environments to be mapped. These vessels are used to conduct hydrographic surveys in a number of marine environments such as oceans, rivers and lakes. The data collected by these vessels can be indicative of one or more characteristics of the marine environment such as its depth, the seafloor topography etc. Hydrographic surveying vessels are typically equipped with echosounders which use sonar technology to gather data which can be processed to infer characteristics of the marine environment. The data collected from hydrographic surveys provide useful information for consideration in the marine navigation, maritime infrastructure and resource exploration industries.

[0005] While hydrographic surveying vessels provide useful information in regard to the depth and seafloor topography of a marine environment, existing hydrographic surveying vessels and the methods used to conduct hydrographic surveys have a number of disadvantages. In particular, conducting a hydrographic survey is an expensive endeavour. The acquisition, operation and maintenance costs associated with hydrographic surveying vessels can be significant. These vessels are specialized and require substantial investments in construction, outfitting, and ongoing maintenance to enable their operation.

[0006] Further, the width of the marine environment that can be monitored by a typical hydrographic surveying vessel as it moves (referred to as the swath) is typically limited to the portion of the marine environment that is within a specified distance of the hydrographic surveying vessel. This distance is related to the sensor systems employed, the depth of the body of water that is being surveyed and the speed at which the hydrographic surveying vessel travels.

[0007] When conducting a hydrographic survey, a hydrographic surveying vessel will typically conduct a number of passes across the relevant marine environment. A pass of a hydrographic surveying vessel is a single run made by the vessel along a specific line or course of the marine

environment. Where a hydrographic survey is desired to be conducted on a marine environment that is larger than the swath of the hydrographic surveying vessel, the hydrographic surveying vessel will typically conduct multiple passes to survey the entire marine environment. It is advantageous to reduce the number of passes required to be conducted by the hydrographic surveying vessel. Doing so reduces the time taken to conduct the hydrographic survey which can in turn reduce the cost of conducting the hydrographic survey and enable more efficient use of the hydrographic surveying vessel.

[0008] It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

SUMMARY

[0009] In some embodiments, there is provided a hydrographic surveying vessel. The hydrographic surveying vessel may comprise a hull. The hydrographic surveying vessel may comprise a marine manoeuvring system. The hydrographic surveying vessel may comprise an acoustic wave generator. A first end portion of the marine manoeuvring system may be configured to be connected to the hull. A second end portion of the marine manoeuvring system may be configured to be connected to the acoustic wave generator. The second end portion of the marine manoeuvring system may be further away from the hull than the first end portion when the marine manoeuvring system is connected to the hull.

[0010] In some embodiments, the hydrographic surveying vessel further comprises an acoustic wave generator controller. The acoustic wave generator controller may be housed within the hull. The acoustic wave generator controller may be in communication with the acoustic wave generator, thereby enabling the acoustic wave generator controller to control the acoustic wave generator.

[0011] In some embodiments, the hydrographic surveying vessel further comprises a sensing system. The sensing system may comprise a motion reference unit that is configured to generate motion data. The motion data may be time series data indicative of a roll angle, a pitch angle and a heave angle of the hydrographic surveying vessel. The sensing system may comprise a Global Navigation Satellite System (GNSS) module configured to generate GNSS data that is indicative of a heading, a latitude and a longitude of the hydrographic surveying vessel.

[0012] In some embodiments, the hydrographic surveying vessel further comprises a network interface that is configured to enable communication between the hydrographic surveying vessel and another computing device.

[0013] In some embodiments, the hydrographic surveying vessel further comprises a power system, at least part of the power system being housed within the housing.

[0014] In some embodiments, the marine manoeuvring system comprises a first end body. In some embodiments, the marine manoeuvring system comprises a second end body. In some embodiments, the marine manoeuvring system comprises a plurality of manoeuvring elements.

[0015] In some embodiments, the first end body defines at least part of a first end of the marine manoeuvring system. In some embodiments the second end body defines at least part of a second end of the marine manoeuvring system.

[0016] In some embodiments, one or more of the manoeuvring elements extends from a first manoeuvring element end to a second manoeuvring element end. In some embodiments, one or more of the manoeuvring elements is connected to the first end body at the first manoeuvring element end. In some embodiments, one or more of the manoeuvring elements is connected to the second end body at the second manoeuvring element end.

[0017] In some embodiments, the first end body comprises a first end plate. In some embodiments, the second end body comprises a second end plate.

[0018] In some embodiments, one or more of the manoeuvring elements extends orthogonally with respect to an inner surface of the first end body and an inner surface of the second end body.

[0019] In some embodiments, the manoeuvring elements are vanes that are configured to influence a heading of the hydrographic surveying vessel in a fluid.

[0020] In some embodiments, the first end body comprises a hull connecting portion that is configured to enable the hull to be connected to the first end body.

[0021] In some embodiments, the second end body comprises an acoustic wave generator connecting portion that is configured to enable the acoustic wave generator to be connected to the second end body.

[0022] In some embodiments, the acoustic wave generator is disposed on an opposite side of the second end body to the manoeuvring elements.

[0023] In some embodiments, the acoustic wave generator is disposed on an opposite side of the manoeuvring elements to the hull, when the hull is connected to the marine manoeuvring system.

[0024] In some embodiments, the marine manoeuvring system defines a channel that is configured to receive a cable.

[0025] In some embodiments, the hydrographic surveying vessel further comprises the cable. The acoustic wave generator controller may communicate with the acoustic wave generator using the cable.

[0026] In some embodiments, one of the manoeuvring elements defines at least part of the channel, the part of the channel defined by the manoeuvring element extending from a first manoeuvring element end of the manoeuvring element to a second manoeuvring element end of the manoeuvring element.

[0027] In some embodiments, the first end body defines a first part of the channel. In some embodiments, the first part of the channel extends from a first end face of the first end body to a second end face of the first end body. In some embodiments, the part of the channel that is defined by the manoeuvring element is an intermediate part of the channel.

[0028] In some embodiments, the second end body defines a second part of the channel, the second part of the channel extending from a first end face of the second end body to a second end face of the second end body.

[0029] In some embodiments, the plurality of manoeuvring elements comprises a fixed manoeuvring element. In some embodiments, the plurality of manoeuvring elements comprises a movable manoeuvring element.

[0030] In some embodiments, the fixed manoeuvring element defines an intermediate part of the channel.

[0031] In some embodiments, the intermediate part of the channel extends from a first manoeuvring element end of the fixed manoeuvring element to a second manoeuvring element end of the fixed manoeuvring element.

[0032] In some embodiments, the marine manoeuvring system comprises an elongate element that extends between the first end body and the second end body, the elongate element defining at least part of the channel.

[0033] In some embodiments, the first end body defines a first part of the channel. The first part of the channel may extend from a first end face of the first end body to a second end face of the first end body. In some embodiments, the elongate element defines a second part of the channel, the second part of the channel extending along the length of the elongate element.

[0034] In some embodiments, the second end body defines a third part of the channel. The third part of the channel may extend from a first end face of the second end body to a second end face of the second end body.

[0035] In some embodiments, the first part of the channel and the second part of the channel are coaxial. In some embodiments, the first part of the channel and the third part of the channel are coaxial. In some embodiments, the second part of the channel and the third part of the channel are coaxial. In some embodiments, the first part of the channel, the second part of the channel and the third part of the channel are coaxial.

[0036] In some embodiments, the elongate element is closer to a trailing end of the marine manoeuvring system than a leading end of the marine manoeuvring system.

[0037] In some embodiments, at least part of the elongate element is closer to the trailing end of the marine manoeuvring system than each of the manoeuvring elements.

[0038] In some embodiments, the elongate element is laterally offset with respect to a rearmost manoeuvring element.

[0039] In some embodiments, the acoustic wave generator is closer to a leading end of the marine manoeuvring system than a trailing end of the marine manoeuvring system.

[0040] In some embodiments, the acoustic wave generator is mounted to a leading quarter of the marine manoeuvring system.

[0041] In some embodiments, the housing comprises a cable gland. The cable gland may be configured to enable a cable to pass from outside the housing into the housing. The cable gland may be configured to inhibit water ingress. The cable gland may be configured to inhibit water ingress into the housing.

[0042] In some embodiments, the hydrographic surveying vessel further comprises one or more vessel tow mounting portions. Each vessel tow mounting portion may be configured to enable connection of a connector element.

[0043] In some embodiments, the hydrographic surveying vessel further comprises a towing connector assembly. The towing connector assembly may comprise a towing connector comprising a plurality of towing connector mounting portions. The towing connector assembly may comprise a plurality of connector elements. One or more of the connector elements may be configured to be connected to one of the towing connector mounting portions at one end. One or more of the connector elements may be configured to be connected to one of the vessel tow mounting portions at another end.

[0044] In some embodiments, the acoustic wave generator comprises a multibeam echosounder.

[0045] In some embodiments, there is provided a hydrographic surveying system. The hydrographic surveying system may comprise the hydrographic surveying vessel. The hydrographic surveying system may comprise a second hydrographic surveying vessel. The hydrographic surveying system may comprise a towing system that is configured to connect to the hydrographic surveying vessel and the second hydrographic surveying vessel, thereby operably linking the hydrographic surveying vessel and the second hydrographic surveying vessel.

[0046] In some embodiments, the second hydrographic surveying vessel comprises a second hull; a second marine manoeuvring system; a second acoustic wave generator; and a second towing connector assembly. The second towing connector assembly may comprise a second towing connector comprising a plurality of second towing connector mounting portions. The second towing connector assembly may comprise a plurality of second connector elements. A first end of the second marine manoeuvring system may be configured to be connected to the second hull. A second end of the second marine manoeuvring system may be configured to be connected to the second acoustic wave generator, the second end of the second marine manoeuvring system being further away from the second hull than the first end when the second marine manoeuvring system is connected to the second hull. Each second connector element may be configured to be connected to one of the second towing connector mounting portions at one end. One or more of the second connector elements may be configured to be

connected to a respective second vessel tow mounting portion of the second hydrographic surveying vessel at another end.

[0047] In some embodiments, the marine manoeuvring system is configured to bias the hydrographic surveying vessel in a first direction in response to movement through a fluid in a movement direction. In some embodiments, the second marine manoeuvring system is configured to bias the second hydrographic surveying vessel in a second direction in response to movement through the fluid in the movement direction. In some embodiments, the first direction is different to the second direction.

[0048] In some embodiments, the towing system comprises a first towing element that is configured to be operably connected to the towing connector. In some embodiments, the towing system comprises a second towing element that is configured to be operably connected to the second towing connector. In some embodiments, the towing system comprises a third towing element that is configured to be operably connected to the hydrographic surveying vessel at one end and the second hydrographic surveying vessel at another end, such that relative movement between the hydrographic surveying vessel and the second hydrographic surveying vessel is constrained.

[0049] In some embodiments, there is provided a hydrographic surveying system. The hydrographic surveying system may comprise a hydrographic surveying vessel. The hydrographic surveying vessel may comprise a hydrographic surveying vessel hull. The hydrographic surveying vessel may comprise an acoustic wave generator portion. The acoustic wave generator portion may be mounted at an underside of the hydrographic surveying vessel. The acoustic wave generator portion may comprise an acoustic wave generator. The hydrographic surveying vessel may comprise a hydrographic surveying vessel tow mounting portion. The hydrographic surveying system may comprise a marine manoeuvring vessel. The marine manoeuvring vessel may comprise a marine manoeuvring vessel hull. The marine manoeuvring vessel may comprise a marine manoeuvring system. The marine manoeuvring vessel may comprise a marine manoeuvring vessel towing connector assembly. The hydrographic surveying vessel tow mounting portion may be configured to facilitate a connection between the hydrographic surveying vessel and a towing system. The marine manoeuvring vessel towing connector assembly may be configured to be connected to the towing system. The hydrographic surveying vessel and the marine manoeuvring vessel may be operably connected via the towing system. Movement of the marine manoeuvring vessel may cause movement of the hydrographic surveying vessel.

[0050] In some embodiments, the hydrographic surveying vessel comprises an acoustic wave generator connecting portion that is configured to enable the acoustic wave generator portion to be connected to the hydrographic surveying vessel hull.

[0051] In some embodiments, the hydrographic surveying system further comprises a sensing system, the sensing system comprising: a motion reference unit that is configured to generate

motion data, the motion data being time series data indicative of a roll angle, a pitch angle and a heave angle of the hydrographic surveying vessel at a plurality of times within a time window; and a Global Navigation Satellite System (GNSS) module configured to generate GNSS data that is indicative of a heading, a latitude and a longitude of the hydrographic surveying vessel.

[0052] In some embodiments, the hydrographic surveying vessel hull houses at least part of the sensing system.

[0053] In some embodiments, the acoustic wave generator comprises a multibeam echosounder.

[0054] In some embodiments, the marine manoeuvring system comprises: a first end body; a second end body; and a plurality of manoeuvring elements that extend between the first end body and the second end body.

[0055] In some embodiments, one or more of the manoeuvring elements extends orthogonally with respect to an inner surface of the first end body and an inner surface of the second end body.

[0056] In some embodiments, the marine manoeuvring vessel towing connector assembly comprises: a towing connector comprising a plurality of towing connector mounting portions; and a plurality of connector elements, each connector element being configured to connect to one of the towing connector mounting portions at a first end.

[0057] In some embodiments, one or more of the connector elements are configured to connect to a tow mounting portion of the marine manoeuvring vessel at a second end.

[0058] In some embodiments, the hydrographic surveying system further comprises the towing system.

[0059] In some embodiments, the towing system comprises a towing element.

[0060] In some embodiments, the towing element is configured to be operatively connected, at a first portion, to the hydrographic surveying vessel and/or the marine manoeuvring vessel, and, at a second portion, to a towing vessel, such that movement of the towing vessel causes movement of the hydrographic surveying vessel and/or the marine manoeuvring vessel.

[0061] In some embodiments, the towing element is configured to be connected to the hydrographic surveying vessel at the first portion.

[0062] In some embodiments, one or more of the connector elements is configured to be connected, at its second end or at an intermediate point, to the towing element.

[0063] In some embodiments, the one or more of the connector elements is configured to be connected to the towing element at a junction.

[0064] In some embodiments, the towing element is configured to be connected to the marine manoeuvring vessel at the first portion.

[0065] In some embodiments, the hydrographic surveying vessel comprises a towing connector assembly, the towing connector assembly being configured to be connected to the towing system.

[0066] In some embodiments, the towing connector assembly is configured to connect to the towing system at a different point to the marine manoeuvring vessel.

[0067] In some embodiments, the hydrographic surveying system further comprises: a second hydrographic surveying vessel; and a second marine manoeuvring vessel.

[0068] In some embodiments, the second hydrographic surveying vessel and the second marine manoeuvring vessel are operatively connected.

[0069] In some embodiments, the towing system further comprises a second towing element.

[0070] In some embodiments, the second towing element is configured to be operatively connected, at a first portion, to the second hydrographic surveying vessel and/or the second marine manoeuvring vessel, and, at a second portion, to the towing vessel, such that movement of the towing vessel causes movement of the second hydrographic surveying vessel and the second marine manoeuvring vessel.

[0071] In some embodiments, the marine manoeuvring vessel is configured to bias the hydrographic surveying vessel in a first direction in response to movement through a fluid in a movement direction.

[0072] In some embodiments, the second marine manoeuvring vessel is configured to bias the second hydrographic surveying vessel in a second direction in response to movement through the fluid in the movement direction.

[0073] In some embodiments, the first direction is different to the second direction.

[0074] In some embodiments, the towing system further comprises a third towing element.

[0075] In some embodiments, the third towing element is configured to be operably connected to the hydrographic surveying vessel at or near one end and the second hydrographic surveying vessel at or near another end, such that relative movement between the hydrographic surveying vessel and the second hydrographic surveying vessel is constrained.

[0076] In some embodiments, there is provided a hydrographic surveying vessel. The hydrographic surveying vessel may comprise: a hull; a marine manoeuvring system that is configured to influence a heading of the hydrographic surveying vessel; and an acoustic wave generator portion comprising an acoustic wave generator, the acoustic wave generator portion being configured to be connected to the hull.

[0077] In some embodiments, the hydrographic surveying vessel further comprises a control system.

[0078] In some embodiments, the control system comprises a remote control interface configured to enable an operator to control the marine manoeuvring system, thereby influencing the heading of the hydrographic surveying vessel.

[0079] In some embodiments, the hydrographic surveying vessel further comprises a sensing system.

[0080] In some embodiments, the control system is configured to control the marine manoeuvring system based at least in part on sensing system data determined using the sensing system.

[0081] In some embodiments, the sensing system comprises one or more of: a Global Navigation Satellite System (GNSS) module configured to generate GNSS data that is indicative of a latitude and a longitude of the hydrographic surveying vessel; an altimeter that is configured to indicate an altitude of the hydrographic surveying vessel; an accelerometer that is configured to generate an acceleration output indicative of an acceleration of the hydrographic surveying vessel; a gyroscope that is configured to generate gyroscopic data indicative of an orientation of the hydrographic surveying vessel; a magnetometer that is configured to generate magnetic field data that is indicative of an azimuth orientation of the hydrographic surveying vessel; and an imaging module that is configured to generate image data that is associated with a region around the hydrographic surveying vessel.

[0082] In some embodiments, the imaging module comprises one or more of: a visible spectrum imaging module that is configured to generate visible spectrum imaging data; a light detection and ranging (LIDAR) module that is configured to generate LIDAR data; and a radio detecting and ranging (RADAR) module that is configured to generate RADAR data.

[0083] In some embodiments, the image data comprises one or more of the visible spectrum image data, the LIDAR data and the RADAR data.

[0084] In some embodiments, the marine manoeuvring system comprises a rudder.

[0085] In some embodiments, the control system comprises an electric motor that is operably connected to the rudder; and configured to rotate the rudder within a range of motion.

[0086] In some embodiments, the hydrographic surveying vessel comprises one or more tow mounting portions.

[0087] In some embodiments, there is provided a hydrographic surveying system. The hydrographic surveying system may comprise the hydrographic surveying vessel. The hydrographic surveying system may comprise a towing system that is configured to operatively link the hydrographic surveying vessel and a towing vessel.

[0088] In some embodiments, the towing system comprises a towing element that is configured to be connected to the hydrographic surveying vessel at a first portion and the towing vessel at a second portion.

[0089] In some embodiments, the towing element is configured to connect to one of the tow mounting portions of the hydrographic surveying vessel.

[0090] In some embodiments, the towing system comprises a second towing element.

[0091] In some embodiments, the second towing element is configured to connect to the hydrographic surveying vessel at a first end and a junction with the first towing element at a second end.

[0092] In some embodiments, the acoustic wave generator comprises a multibeam echosounder.

[0093] In some embodiments, the hydrographic surveying system further comprises a second hydrographic surveying vessel.

[0094] In some embodiments, the second hydrographic surveying vessel comprises a second hull, a second marine manoeuvring system, a second acoustic wave generator portion comprising a second acoustic wave generator, the second acoustic wave generator portion being configured to be connected to the second hull, a second sensing system and a second control system.

[0095] In some embodiments, the second control system comprises a second remote control interface configured to enable an operator to control the second marine manoeuvring system; and/or the second control system is configured to control the marine manoeuvring system based at least in part on sensing data determined using the second sensing system.

[0096] In some embodiments, the second hydrographic surveying vessel comprises one or more tow mounting portions.

[0097] In some embodiments, the towing system further comprises a third towing element that is configured to connect to the second hydrographic surveying vessel at a first portion and the towing vessel at a second portion.

[0098] In some embodiments, the third towing element is configured to connect to one of the tow mounting portions of the second hydrographic surveying vessel.

[0099] In some embodiments, the towing system comprises a fourth towing element.

[00100] In some embodiments, the fourth towing element is configured to connect to the second hydrographic surveying vessel at a first end and a junction with the third towing element at a second end.

BRIEF DESCRIPTION OF THE DRAWINGS

[00101] Embodiments of the disclosure are described further below by way of example only with reference to the accompanying Figures, in which:

Figure 1 is a schematic diagram of a hydrographic surveying vessel in a marine environment;

Figure 2 is a perspective view of a hydrographic surveying vessel, according to some embodiments;

Figure 3 is a side view of the hydrographic surveying vessel of Figure 2, according to some embodiments;

Figure 4 is a front view of the hydrographic surveying vessel of Figure 2, according to some embodiments;

Figure 5 is a top view of the hydrographic surveying vessel of Figure 2, according to some embodiments;

Figure 6 is a side view of another hydrographic surveying vessel, according to some embodiments;

Figure 7 is a schematic diagram of the hydrographic surveying vessel of Figure 6;

Figure 8 is a top view of part of a manoeuvring system of the hydrographic surveying vessel of Figure 6;

Figure 9 is a front view of the hydrographic surveying vessel of Figure 6;

Figure 9A is a side view of a hydrographic surveying vessel, according to some embodiments;

Figure 9B is a top view of part of a manoeuvring system of the hydrographic surveying vessel of Figures 9A;

Figure 9C is a plan view of a section plane of an elongate element of the hydrographic surveying vessel of Figures 9A;

Figure 10 is a schematic diagram of a top view of a hydrographic surveying system that includes the hydrographic surveying vessel of Figure 2 and/or the hydrographic surveying vessel of Figure 6, according to some embodiments;

Figure 11 is a schematic diagram of a rear view of the hydrographic surveying system of Figure 10, according to some embodiments;

Figure 12 is another schematic diagram of the hydrographic surveying system of Figure 11, showing a total effective swath of the hydrographic surveying system, according to some embodiments;

Figure 13 is a perspective view of a marine manoeuvring vessel, according to some embodiments;

Figure 14 is a side view of a hydrographic surveying vessel, according to some embodiments;

Figure 15 is a front view of the hydrographic surveying vessel of Figure 14, according to some embodiments;

Figure 16 is a schematic diagram of a top view of a hydrographic surveying system that includes the marine manoeuvring vessel of Figure 13 and the hydrographic surveying vessel of Figure 14, according to some embodiments;

Figure 17 is a schematic diagram of a rear view of the hydrographic surveying system of Figure 16, according to some embodiments;

Figure 18 is a schematic diagram of a top view of a hydrographic surveying system, according to some embodiments;

Figure 19 is a schematic diagram of a rear view of the hydrographic surveying system of Figure 18, according to some embodiments;

Figure 20 is an upper perspective view of a part of the hydrographic surveying system of Figure 18, according to some embodiments;

Figure 21 is a lower perspective view of the part of the hydrographic surveying system of Figure 18 that is shown in Figure 20, showing a representation of the hydrographic surveying system from under water;

Figure 22 shows a schematic diagram of a top view of a hydrographic surveying system, according to some embodiments;

Figure 23 shows a schematic diagram of a rear view of the hydrographic surveying system of Figure 22, according to some embodiments; and

Figure 24 shows a perspective view of a hydrographic surveying vessel, according to some embodiments.

DETAILED DESCRIPTION

[00102] The disclosure relates to a hydrographic surveying vessel and a hydrographic surveying system.

Hydrographic Surveying Vessel 100

[00103] Figure 1 is a schematic diagram of a hydrographic surveying vessel 100. The hydrographic surveying vessel 100 is configured to be propelled through water 101. The hydrographic surveying vessel 100 includes a propulsion system to propel it through the water 101. The hydrographic surveying vessel 100 is configured to conduct a hydrographic survey of a marine environment 102 that includes the water 101. The illustrated marine environment 102 is an ocean. It will, however, be understood that hydrographic surveys may be conducted in any marine environment, including lakes and/or rivers.

[00104] The hydrographic surveying vessel 100 comprises an acoustic wave generator (not shown). The acoustic wave generator generates acoustic waves. The hydrographic surveying vessel 100 also comprises a receiver (not shown). The receiver detects acoustic waves that are emitted by the acoustic wave generator and reflected by one or more portions of the marine environment 102. Portions of the marine environment 102 such as the floor of the marine environment 102 and rock or coral formations reflect at least some of the acoustic waves generated by the acoustic wave generator. One or more characteristics of the marine environment 102 are determined at least in part based on the detected reflected acoustic waves.

[00105] Throughout this description, a hydrographic surveying vessel emitting acoustic waves and detecting the reflection of those acoustic waves by a portion of a marine environment may be considered surveying that portion of the marine environment. Alternatively, a hydrographic surveying vessel emitting acoustic waves and detecting the reflection of those acoustic waves by a portion of a marine environment may be considered imaging that portion of the marine environment.

[00106] The receiver of the hydrographic surveying vessel 100 of Figure 1 can detect acoustic waves that are reflected by the portion of the marine environment 102 that is within a particular

distance from the hydrographic surveying vessel 100. The lateral width (i.e. the width in a direction orthogonal to the direction of travel of the hydrographic surveying vessel 100) of the floor of the marine environment 102 that may be imaged by the hydrographic surveying vessel 100 as it moves through the marine environment 102 is referred to as the swath 104 of the hydrographic surveying vessel 100.

[00107] Where the marine environment 102 is larger than the hydrographic surveying vessel 100 can survey within its swath 104, the hydrographic surveying vessel 100 needs to perform multiple passes of the marine environment 102 to complete a survey of that marine environment 102. This increases the time over which the hydrographic surveying vessel 100 must be operated to survey a marine environment of a fixed size, compared to a case where the marine environment was able to be surveyed with a lower number of passes.

[00108] It is therefore advantageous to reduce the number of passes required to be conducted by the hydrographic surveying vessel 100. Doing so reduces the time taken to conduct the hydrographic survey which can in turn reduce the cost of conducting the hydrographic survey and enable more efficient use of the hydrographic surveying vessel 100.

[00109] The hydrographic surveying vessels and systems described herein provide for an increased swath. That is, the hydrographic surveying vessels and systems described herein enable a larger portion of the marine environment to be surveyed in a single pass. The hydrographic surveying vessels and systems described herein therefore enable the time taken to conduct a hydrographic survey to be reduced, leading to a reduction in the cost of completing the survey and allowing the hydrographic surveying vessels and systems described herein to be used more efficiently.

Hydrographic Surveying Vessel 200

[00110] Figures 2 to 5 show a hydrographic surveying vessel 200, according to some embodiments of the present disclosure. Figures 6 to 8 show a hydrographic surveying system 201, according to some embodiments of the present disclosure.

[00111] The hydrographic surveying vessel 200 comprises a hull 202. The hull 202 extends from a front 202A to a rear 202B. The hull 202 comprises a plurality of hull walls 204. The hull walls 204 define an internal volume of the hull 202. The hull 202 may comprise one or more hull openings that provide access to the internal volume of the hull 202 from outside the hull 202. The hull openings may be capped to inhibit water ingress during use of the hydrographic surveying vessel 200.

[00112] The hydrographic surveying vessel 200 comprises a mast 281. The mast 281 extends outwards from the hull 202. The mast 281 extends upwards when the hydrographic surveying vessel 200 is in use.

[00113] The hydrographic surveying vessel 200 comprises manoeuvring system 206. The manoeuvring system 206 may be referred to as a marine manoeuvring system 206. Thus, the hydrographic surveying vessel 200 may be said to comprise a marine manoeuvring system 206.

The marine manoeuvring system 206 extends between a first end portion 208 and a second end portion 210. The first end portion 208 is configured to be connected to the hull 202. In Figure 2, the first end portion 208 is connected to the hull 202. The marine manoeuvring system 206 comprises a first end body 212. In particular, the first end portion 208 comprises the first end body 212. The first end body 212 defines at least part of a first end of the marine manoeuvring system 206. In the illustrated embodiment, the first end body 212 defines the first end of the marine manoeuvring system 206.

[00114] The first end body 212 comprises a first end plate. The first end plate may be referred to as a first end sheet. The first end plate may be referred to a first planar end portion. The first end plate extends between a first end face and a second end face. In particular, the first end plate extends between a first end plate surface 214 and a second end plate surface 216. The first end face defines the first end plate surface 214. The first end plate surface 214 is an upper surface of the first end plate. The second end face defines the second end plate surface 216. The second end plate surface 216 is a lower surface of the first end plate. The second end plate surface 216 may be considered an inner surface of the first end body 212. A thickness of the first end plate is the distance between the first end plate surface 214 and the second end plate surface 216 at one or more points of the first end plate. The first end plate surface 214 is parallel to the second end plate surface 216. The thickness of the first end plate is less than a width of the first end plate and a length of the first end plate.

[00115] The marine manoeuvring system 206 comprises a second end body 218. In particular, the second end portion 210 comprises the second end body 218. The second end body 218 defines at least part of a second end of the marine manoeuvring system 206. In the illustrated embodiment, the second end body 218 defines the second end of the marine manoeuvring system 206.

[00116] The second end body 218 comprises a second end plate. The second end plate may be referred to as a second end sheet. The second end plate may be referred to a second planar end portion. The second end plate extends between a first end face and a second end face. The first end face of the second end plate may be referred to as a third end face of the marine manoeuvring system 206. The second end face of the second end plate may be referred to as a fourth end face of the marine manoeuvring system 206. The second end plate extends between a third end plate surface 220 and a fourth end plate surface 222. The first end face of the second end plate defines the third end plate surface 220. The third end plate surface 220 is an upper surface of the first end plate. The third end plate surface 220 may be considered an inner surface of the second end body 218. The second end face of the second end plate defines the fourth end plate surface 222. The fourth end plate surface 222 is a lower surface of the second end plate. A thickness of the second end plate is the distance between the third end plate surface 220 and the fourth end plate surface 222 at one or more points of the second end plate. The third end plate surface 220 is parallel to the fourth end plate surface 222. The thickness of

the second end plate is less than a width of the second end plate and a length of the second end plate.

[00117] The marine manoeuvring system 206 comprises a plurality of manoeuvring elements 224. One or more of the manoeuvring elements 224 extends from a first manoeuvring element end 226 to a second manoeuvring element end 228. In the illustrated embodiment, each manoeuvring element 224 extends from a respective first manoeuvring element end 226 to a respective second manoeuvring element end 228.

[00118] One or more of the manoeuvring elements 224 is connected to the first end body 212 at the first manoeuvring element end 226. In the illustrated embodiment, each of the manoeuvring elements 224 is connected to the first end body 212 at its respective first manoeuvring element end 226. The manoeuvring elements 224 are fixedly connected to the first end body 212. One or more of the manoeuvring elements 224 may, for example, be welded to the first end body 212. Alternatively, one or more of the manoeuvring elements 224 may be connected to the first end body 212 using a bolted connection, or another type of mechanical connection.

[00119] One or more of the manoeuvring elements 224 is connected to the second end body 218 at the second manoeuvring element end 228. In the illustrated embodiment, each of the manoeuvring elements 224 is connected to the second end body 218 at its respective second manoeuvring element end 228. The manoeuvring elements 224 are fixedly connected to the second end body 218. One or more of the manoeuvring elements 224 may, for example, be welded to the second end body 218. Alternatively, one or more of the manoeuvring elements 224 may be connected to the second end body 218 using a bolted connection, or another type of mechanical connection.

[00120] One or more of the manoeuvring elements 224 extends orthogonally with respect to the first end body 212. In particular, each manoeuvring element 224 extends orthogonally with respect to the second end plate surface 216 of the first end plate. One or more of the manoeuvring elements 224 extends orthogonally with respect to the second end body 218. In particular, each manoeuvring element 224 extends orthogonally with respect to the third end plate surface 220 of the second end plate.

[00121] The manoeuvring elements 224 comprise vanes. The manoeuvring elements 224 may be in the form of vanes. The manoeuvring elements 224 are configured to influence a heading of the hydrographic surveying vessel 200 in use. Each manoeuvring element 224 extends from a leading edge 225 to a trailing edge 227. A thickness of the manoeuvring elements 224 may be defined as a distance between a first face 229 of the respective manoeuvring element 224 and a second face 231 of the respective manoeuvring element 224. In some embodiments, the thickness of one or more of the manoeuvring elements 224 is constant across the manoeuvring element 224. In some embodiments, the thickness of one or more of the manoeuvring elements 224 changes across the manoeuvring element 224. The thickness of each

manoeuvring element 224 is relatively low compared to the orthogonal dimensions of the respective manoeuvring element 224.

[00122] Each manoeuvring element 224 curves along its length as it extends from its leading edge 225 to its trailing edge 227. It will be appreciated, however, that in some embodiments, one or more of the manoeuvring elements 224 are planar. The manoeuvring elements 224 are arranged in a cascade, with a fluid gap being provided between adjacent manoeuvring elements 224. The curvature of one or more of the manoeuvring elements 224 and/or an angle that one or more of the manoeuvring elements 224 is disposed at relative to a longitudinal direction of the hull 202 can impact the extent to which the marine manoeuvring system 206 influences the heading of the hydrographic surveying vessel 200.

[00123] The first end portion 208 comprises a hull connecting portion 230. In particular, the first end body 212 comprises the hull connecting portion 230. The hull connecting portion 230 enables the hull 202 to be connected to the first end portion 208 of the marine manoeuvring system 206. The hull connecting portion 230 is shaped such that it generally matches a profile of the hull 202. In the illustrated embodiment, the first end portion 208 comprises a plurality of hull connecting portions 230. Each hull connecting portion 230 enables the hull 202 to be connected to the first end portion 208 of the marine manoeuvring system 206. In the illustrated embodiment, each hull connecting portion 230 forms a generally C-shaped portion that matches part of the cylindrical shape of the hull 202.

[00124] The hull 202 is connected to the marine manoeuvring system 206 using a hull connection system 232. The illustrated hydrographic surveying vessel 200 comprises a hull connection system 232 for each hull connecting portion 230. In some embodiments, one or more of the hull connection systems 232 comprises a rigid hull connection mechanism. The hull connection mechanism connects the hull 202 to the marine manoeuvring system 206. The hull connection mechanism may comprise one or more rigid bodies, each configured to extend around at least a portion of the hull 202. One or more of the rigid bodies may connect to a respective hull connecting portion 230, thereby securing the hull 202 with respect to the marine manoeuvring system 206. In some embodiments, one or more of the hull connection systems 232 comprises a hull connection strap. Each hull connection strap cooperates with a respective hull connecting portion 230 to enable the hull 202 to be connected to the marine manoeuvring system 206. Each hull connection system 232 may comprise a strap securing system (not shown) to secure a respective hull connection strap in place to retain the hull 202 to the marine manoeuvring system 206.

[00125] In some embodiments, the hull 202 may be connected to the marine manoeuvring system 206 using another type of connection. For example, the hull 202 may be connected to the marine manoeuvring system 206 using a bolted connection.

[00126] The hull 202 defines a hull channel 236. The hull channel 236 extends through the hull 202, from a first hull opening 238 to a second hull opening 240. The hydrographic surveying

vessel 200 comprises a tube 242. The tube 242 extends through the hull channel 236, and connects, at one end, to the marine manoeuvring system 206.

[00127] The hydrographic surveying vessel 200 comprises an acoustic wave generator 246. The acoustic wave generator 246 generates acoustic waves in a fluid around the acoustic wave generator 246. In this case, the acoustic wave generator 246 is configured to generate acoustic waves in the water that surrounds the acoustic wave generator 246 in use.

[00128] The hydrographic surveying vessel 200 comprises an acoustic wave receiver. The acoustic wave receiver is configured to detect acoustic waves that are emitted by the acoustic wave generator 246 and reflected by a portion of the marine environment 264. The acoustic wave generator 246 may comprise the acoustic wave receiver.

[00129] The acoustic wave generator 246 comprises a multibeam echosounder. In the illustrated embodiment, the acoustic wave generator 246 is in the form of a multibeam echosounder. In some embodiments, the acoustic wave generator 246 may comprise, or be in the form of, a single beam echosounder. In some embodiments, the acoustic wave generator 246 may comprise, or be in the form of, a side scan sonar system.

[00130] In some embodiments, the acoustic wave generator 246 is mounted directly to the marine manoeuvring system 206. For example, the acoustic wave generator 246 may be mounted to the second end body 218 of the marine manoeuvring system 206. This may be a bolted connection.

[00131] In some embodiments, the hydrographic surveying vessel 200 comprises an acoustic wave generator portion 244. This is the case in the illustrated embodiment. The acoustic wave generator portion 244 comprises the acoustic wave generator 246. The acoustic wave generator portion 244 may comprise one or more other components. For example, the acoustic wave generator portion 244 may comprise a frame. The acoustic wave generator 246 may be mounted to the frame. The frame may be mounted to the marine manoeuvring system 206. For example, the frame may be mounted to the second end body 218 of the marine manoeuvring system 206. The frame may be shaped to protect the acoustic wave generator 246. For example, the frame may comprise a shroud. The shroud may be configured to protect the acoustic wave generator 246.

[00132] Where the acoustic wave generator 246 is described to be connected to the marine manoeuvring system 206 herein, it will be appreciated that in some embodiments, this may be a direct connection. For example, the acoustic wave generator 246 may be bolted to the second end body 218. It will also be appreciated that in some embodiments, the acoustic wave generator 246 may be indirectly connected to the marine manoeuvring system 206. For example, the acoustic wave generator 246 may be connected to the marine manoeuvring system 206 via one or more intermediate component. The intermediate component may be a part of the acoustic wave generator portion 244, where present. For example, the acoustic wave generator portion 244 may comprise a frame. The acoustic wave generator 246 may connect to

the frame and the frame may connect to the marine manoeuvring system 206. The acoustic wave generator 246 will also be considered to be connected to the marine manoeuvring system 206 in such cases.

[00133] The hydrographic surveying vessel 200 comprises a keel 248. In particular, the acoustic wave generator portion 244 comprises the keel 248. The keel 248 is in the form of an elongate body. The keel 248 extends in a longitudinal direction from a first keel end 250 to a second keel end 252. The acoustic wave generator 246 is connected to the keel 248. In particular, the acoustic wave generator 246 removably connectable to the keel 248. The keel 248 is configured to enable the removable connection of the acoustic wave generator 246. The keel 248 is connected to the marine manoeuvring system 206. It will be appreciated that the keel 248 may not be included in some embodiments.

[00134] The second end portion 210 of the marine manoeuvring system 206 is configured to be connected to the acoustic wave generator 246. In other words, the acoustic wave generator 346 is configured to be connected to the second end portion 210 of the marine manoeuvring system 206. The second end portion 210 of the marine manoeuvring system 206 is configured to be connected to the acoustic wave generator portion 244. In the illustrated embodiment, the second end body 218 of the marine manoeuvring system 206 comprises an acoustic wave generator connecting portion (not shown). The acoustic wave generator connecting portion enables the acoustic wave generator portion 244 to be connected to the second end body 218. In other words, the acoustic wave generator connecting portion enables the acoustic wave generator portion 244 to be connected to the second end portion 210 of the marine manoeuvring system 206. The illustrated embodiment shows the acoustic wave generator portion 244 connected to the second end body 218 at the acoustic wave generator connecting portion of the second body 218.

[00135] In some embodiments, the acoustic wave generator 246 may directly connect to the marine manoeuvring system 206. That is, some embodiments may not include the keel 248.

[00136] In the illustrated embodiment, the marine manoeuvring system 206 is connected to the hull 202. In this configuration, the second end portion 210 of the marine manoeuvring system 206 is further away from the hull 202 than the first end portion 208 of the marine manoeuvring system 206. The acoustic wave generator portion 244 is therefore further away from the hull 202 than the first end portion 208 of the marine manoeuvring system 206. Similarly, the acoustic wave generator portion 244 is further away from the hull 202 than the second end portion 210 of the marine manoeuvring system 206. In the illustrated embodiment, the acoustic wave generator 246 is further away from the hull 202 than the first end portion 208 of the marine manoeuvring system 206. The acoustic wave generator 246 is further away from the hull 202 than the second end portion 210 of the marine manoeuvring system 206. The acoustic wave generator 246 is further away from the hull 202 than the keel 248.

[00137] The acoustic wave generator 246 is disposed on an opposite side of the second end body 218 as the manoeuvring elements 224. The acoustic wave generator 246 is disposed on an opposite side of the manoeuvring elements 224 as the hull 202.

[00138] The hydrographic surveying vessel 200 comprises one or more vessel tow mounting portions 254. The illustrated embodiment comprises a plurality of vessel tow mounting portions 254. In particular, the illustrated hydrographic surveying vessel 200 comprises four vessel tow mounting portions 254. The marine manoeuvring system 206 comprises one or more of the vessel tow mounting portions 254. In the illustrated embodiment, the first end portion 208 of the marine manoeuvring system 206 comprises a number of the vessel tow mounting portions 254. In particular, the first end portion 208 of the marine manoeuvring system 206 comprises two of the vessel tow mounting portions 254. The second end portion 210 of the marine manoeuvring system 206 comprises a number of the vessel tow mounting portions 254. In particular, the second end portion 210 of the marine manoeuvring system 206 comprises two of the vessel tow mounting portions 254.

[00139] The hydrographic surveying vessel 200 comprises a towing connector assembly 256. The towing connector assembly 256 may be referred to as a bridle. The towing connector assembly 256 comprises a towing connector 258. The towing connector 258 comprises one or more towing connector bodies. In the illustrated embodiment, the towing connector 258 comprises a plurality of connected towing connector bodies. Each of the towing connector bodies is rigid. One or more of the towing connector bodies is pivotally connected to one or more other towing connector body.

[00140] The towing connector 258 comprises a plurality of towing connector mounting portions 260. The towing connector 258 comprises a plurality of connector elements 262. One or more of the vessel tow mounting portions 254 enable connection of a respective connector element 262 thereto. One or more of the connector elements 262 is connected to one of the towing connector mounting portions 260. In particular, one or more of the connector elements 262 is connected to one of the towing connector mounting portions 260 at one end. In other words, one or more of the connector elements 262 is connected to one of the towing connector mounting portions 260 at a first end. One or more of the connector elements 262 is connected to one of the vessel tow mounting portions 254 at another end. In other words, one or more of the connector elements 262 is connected to one of the vessel tow mounting portions 254 at a second end. One or more of the connector elements 262 is both connected to the towing connector at its first end and a respective vessel tow mounting portion 254 of the hydrographic surveying vessel 200 at its second end.

[00141] The hydrographic surveying vessel 200 comprises a sensing system (not shown). The sensing system comprises a motion reference unit (MRU). The MRU is configured to generate motion data. The motion data is time series data indicative of a value of one or more motion parameters associated with the hydrographic surveying vessel 200. The motion data comprises

roll angle data. The roll angle data is indicative of a roll angle of the hydrographic surveying vessel 200 across a time window of operation of the hydrographic surveying vessel 200. The motion data comprises pitch angle data. The pitch angle data is indicative of a pitch angle of the hydrographic surveying vessel 200 across the time window of operation. The motion data comprises heave angle data. The heave angle data is indicative of a heave angle of the hydrographic surveying vessel 200 across the time window of operation.

[00142] The sensing system comprises a Global Navigation Satellite System (GNSS) module. The GNSS module is configured to generate GNSS data. The GNSS data is time series data. The GNSS data is indicative of a heading of the hydrographic surveying vessel 200 across the time window of operation of the hydrographic surveying vessel 200. The GNSS data is indicative of a longitude of the hydrographic surveying vessel 200 across the time window of operation. The GNSS data is indicative of a latitude of the hydrographic surveying vessel 200 across the time window of operation.

[00143] At least part of the sensing system may be housed within the hull 202. For example, the MRU may be housed within the hull 202. The GNSS module may be housed within the hull 202. One or more parts of the MRU and/or the GNSS module may extend outside the hull 202. For example, an antenna of the GNSS module may extend out of the hull 202. In the illustrated embodiment, the antenna of the GNSS module extends through the mast 281. At least part of the sensing system may be mounted externally to the hull 202. For example, the MRU may be mounted to an exterior of the hull 202. The GNSS module may be mounted to an exterior of the hull 202.

[00144] In some embodiments, one or more of the GNSS module, the MRU and the acoustic wave generator 246 are part of an integrated unit. That is, in some embodiments, the hydrographic surveying vessel 200 comprises a sensing unit that comprises the GNSS module, the MRU and the acoustic wave generator 246. This sensing unit may be referred to as the acoustic wave generator 246. That is, each of the components of the sensing unit may be part of a combined unit that is mounted to the second end body 218 of the marine manoeuvring system 206, as described with reference to the acoustic wave generator 246.

[00145] The hydrographic surveying vessel 200 is a powered vessel. That is, it is powered by one or more power sources. In some embodiments, the hydrographic surveying vessel 200 is electrically connected to a towing vessel. For example, one or more electrical cables may extend from the towing vessel, along the towing system used to tow the hydrographic surveying vessel 200, to the hydrographic surveying vessel 200. Power can be supplied to the hydrographic surveying vessel 200 using this electrical connection. In some embodiments, the hydrographic surveying vessel 200 comprises an onboard power source. This may be the same as, or similar to, power system 779 described below with reference to hydrographic surveying vessel 700. In some embodiments, both a direct electrical connection to the towing vessel and

an onboard power system may be used. In this case, the onboard power system may be used in the case where the direct connection fails.

[00146] Referring to Figure 2A, the hydrographic surveying vessel 200 comprises a cable 255. The illustrated cable 255 is a power and telemetry cable. The hydrographic surveying vessel 200 can communicate with a towing vessel via the cable 255. Similarly, the towing vessel can communicate with the hydrographic surveying vessel 200 via the cable 255. Further, the towing vessel can provide power to the hydrographic surveying vessel 200 via the cable 255. The cable extends from the housing 204, along a connector element 462, to a termination block 257. The termination block 257 is connected to a towing connector assembly 456. The termination block 257 is also connected to an armoured towing cable 259. The armoured towing cable 259 may facilitate the electrical and telemetric connection between the towing vessel and the hydrographic surveying vessel 200. For example, the cable 255 may extend along the length of the armoured towing cable.

Hydrographic Surveying Vessel 700

[00147] Figures 6 to 9 show another hydrographic surveying vessel 700, according to some embodiments of the present disclosure. One or more features of the hydrographic surveying vessel 700 may be the same as, or similar to, one or more features of the hydrographic surveying vessel 200 described with reference to Figures 2 to 5. One or more features of the hydrographic surveying vessel 700 may be different to one or more features of the hydrographic surveying vessel 200.

[00148] The hydrographic surveying vessel 700 comprises a hull 702. The hull 702 extends from a front 702A to a rear 702B. The hull 702 comprises a plurality of hull walls 704. The hull walls 704 define an internal volume of the hull 702. The hull 702 may comprise one or more hull openings that provide access to the internal volume of the hull 702 from outside the hull 702. The hull openings may be capped to inhibit water ingress during use of the hydrographic surveying vessel 700.

[00149] The hydrographic surveying vessel 700 comprises a manoeuvring system 706. The manoeuvring system 706 may be referred to as a marine manoeuvring system 706. Thus, the hydrographic surveying vessel 700 comprises a marine manoeuvring system 706. The marine manoeuvring system 706 extends between a first end portion 708 and a second end portion 710. The first end portion 708 is configured to be connected to the hull 702. In Figure 6, the first end portion 708 is connected to the hull 702. The marine manoeuvring system 706 comprises a first end body 712. In particular, the first end portion 708 comprises the first end body 712. The first end body 712 defines at least part of a first end of the marine manoeuvring system 706. In the illustrated embodiment, the first end body 712 defines the first end of the marine manoeuvring system 706.

[00150] The first end body 712 comprises a first end plate. The first end plate may be referred to as a first end sheet. The first end plate may be referred to as a first planar end portion. The first

end plate extends between a first end face and a second end face. In particular, the first end plate extends between a first end plate surface 714 and a second end plate surface 716. The first end face defines the first end plate surface 714. The first end plate surface 714 is an upper surface of the first end plate. The second end face defines the second end plate surface 716. The second end plate surface 716 is a lower surface of the first end plate. The second end plate surface 716 may be considered an inner surface of the first end body 712. A thickness of the first end plate is the distance between the first end plate surface 714 and the second end plate surface 716 at one or more points of the first end plate. The first end plate surface 714 is parallel to the second end plate surface 716. The thickness of the first end plate is less than a width of the first end plate and a length of the first end plate.

[00151] The marine manoeuvring system 706 comprises a second end body 718. In particular, the second end portion 710 comprises the second end body 718. The second end body 718 defines at least part of a second end of the marine manoeuvring system 706. In the illustrated embodiment, the second end body 718 defines the second end the marine manoeuvring system 706.

[00152] The second end body 718 comprises a second end plate. The second end plate may be referred to as a second end sheet. The second end plate may be referred to a second planar end portion. The second end plate extends between a first end face and a second end face. The first end face of the second end plate may be referred to as a third end face of the marine manoeuvring system 706. The second end face of the second end plate may be referred to as a fourth end face of the marine manoeuvring system 706. The second end plate extends between a third end plate surface 720 and a fourth end plate surface 722. The first end face of the second end plate defines the third end plate surface 720. The third end plate surface 720 is an upper surface of the first end plate. The third end plate surface 720 may be considered an inner surface of the second end body 718. The second end face of the second end plate defines the fourth end plate surface 722. The fourth end plate surface 722 is a lower surface of the second end plate. A thickness of the second end plate is the distance between the third end plate surface 720 and the fourth end plate surface 722 at one or more points of the second end plate. The third end plate surface 720 is parallel to the fourth end plate surface 722. The thickness of the second end plate is less than a width of the second end plate and a length of the second end plate.

[00153] The marine manoeuvring system 706 comprises a plurality of manoeuvring elements 724. The manoeuvring elements 724 may be referred to as marine manoeuvring elements. One or more of the manoeuvring elements 724 extends from a first manoeuvring element end 726 to a second manoeuvring element end 728. In the illustrated embodiment, each manoeuvring element 724 extends from a respective first manoeuvring element end 726 to a respective second manoeuvring element end 728.

[00154] One or more of the manoeuvring elements 724 is connected to the first end body 712 at the first manoeuvring element end 726. In the illustrated embodiment, each of the manoeuvring elements 724 is connected to the first end body 712 at its respective first manoeuvring element end 726. One or more of the manoeuvring elements 724 is connected to the second end body 718 at the second manoeuvring element end 728. In the illustrated embodiment, each of the manoeuvring elements 724 is connected to the second end body 718 at its respective second manoeuvring element end 728.

[00155] One or more of the manoeuvring elements 724 extends orthogonally with respect to the first end body 712. In particular, each manoeuvring element 724 extends orthogonally with respect to at least part of the second end plate surface 716 of the first end plate. One or more of the manoeuvring elements 724 extends orthogonally with respect to the second end body 718. In particular, each manoeuvring element 724 extends orthogonally with respect to at least part of the third end plate surface 720 of the second end plate.

[00156] The manoeuvring elements 724 comprise vanes. The manoeuvring elements 724 are configured to influence a heading of the hydrographic surveying vessel 700 in use. Each manoeuvring element 724 extends from a leading edge 725 to a trailing edge 727. A thickness of the manoeuvring elements 724 may be defined as a distance between a first face 729 of the respective manoeuvring element 724 and a second face 731 of the respective manoeuvring element 724.

[00157] In some embodiments, the thickness of one or more of the manoeuvring elements 724 is constant across the manoeuvring element 724. In the illustrated embodiment, the thickness of the manoeuvring elements 724 changes across their length. The thickness of each manoeuvring element 724 is relatively low compared to the orthogonal dimensions of the respective manoeuvring element 724.

[00158] One or more of the manoeuvring elements 724 curves along its length as it extends from its leading edge 725 to its trailing edge 727. It will be appreciated, however, that in some embodiments, one or more of the manoeuvring elements 724 are planar.

[00159] Referring to Figure 8, the marine manoeuvring system 706 comprises a fixed manoeuvring element 724A. The fixed manoeuvring element 724A comprises a vane. The vane extends between the first end body 712 and the second end body 718. The fixed manoeuvring element 724A may be said to be in the form of a vane. The fixed manoeuvring element 724 is fixedly connected to the first end body 712. For example, the fixed manoeuvring element 724A may be welded to the first end body 712. Alternatively, the fixed manoeuvring element 724A may be connected to the first end body 712 with a bolted connection, with it being understood that the fixed manoeuvring element 724A is not intended to be moved with respect to the first end body 712 between uses of the hydrographic surveying vessel 700. The fixed manoeuvring element 724 is fixedly connected to the second end body 718. For example, the fixed manoeuvring element 724A may be welded to the second end body 718. Alternatively, the fixed

manoeuvring element 724A may be connected to the second end body 718 with a bolted connection, with it being understood that the fixed manoeuvring element 724A is not intended to be moved with respect to the second end body 718 between uses of the hydrographic surveying vessel 700.

[00160] A thickness of the fixed manoeuvring element 724A changes along its length. In particular, the thickness of the fixed manoeuvring element 724A increases along its length. That is, the thickness of the fixed manoeuvring element 724A increases as the fixed manoeuvring element 724A is traversed from its leading edge 725 towards its trailing edge 727. It will be appreciated that in some embodiments, the thickness of the fixed manoeuvring element 724A does not change along at least part of its length. That is, the thickness of the fixed manoeuvring element 724A may be constant along at least part of its length. The thickness of the fixed manoeuvring element 724A may be constant along its entire length.

[00161] The fixed manoeuvring element 724A curves along its length. The illustrated fixed manoeuvring element 724A curves along its entire length. The curve may be characterized by a radius of curvature. The curve may be characterized by a spline. The first face 729 of the fixed manoeuvring element 724A may curve along a first curve profile. The second face 731 may curve along a second curve profile. The first curve profile may be the same as the second curve profile. The first curve profile may be different from the second curve profile. It will be appreciated that in some embodiments, the fixed manoeuvring element 724A does not curve along at least part of its length. That is, the fixed manoeuvring element 724A may be straight along at least part of its length. The fixed manoeuvring element 724A may be straight along its entire length.

[00162] The illustrated marine manoeuvring system 706 comprises a plurality of fixed manoeuvring elements 724A. In particular, the illustrated marine manoeuvring system 706 comprises four fixed manoeuvring elements 724A.

[00163] The marine manoeuvring system 706 comprises a moveable manoeuvring element 724B. The moveable manoeuvring element 724B may be referred to as a pivotable manoeuvring element. The moveable manoeuvring element 724B is movably connected to the first end body 712. The moveable manoeuvring element 724B is movably connected to the second end body 718. The moveable manoeuvring element 724B is moveable between a first position and a second position.

[00164] The moveable manoeuvring element 724B comprises a first end plate 733 (see Figure 6). The first end plate 733 is at the first manoeuvring element end 726 of the moveable manoeuvring element 724B. The first end plate 733 comprises a first connection portion (not shown). The first connection portion is at a forward portion of the first end plate 733. The forward portion is at or near a forward end of the first end plate 733, in use. The first connection portion is in the form of a hole configured to receive a bolt. The first end plate 733 comprises a second connection portion (not shown). The second connection portion is at a rearward portion

of the first end plate 733. The rearward portion is at or near a rear end of the first end plate 733, in use. The second connection portion is in the form of a hole configured to receive a bolt. The moveable manoeuvring element 724B is connected to the first end body 712 via the first end plate 733. Specifically, this is a bolted connection that uses the first connection portion and the second connection portion.

[00165] The moveable manoeuvring element 724B comprises a second end plate 735 (see Figure 6). The second end plate 735 is at the second manoeuvring element end 728 of the moveable manoeuvring element 724B. The second end plate 735 comprises a first connection portion 737. The first connection portion 737 is at a forward portion 739 of the second end plate 735. The forward portion 739 is at or near a forward end of the second end plate 735, in use. The first connection portion 737 is in the form of a hole configured to receive a bolt. The second end plate 735 comprises a second connection portion 741. The second connection portion 741 is at a rearward portion 743 of the second end plate 735. The rearward portion 743 is at or near a rear end of the second end plate 735, in use. The second connection portion 741 is in the form of a hole configured to receive a bolt. The moveable manoeuvring element 724B is connected to the second end body 718 via the second end plate 735. Specifically, this is a bolted connection that uses the first connection portion 737 and the second connection portion 741.

[00166] The moveable manoeuvring element 724 comprises a vane 724C. The vane 724C extends between the first end plate 733 and the second end plate 735.

[00167] The second end body 718 comprises a forward connection portion. The forward connection portion is in the form of a hole. The hole of the first connection portion 737 of the moveable manoeuvring element 724B is aligned with the hole of the forward connection portion of the second end body 718. A bolt is extended therethrough to enable a connection between the components to be made at that point.

[00168] The second end body 718 comprises a plurality of rearward connection portions. The rearward connection portions are in the form of holes. In the illustrated embodiment, the second end body 718 comprises a first rearward connection portion (which is hidden behind a bolt of a bolted connection between the second end body 718 and the second end plate 735). The second end body 718 comprises a second rearward connection portion 745. The hole of the second connection portion 741 of the moveable manoeuvring element 724B is aligned with one of the holes of the rearward connection portions of the second end body 718, and a bolt is extended therethrough to enable a connection between the components to be made at that point. It will be understood that the particular rearward connection portion that is used for the connection will influence an angle 749 that the moveable manoeuvring element 724B makes with a longitudinal axis 747 of the marine manoeuvring system 206. That is, a part of the length of the moveable manoeuvring element 724B makes a first angle 249, with respect to the longitudinal axis 747, when the moveable manoeuvring element 724B is connected to the

second end body 718 using the first rearward connection portion. That part of the length of the moveable manoeuvring element 724B makes a second angle, with respect to the longitudinal axis 747, when the moveable manoeuvring element 724B is connected to the second body 718 using the second rearward connection portion. The second angle is different to the first angle. In this way, the hydrodynamic characteristics of the marine manoeuvring system 206 can be adjusted between uses. Specifically, the moveable manoeuvring element 724B is pivotable about a pivot axis. The pivot axis is at or towards a forward point of the moveable manoeuvring element 724B. The pivot axis is orthogonal to the longitudinal axis 747. The pivot axis extends from the first end body 712 towards the second end body 718.

[00169] It will be appreciated that the first end body 712 also includes equivalent forward and rearward connection portions. While the forward and rearward connection portions are described to be in the form of holes that facilitate a bolted connection, it will be appreciated that they may take other forms that also enable movement of the moveable manoeuvring elements 724B between uses.

[00170] In some embodiments, the angle 749 that a moveable manoeuvring element 724B makes with respect to the longitudinal axis 747 is actively controlled. For example, an actuator may control the movement of the moveable manoeuvring element 724B. That is, the marine manoeuvring system 706 may comprise an actuator that is configured to actuate the moveable manoeuvring element 724B. The actuator may move the moveable manoeuvring element 724B in use. For example, the actuator may cause the moveable manoeuvring element 724B to pivot about a forward point in use.

[00171] A thickness of the vane 724C of the moveable manoeuvring element 724B changes along its length. In particular, the thickness of the vane 724C of the moveable manoeuvring element 724B decreases along its length. That is, the thickness of the vane 724C of the moveable manoeuvring element 724B decreases as the vane 724C is traversed from its leading edge 725 towards its trailing edge 727. It will be appreciated that in some embodiments, the thickness of the vane 724C does not change along at least part of its length. That is, the thickness of the vane 724C may be constant along at least part of its length. The thickness of the vane 724C may be constant along its entire length.

[00172] The vane 724C of the moveable manoeuvring element 724B does not curve along its length. It will be appreciated that in some embodiments, the vane 724C may curve along its length. The curve may be characterized by a radius of curvature. The curve may be characterized by a spline. The first face 729 of the vane 724C may curve along a first curve profile. The second face 731 may curve along a second curve profile. The first curve profile may be the same as the second curve profile. The first curve profile may be different from the second curve profile.

[00173] The illustrated marine manoeuvring system 706 comprises a plurality of moveable manoeuvring elements 724B. In particular, the illustrated marine manoeuvring system 706

comprises four moveable manoeuvring elements 724B. The moveable manoeuvring element 724B of Figure 8 are each shown in their first position.

[00174] Each moveable manoeuvring element 724B is paired with a corresponding fixed manoeuvring element 724A. The marine manoeuvring system 706 may therefore be said to comprise a plurality of manoeuvring element pairs 751. More broadly, the marine manoeuvring system 706 comprises a pair of manoeuvring elements comprising a leading manoeuvring element and a trailing manoeuvring element. The leading manoeuvring element is aligned with the trailing manoeuvring element. In the illustrated embodiment, the leading manoeuvring element is a fixed manoeuvring element 724A. The trailing manoeuvring element is a moveable manoeuvring element 724B.

[00175] The leading edge 725 of moveable manoeuvring element 724B is adjacent to the trailing edge 727 of a corresponding fixed manoeuvring element 724A. In other words, the fixed manoeuvring elements 724A may be considered leading manoeuvring elements. The moveable manoeuvring elements 724B may be considered trailing manoeuvring elements. In this way, the manoeuvring element pairs 751 can each emulate a longer manoeuvring element in use.

[00176] The manoeuvring element pairs 751 are arranged in a cascade, with a fluid gap being provided between adjacent manoeuvring element pairs 751. The curvature of one or more of the manoeuvring element pairs 751, their sub-components, and/or an angle that one or more of the manoeuvring elements 224 is disposed at relative to a longitudinal direction 747 of the hull 702 can impact the extent to which the marine manoeuvring system 706 influences the heading of the hydrographic surveying vessel 700.

[00177] The moveable manoeuvring elements 724B are described herein as being pivotable about a pivot axis. The pivot axis is at or near a forward portion of the moveable manoeuvring elements 724B. That is, the pivot axis is at or near a leading edge 725 of the vane 724C. It will be appreciated that in some embodiments, the moveable manoeuvring elements 724B may pivot about a pivot axis that is at or near a rearward edge 727 of the moveable manoeuvring element 724B. That is, the pivot axis may be at or near the trailing edge of the vane 724C.

[00178] In some embodiments, the trailing manoeuvring elements are fixed manoeuvring elements. That is, in some embodiments, the moveable manoeuvring elements 724B, that are described as moveable herein, may be fixed with respect to the first end body 212 and/or the second end body 218.

[00179] In some embodiments, the leading manoeuvring elements are moveable. That is, in some embodiments, the fixed manoeuvring elements 724A, that are described as fixed herein, are moveable.

[00180] In this case, the leading manoeuvring elements may pivot about a pivot axis that is at or near a leading edge thereof. Alternatively, the leading manoeuvring elements may pivot about a pivot axis that is at or near a trailing edge thereof.

[00181] In some embodiments, one or more of the fixed manoeuvring elements 724A may comprise a first end plate. The first end plate may be like that described with respect to the moveable manoeuvring elements 724B. One or more of the fixed manoeuvring elements 724A may comprise a second end plate. The second end plate may be like that described with respect to the moveable manoeuvring elements 724B. The fixed manoeuvring elements 724A each comprise a vane. The vane may extend between the first end plate and the second end plate.

[00182] The first end portion 708 comprises a hull connecting portion 730. In particular, the first end body 712 comprises the hull connecting portion 730. The hull connecting portion 730 enables the hull 702 to be connected to the first end portion 708 of the marine manoeuvring system 706. A hull connection system 232 is mounted to the hull connecting portion 730. The illustrated first end portion 708 comprises a plurality of hull connecting portions 730. Specifically, it comprises three hull connecting portions 730. The hull connecting portions 730 are spaced across the length of the first end portion 708.

[00183] The hull 702 is connected to the marine manoeuvring system 706 using a plurality of hull connection systems 732. The illustrated hydrographic surveying vessel 700 comprises a hull connection system 732 for each hull connecting portion 730. In some embodiments, one or more of the hull connection systems 732 comprises a hull connection mechanism. The hull connection mechanism may be rigid. The hull connection mechanism connects the hull 702 to the marine manoeuvring system 706. The hull connection mechanism may comprise one or more rigid bodies, each configured to extend around at least a portion of the hull 702. One or more of the rigid bodies may connect to a respective hull connecting portion 730, thereby securing the hull 702 with respect to the marine manoeuvring system 706. In some embodiments, one or more of the hull connection systems 732 comprises a hull connection strap. Each hull connection strap cooperates with a respective hull connecting portion 730 to enable the hull 702 to be connected to the marine manoeuvring system 706. Each hull connection system 732 may comprise a strap securing system to secure a respective hull connection strap in place to retain the hull 702 to the marine manoeuvring system 706. A strap may be connected to a base 791 of the respective hull connection system 732. The base 291 is configured to be connected to the first end body 712.

[00184] A hull connection system 732 comprises a vessel lifting mount 734. The vessel lifting mount 734 is configured to enable the hydrographic surveying vessel 700 to be lifted on and off another vessel and/or a dock.

[00185] In some embodiments, the hull 702 may be connected to the marine manoeuvring system 706 using another type of connection. For example, the hull 702 may be connected to the marine manoeuvring system 706 using a bolted connection.

[00186] The hydrographic surveying vessel 700 comprises an acoustic wave generator 746 (see Figure 7). The acoustic wave generator 746 generates acoustic waves in a fluid around the

acoustic wave generator 746. In this case, the acoustic wave generator 746 is configured to generate acoustic waves in the water that surrounds the acoustic wave generator 746 in use.

[00187] The hydrographic surveying vessel 700 comprises an acoustic wave receiver. The acoustic wave receiver is configured to detect acoustic waves that are emitted by the acoustic wave generator 746 and reflected by a portion of the marine environment 764. The acoustic wave generator 746 may comprise the acoustic wave receiver.

[00188] The acoustic wave generator 746 comprises a multibeam echosounder. In the illustrated embodiment, the acoustic wave generator 746 is in the form of a multibeam echosounder. In some embodiments, the acoustic wave generator 746 may comprise, or be in the form of, a single beam echosounder. In some embodiments, the acoustic wave generator 746 may comprise, or be in the form of, a side scan sonar system.

[00189] In some embodiments, the acoustic wave generator 746 is mounted directly to the marine manoeuvring system 706. For example, the acoustic wave generator 746 may be connected to the second end body 718 of the marine manoeuvring system 706. This may be a bolted connection. The second end body 718 may be said to be configured to be connected to the acoustic wave generator 746.

[00190] In some embodiments, the hydrographic surveying vessel 700 comprises an acoustic wave generator portion 744. The acoustic wave generator portion 744 is configured to be mounted to the second end 710 of the marine manoeuvring system 706. In particular, the acoustic wave generator portion 744 is configured to be mounted to the second end body 218. In other words, the second end 710 of the marine manoeuvring system 706 is configured to be connected to the acoustic wave generator portion 744. In particular, the second end body 218 of the marine manoeuvring system 706 is configured to be connected to the acoustic wave generator portion 744. This is the case in the illustrated embodiment. The acoustic wave generator portion 744 comprises the acoustic wave generator 746. The acoustic wave generator portion 744 may comprise one or more other components. For example, the acoustic wave generator portion 744 comprises a frame 793. The acoustic wave generator 746 may be mounted to the frame 793. The frame 793 may be mounted to the marine manoeuvring system 706. For example, the frame 793 may be mounted to the second end body 718 of the marine manoeuvring system 706. The frame 793 may be shaped to protect the acoustic wave generator 746. For example, the frame 793 may comprise a shroud. The shroud may be configured to protect the acoustic wave generator 746.

[00191] Where the acoustic wave generator 746 is described to be connected to the marine manoeuvring system 706 herein, it will be appreciated that in some embodiments, this may be a direct connection. For example, the acoustic wave generator 746 may be bolted to the second end body 718. That is, the acoustic wave generator 746 may be directly connected to the marine manoeuvring system 706.

[00192] It will also be appreciated that in some embodiments, the acoustic wave generator 746 may be connected to the marine manoeuvring system 706 using an indirect connection. For example, the acoustic wave generator 746 may be connected to the marine manoeuvring system 706 via one or more intermediate components. The intermediate component may be a part of the acoustic wave generator portion 744, where present. For the purposes of this disclosure, the acoustic wave generator 746 is considered to be connected to the marine manoeuvring system 706 when connected via one or more intermediate components.

[00193] In some embodiments, a flange connector may be connected to the second end body 718 at one end, and extend away from the second end body 718. That is, the flange connector may extend from the second end body 718. The flange connector may extend away from the first end body 712. That is, the flange connector may extend downwards. The acoustic wave generator portion 744 may be said to comprise the flange connector. The flange connector comprises a flange. The acoustic wave generator 746 is configured to connect to the flange of the flange connector. The acoustic wave generator 746 may comprise a flange. The flange of the acoustic wave generator 746 may be connected to the flange of the flange connector. This may be done, for example, using bolted connections. It will be appreciated that one or more of the acoustic wave generators described herein with reference to other vessels may be connected to other component(s) of the respective vessels (for example, the respective marine manoeuvring system) via a flange connector as described here.

[00194] As described herein, the hydrographic surveying vessel 700 comprises the frame 793. In some embodiments, the acoustic wave generator portion 744 comprises the frame 793. The frame 793 is mounted to the second end body 718 of the marine manoeuvring system 706. The acoustic wave generator 746 may connect to the frame 793. The frame 793 may connect to the marine manoeuvring system 706. In this way, the acoustic wave generator 746 may be connected to the second end body 718 via the frame 793. The acoustic wave generator 746 will also be considered to be connected to the marine manoeuvring system 706 in such cases.

[00195] Referring to Figure 7, the frame 793 comprises a number of frame members. The frame 793 comprises one or more leading frame members 793A. The leading frame members 793A are at a leading end of the frame 793. The leading frame members 793A are connected to the marine manoeuvring system 706 at one end and another frame member at another end. The frame 793 comprises one or more intermediate frame members 793B. The intermediate frame members 793B are connected to the marine manoeuvring system 706 at one end and another frame member at another end. The frame 793 comprises one or more trailing frame members 793C. The trailing frame members 793C are connected to the marine manoeuvring system 706 at one end and another frame member at another end. The intermediate frame members 793B are between the leading frame members 793A and the trailing frame members 793C. The frame 793 comprises one or more longitudinal frame members 793D. The longitudinal frame members 793D extend in a direction that is generally

parallel to the longitudinal axis 747. One or more of the leading frame members 793A is connected to a longitudinal frame member 793D at an end of the respective leading frame member 793A. This is the other end, compared to that which is connected to the marine manoeuvring system 706. One or more of the intermediate frame members 793B is connected to a longitudinal frame member 793D at an end of the respective intermediate frame member 793B. This is the other end, compared to that which is connected to the marine manoeuvring system 706. One or more of the trailing frame members 793C is connected to a longitudinal frame member 793D at an end of the respective trailing frame member 793C. This is the other end, compared to that which is connected to the marine manoeuvring system 706. The frame 793 may comprise one or more other components. For example, the frame 793 may comprise a shroud. The shroud may be configured to protect at least part of the acoustic wave generator 746.

[00196] In the illustrated embodiment, the marine manoeuvring system 706 is connected to the hull 702. In this configuration, the second end portion 710 of the marine manoeuvring system 706 is further away from the hull 702 than the first end portion 708 of the marine manoeuvring system 706. That is, the second end body 718 is further away from the hull 702 than the first end body 712. The acoustic wave generator portion 744 is therefore further away from the hull 702 than the first end portion 708 of the marine manoeuvring system 706.

Similarly, the acoustic wave generator portion 744 is further away from the hull 702 than the second end portion 710 of the marine manoeuvring system 706. In the illustrated embodiment, the acoustic wave generator 746 is further away from the hull 702 than the first end portion 708 of the marine manoeuvring system 706. The acoustic wave generator 746 is further away from the hull 702 than the second end portion 710 of the marine manoeuvring system 706. The acoustic wave generator 746 is further away from the hull 702 than the first end body 712 of the marine manoeuvring system 706. The acoustic wave generator 746 is further away from the hull 702 than the second end body 718 of the marine manoeuvring system 706.

[00197] The acoustic wave generator 746 is disposed on an opposite side of the second end body 718 to the manoeuvring elements 724. The acoustic wave generator 746 is disposed on an opposite side of the manoeuvring elements 724 to the hull 702.

[00198] The acoustic wave generator 746 is mounted to the marine manoeuvring system 706 towards a leading end 736 of the marine manoeuvring system 706. The acoustic wave generator 746 is mounted towards a leading end 738 of the second end portion 718 of the marine manoeuvring system 706. In particular, the acoustic wave generator 746 is mounted to the marine manoeuvring system 706 such that it is closer to the leading end 736 of the marine manoeuvring system 706 than a trailing end of the marine manoeuvring system 706. The acoustic wave generator 746 is mounted closer to the leading end 738 of the second end body 718 than the trailing end of the second end body 718. In some embodiments, the acoustic wave generator 746 is mounted to the second end body 718 within a front third of the second end

body 718. In some embodiments, the acoustic wave generator 746 is mounted to the second end body 718 within a front quarter of the second end body 718. In some embodiments, at least some of the acoustic wave generator 746 may be forward of the leading end 738 of the second end body 718.

[00199] Mounting the acoustic wave generator 746 towards the leading end 736 of the marine manoeuvring system 706 provides a number of advantages. For example, mounting the acoustic wave generator 746 in this way may reduce the impact that turbulence induced in the water around the acoustic wave generator 746 by the marine manoeuvring system 706 has on the acoustic waves emitted and/or detected by the acoustic wave generator 746.

[00200] The hydrographic surveying vessel 700 comprises one or more vessel tow mounting portions 754. The illustrated embodiment comprises a plurality of vessel tow mounting portions 754. In particular, the illustrated hydrographic surveying vessel 700 comprises four vessel tow mounting portions 754. The marine manoeuvring system 706 comprises one or more of the vessel tow mounting portions 754. In the illustrated embodiment, the first end portion 708 of the marine manoeuvring system 706 comprises one or more of the vessel tow mounting portions 754. In particular, the first end portion 708 of the marine manoeuvring system 706 comprises two of the vessel tow mounting portions 754. The vessel tow mounting portions 754 are off-axis with respect to another portion of the first end portion 708. The vessel tow mounting portions 754 may be bent such that they are off-axis. The second end portion 710 of the marine manoeuvring system 706 comprises a number of the vessel tow mounting portions 754. In particular, the second end portion 710 of the marine manoeuvring system 706 comprises two of the vessel tow mounting portions 754. The vessel tow mounting portions 754 are off-axis with respect to another portion of the second end portion 710. The vessel tow mounting portions 754 may be bent such that they are off-axis.

[00201] In some embodiments, one or more parts of the marine manoeuvring system 706 are coated with an anti-fouling paint. The entire marine manoeuvring system 706 may be coated with the anti-fouling paint.

[00202] Referring to Figure 7, the hydrographic surveying vessel 200 comprises a sensing system 771. At least part of the sensing system 771 is housed in the hull 702. The sensing system 771 comprises a motion reference unit (MRU). The MRU is configured to generate motion data. The motion data is time series data indicative of a value of one or more motion parameters associated with the hydrographic surveying vessel 700. The motion data comprises roll angle data. The roll angle data is indicative of a roll angle of the hydrographic surveying vessel 700 across a time window of operation of the hydrographic surveying vessel 700. The motion data comprises pitch angle data. The pitch angle data is indicative of a pitch angle of the hydrographic surveying vessel 700 across the time window of operation. The motion data comprises heave angle data. The heave angle data is indicative of a heave angle of the hydrographic surveying vessel 700 across the time window of operation.

[00203] The sensing system 771 comprises a Global Navigation Satellite System (GNSS) module 773. The GNSS module 773 is configured to generate GNSS data. The GNSS data is time series data. The GNSS data is indicative of a heading of the hydrographic surveying vessel 700 across the time window of operation of the hydrographic surveying vessel 700. The GNSS data is indicative of a longitude of the hydrographic surveying vessel 700 across the time window of operation. The GNSS data is indicative of a latitude of the hydrographic surveying vessel 700 across the time window of operation.

[00204] The illustrated sensing system 771 comprises a plurality of GNSS modules 773. In particular, the sensing system 771 comprises two GNSS modules 773. The GNSS modules 773 may be spatially separated. That is, the GNSS modules 773 may be mounted at different parts of the hydrographic surveying vessel 700. For example, one GNSS module 773 may be mounted towards a leading edge of the hydrographic surveying vessel 700. Another GNSS module 773 may be mounted towards a trailing edge of the hydrographic surveying vessel 700. Alternatively, one GNSS module 273 may be mounted on a first lateral side of the hydrographic surveying vessel 700. The other GNSS module 273 may be mounted on a second lateral side of the hydrographic surveying vessel 700.

[00205] At least part of the sensing system 771 may be housed within the hull 702. For example, the MRU may be housed within the hull 702. The GNSS module 773 may be housed within the hull 702. One or more parts of the MRU and/or the GNSS module 773 may extend outside the hull 702. For example, an antenna of the GNSS module 773 may extend out of the hull 702. At least part of the sensing system 771 may be mounted externally to the hull 202. For example, the MRU may be mounted to an exterior of the hull 702. The GNSS module 773 may be mounted to an exterior of the hull 702.

[00206] The hydrographic surveying vessel 700 comprises an acoustic wave generator controller 775. The acoustic wave generator controller 775 is housed within the hull 702. The acoustic wave generator controller 775 is configured to communicate with the acoustic wave generator 746. That is, the acoustic wave generator controller 775 is in communication with the acoustic wave generator 746. The acoustic wave generator controller 775 controls the acoustic wave generator 746. This control is enabled by the acoustic wave generator controller 775 being in communication with the acoustic wave generator 746.

[00207] The hydrographic surveying vessel 700 comprises a network interface 777. The network interface 777 is configured to enable the hydrographic surveying vessel 700 to communicate with other computing devices using one or more communication networks. The hydrographic surveying vessel 700 is configured to communicate with other computing devices using a communication network. The hydrographic surveying vessel 700 is configured to transmit data using the communication network.

[00208] The network interface 777 comprises a combination of network interface hardware and network interface software suitable for establishing, maintaining and facilitating communication

over a relevant communication channel. Examples of a suitable communication network include a cloud server network, a wired or wireless internet connection, a wireless local area network (WLAN) such as Wi-Fi (IEEE 82.15.1) or Zigbee (IEEE 802.15.4), a wireless wide area network (WWAN) such as cellular 4G LTE and 5G or another cellular network connection, dedicated short-range communications (DSRC) (e.g. IEEE 802.11p), low power wide area networks (LPWAN) such as SigFox and Lora, Bluetooth™ or other near field radio communication, and/or physical media such as a Universal Serial Bus (USB) connection. The network interface 777 may enable the hydrographic surveying vessel 700 to communicate with the towing vessel via a wired connection that passes along the towing system. In Figure 7, it is illustrated as a wireless system.

[00209] The hydrographic surveying vessel 700 comprises a power system 779. The power system 779 is housed within the housing 702. The illustrated power system 779 comprises a plurality of batteries. The power system 779 powers one or more components of the hydrographic surveying vessel 700. For example, the power system 779 may power the motion reference unit, the GNSS system 773, the acoustic wave generator controller 775, the network interface 777 and/or the acoustic wave generator 746. In some embodiments, at least some of the power system 779 may be mounted outside the housing.

[00210] In some embodiments, the power system 779 comprises a direct electrical connection to a towing vessel. This direct electrical connection may be the same as, or similar to, the electrical connection described with reference to the cable 255 of hydrographic surveying vessel 200.

[00211] The hydrographic surveying vessel 700 comprises a computing device (not shown). The computing device comprises at least one processor. The computing device comprises memory. The memory stores program instructions. The memory may comprise or be in the form of one or more non transitory computer readable medium. The at least one processor is configured to execute the program instructions. The computing device is configured to communicate with one or more of the other systems described herein. For example, the computing device is configured to communicate with one or more of the acoustic wave generator controller 775, the acoustic wave generator 746, the acoustic wave receiver, the power system 779, the motion reference unit, the sensing system 771, the GNSS module 773 and the network interface 777. The computing device may control, or enable control of at least one of the acoustic wave generator controller 775, the acoustic wave generator 746, the acoustic wave receiver, the power system 779, the motion reference unit, the sensing system 771, the GNSS module 773 and the network interface 777. The computing device may store data generated by, or using, at least one of the acoustic wave generator controller 775, the acoustic wave generator 746, the acoustic wave receiver, the power system 779, the motion reference unit, the sensing system 771, the GNSS module 773 and the network interface 777. In some embodiments, the computing device comprises the acoustic wave generator

controller 775. For example, the acoustic wave generator controller 775 may be a software module that is executed by the computing device.

[00212] As described herein, the acoustic wave generator controller 775 communicates with the acoustic wave generator 746. The acoustic wave generator controller 775 communicates with the acoustic wave generator 746 using an acoustic wave generator communication system. The acoustic wave generator communication system is a wired communication system. That is, the acoustic wave generator controller 775 communicates with the acoustic wave generator 746 using one or more cables 761. The one or more cables 761 enable the transmission of data from the acoustic wave generator controller 775 to the acoustic wave generator 746. The one or more cables 761 enable the transmission of power from the acoustic wave generator controller 775 to the acoustic wave generator 746. The one or more cables 761 enable the transmission of data from the acoustic wave generator 746 to the acoustic wave generator controller 775. The one or more cables 761 may enable the transmission of power from the acoustic wave generator 746 to the acoustic wave generator controller 775. As described herein, the acoustic wave generator 746 is on an opposite side of the marine manoeuvring system 706 than the housing 702. As a result, the acoustic wave generator 746 is on an opposite side of the marine manoeuvring system 706 than the acoustic wave generator controller 775. The one or more cables 761 therefore transit the marine manoeuvring system 706.

[00213] The one or more cables 761 and the associated connections at the ends of the cables 761 can be fragile. As a result, protecting the one or more cables 761 from forces that may be exerted on them by the water through which the marine manoeuvring vessel 700 travels, as it moves, can be important. Doing so can increase the life of the marine manoeuvring vessel 700 and/or the acoustic wave generator 746.

[00214] The housing 702 comprises an opening that is configured to enable the one or more cables 761 to pass through. The interface between the one or more cables 761 and the housing 702 is waterproofed. For example, the housing 702 may comprise a cable gland. The cable gland may be configured to enable the one or more cables 761 to pass from inside the housing 702 to outside the housing 702, whilst inhibiting water ingress. The one or more cables 761 may pass through the base 791. The base 791 may therefore comprise a hole through which the one or more cables 761 can pass.

[00215] The marine manoeuvring system 706 defines a channel. The channel is configured to receive a cable 761. That is, the marine manoeuvring system 706 defines a channel that is configured to receive the one or more cables 761.

[00216] The first end body 712 defines a first part of the channel. That is, the first end body 712 defines a first portion of the channel. The first part of the channel extends from the first end face of the first end body 712 to the second end face of the first end body 712. In particular, the first part of the channel extends from an opening on the first end face of the first end body 712

to an opening on the second end face of the first end body 712. The first part of the channel extends through the first end body 712.

[00217] A marine manoeuvring element 724 defines at least part of the channel. In particular, a marine manoeuvring element 724 defines an intermediate part of the channel. The part of the channel that is defined by the marine manoeuvring element 724 extends from the first manoeuvring element end 726 of the manoeuvring element 724 to the second manoeuvring element end 728 of the manoeuvring element 724. In particular, the intermediate part of the channel extends from an opening in the first manoeuvring element end 726 of the manoeuvring element 724 to an opening in the second manoeuvring element end 728 of the manoeuvring element 724.

[00218] The second end body 718 defines a second part of the channel. That is, the second end body 718 defines a second portion of the channel. The second part of the channel extends from the first end face of the second end body 718 to the second end face of the second end body 718. In particular, the second part of the channel extends from an opening on the first end face of the second end body 718 to an opening on the second end face of the second end body 718. The second part of the channel extends through the second end body 718.

[00219] The first part of the channel is coaxial with the intermediate part of the channel. That is, the hole defined through the first end body 712 is coaxial with the hole through the marine manoeuvring element 724. The intermediate part of the channel is coaxial with the second part of the channel. That is, the hole defined through the second end body 718 is coaxial with the hole through the marine manoeuvring element 724.

[00220] In some embodiments, a fixed manoeuvring element 724A defines the intermediate part of the channel. Thus, the intermediate part of the channel extends from the first manoeuvring element end 726 of the fixed manoeuvring element 724A to the second manoeuvring element end 728 of the fixed manoeuvring element 724A.

[00221] In some embodiments, a moveable manoeuvring element 724B defines the intermediate part of the channel. Thus, the intermediate part of the channel extends from the first manoeuvring element end 726 of the moveable manoeuvring element 724B to the second manoeuvring element end 728 of the moveable manoeuvring element 724B.

[00222] In some embodiments, a plurality of the moveable manoeuvring elements 724B and the fixed manoeuvring elements 724A comprise intermediate parts of respective channels. Further, the first end body 212 and/or the second end body 218 may comprise corresponding first parts and second parts of channels. Thus, a plurality of the manoeuvring elements 724, together with the first end body 712 and the second end body 718 may define a plurality of channels. Each channel may be configured to receive one or more of the one or more cables 761.

[00223] It will be appreciated that other configurations are also possible. For example, the marine manoeuvring system may comprise an elongate element that extends between the first

end body 712 and the second end body 718. The elongate element may be a hollow element, defining at least part of a channel through which the one or more cables 761 can pass.

[00224] Advantageously, the provision of a channel through the marine manoeuvring system 706 allows the one or more cables 761 to extend from the acoustic wave generator controller 775 to the acoustic wave generator 746 with reduced environmental exposure. Although the channel may be filled with water, the extent to which the one or more cables 761 are exposed to outside forces can be reduced. The cables 761 themselves can be waterproofed. The provision of the channel through a marine manoeuvring element 724 allows the one or more cables 761 to transit the marine manoeuvring system 706 without adversely affecting the hydrodynamic performance of the marine manoeuvring system 706. Thus, any impacts on the efficiency of the marine manoeuvring system 706 that may be caused by the one or more cables 761 can be reduced.

[00225] In some embodiments, one or more of the GNSS module, the MRU, the computing device, the network interface and the acoustic wave generator 746 are part of an integrated unit. That is, in some embodiments, the hydrographic surveying vessel 700 comprises a sensing unit that comprises one or more of the GNSS module, the MRU, the computing device, the network interface and the acoustic wave generator 746. This sensing unit may be referred to as the acoustic wave generator 746. That is, each of the components of the sensing unit may be part of a combined unit that is mounted to the second end body 718 of the marine manoeuvring system 706, as described with reference to the acoustic wave generator 746.

[00226] Therefore, the advantages described with reference to the one or more cables 761 that connect the acoustic wave generator controller and the acoustic wave generator 746 could also be realised in the case where an integrated sensor unit is positioned on the underside of the marine manoeuvring system 706. This integrated sensor unit could comprise any number of sensors. It wouldn't necessarily even need to include an acoustic wave generator 746 to realise the benefits provided by the channel described herein.

[00227] Figures 9A to 9C show an alternative embodiment of the hydrographic surveying vessel 700 of Figures 6 to 9. A number of the features of the hydrographic surveying vessel 700A of Figures 9A to 9C are the same as the hydrographic surveying vessel 700 described with reference to Figures 6 to 9. Features of hydrographic surveying vessel 700A of Figures 9A to 9C that are similar to, or the same as those of the hydrographic surveying vessel 700 of Figures 6 to 9 are denoted with the same reference numerals. For example, the hydrographic surveying vessel 700 of Figures 9A to 9C comprises a hull 702. The hull 702 extends from a front 702A to a rear 702B. The front 702A may be referred to as a leading end of the hull 702. The hull 702 is connected to a marine manoeuvring system 706. An acoustic wave generator 746 is connected to the marine manoeuvring system 706. A frame 793 is also connected to the marine manoeuvring system 706. One or more of these features of the

hydrographic surveying vessel 700A may be the same as, or similar to, the corresponding feature described for the hydrographic surveying vessel 700 of Figures 6 to 9.

[00228] A number of the features of the hydrographic surveying vessel 700A of Figures 9A to 9C are different to the features of the hydrographic surveying vessel 700 described with reference to Figures 6 to 9. The hydrographic surveying vessel 700A comprises a hull flange connector. In particular, the hydrographic surveying vessel 700A comprise a plurality of hull flange connectors 782A, B, C, D. The hull flange connectors 782A, B, C, D each comprise a hull flange. The hull flange connectors 782A, B, C, D each comprise a blind flange. The blind flanges are connected to the hull flanges to close the openings defined by the hull flanges. Gaskets may be positioned between the hull flanges and blind flanges to enable a watertight connection to be made. The hull flanges enable access to the interior of the hull 702. One or more of the blind flanges may comprise a cable passage portion. The cable passage portion is configured to enable a cable to pass therethrough. The cable passage portion is configured to maintain a watertight seal on the cable, to inhibit water ingress into the hull 702 whilst enabling the cable to pass out from inside the hull 702.

[00229] A number of containers are housed within the housing 702. The containers house electrical components of the hydrographic surveying vessel 700A. The containers are watertight. One or more of the containers may be in the form of a water-tight stainless steel container. The containers contain, in use, at least part of the acoustic wave generator controller 775, batteries and/or other electrical components housed in the housing 702. The containers protect the electrical components from water ingress. A container may enable one or more cables associated with the contained electrical components to exit the container without significant negative impact on the waterproofing of the container.

[00230] As described herein, the marine manoeuvring system 706 defines a channel. In the illustrated embodiment, the channel extends through the first end body 712. In other words, the first end body 712 defines a first part of the channel. A hole in the first end body 712 defines the first part of the channel. The hole in the first end body 712 is closer to a trailing end of the first end body 712 than a leading end of the first end body 712. At least part of the hole defining the first part of the channel is closer to the trailing end of the first end body 712 than each of the marine manoeuvring elements 724.

[00231] An elongate element 752 defines an intermediate part of the channel. The elongate element 752 is in the form of a hollow tube. The elongate element 752 is circular. The elongate element 752 extends between the first end body 712 and the second end body 718. In particular, the elongate element 752 extends from the first end body 712 to the second end body 718. A hollow core of the elongate element 752 defines the intermediate part of the channel. The intermediate part of the channel is coaxial with the first part of the channel. The elongate element 752 is closer to the trailing end of the marine manoeuvring system 706 than the leading end of the marine manoeuvring system 706. The elongate element 752 is closer to

the trailing end of the second end body 718 than the leading end of the second end body 718. At least part of the elongate element 752 is closer to the trailing end of the marine manoeuvring system 706 than each of the marine manoeuvring elements 724. At least part of the elongate element 752 is closer to the trailing end of the second end body 718 than each of the marine manoeuvring elements 724. In other words, at least part of the elongate element 752 is behind the marine manoeuvring elements 724. The elongate element 752 is laterally offset with respect to one of the marine manoeuvring elements 724. The elongate element 752 is laterally offset with respect to the rear-most marine manoeuvring element 724.

[00232] The channel may extend through the second body 718. In other words, the second body 718 may define a second part of the channel. The intermediate part of the channel is between the first part of the channel and the second part of the channel. The intermediate part of the channel is coaxial with the second part of the channel. The first part of the channel is coaxial with the second part of the channel. A hole in the second body 718 defines the second part of the channel. The hole in the second end body 718 is closer to the trailing end of the second end body 718 than the leading end of the second end body 718. At least part of the hole defining the second part of the channel is closer to the trailing end of the second end body 718 than each of the marine manoeuvring elements 724. In other words, at least part of the hole defining the second part of the channel is behind the marine manoeuvring elements 724.

[00233] As described herein, the acoustic wave generator controller 775 communicates with the acoustic wave generator 746 using one or more cables 761. Referring to Figure 9A, the one or more cables 761 extend out of the housing 702 and towards the channel. The one or more cables 761 extend through the channel, thereby connecting the acoustic wave generator controller 775 and the acoustic wave generator 746. The one or more cables 761 may extend along the second end body 718, from near the trailing end of the second end body 718, towards the leading end 738, in making this connection.

[00234] In some embodiments, rather than extending through the second end body 718, the channel may extend through a wall of the elongate element 752. That is, the channel may not comprise the second part that extends through the second end body 718. The elongate element 752 may define a side opening at or near the second end body 718. The side opening may be configured to receive the one or more cables 761 to enable the one or more cables 761 to span from the acoustic wave generator controller 775 to the acoustic wave generator 746.

[00235] A number of hydrodynamic elements 756 are connected to the elongate element 752 (see Figure 9C). The hydrodynamic elements 756 extend between the first end body 712 and the second end body 718. In particular, the hydrodynamic elements 756 extend from the first end body 712 to the second end body 718.

[00236] The hydrodynamic elements 756 act to improve the hydrodynamic characteristics of the elongate element 752. The hydrodynamic elements 756 form a V-shape at a rear of the elongate element 752. In other words, the hydrodynamic elements 756 form an aerofoil shape

at the rear of the elongate element 752. The hydrodynamic elements 756 act to reduce the drag of the elongate element 752. Part of each hydrodynamic element 756 is closer to the trailing end of the marine manoeuvring system 706 than the elongate element 752. The hydrodynamic elements 756 meet at a junction 758. The junction 758 is closer to the trailing end of the marine manoeuvring system 706 than the elongate element 752. The hydrodynamic elements 756 are connected to the elongate element 752. In the illustrated embodiment, the hydrodynamic elements 756 are welded to the elongate element 752.

[00237] By positioning the elongate element 752 behind the marine manoeuvring elements 724, and towards the trailing end of the marine manoeuvring system 706, adverse hydrodynamic effects of the elongate element 752 can be minimised.

[00238] While a number of features of the hydrographic surveying vessel 700A are described herein, it will be understood that one or more of these features may be applied to, or present in, one or more other embodiment of a hydrographic surveying vessel described herein. For example, the hydrographic surveying vessel 700 described with reference to Figures 6 to 9 may include the elongate element 752 mounted towards the trailing end of the marine manoeuvring system 706, described with reference to the hydrographic surveying vessel 700A of Figures 9A to 9C.

Hydrographic Surveying System 201

[00239] Figures 10 to 12 show a hydrographic surveying system 201 according to some embodiments of the present disclosure. In particular, Figures 10 to 12 show the hydrographic surveying system 201 in a marine environment 264. The hydrographic surveying system 201 may comprise the hydrographic surveying vessel 200 described with reference to Figures 2 to 5. The hydrographic surveying system 201 may comprise the hydrographic surveying vessel 700 described with reference to Figures 6 to 9. The hydrographic surveying system 201 comprises a second hydrographic surveying vessel 200B. One or more components of the second hydrographic surveying vessel 200B may be similar to, or the same as one or more components of the hydrographic surveying vessel 200. For example, one or more components of the second hydrographic surveying vessel 200B may be a mirror image of the equivalent component of the hydrographic surveying vessel 200. That is, one or more components of the second hydrographic surveying vessel 200B may be laterally inverted with respect to the equivalent component of the hydrographic surveying vessel 200.

[00240] One or more components of the second hydrographic surveying vessel 200B may be similar to, or the same as one or more components of the hydrographic surveying vessel 700. For example, one or more components of the second hydrographic surveying vessel 200B may be a mirror image of the equivalent component of the hydrographic surveying vessel 700. That is, one or more components of the second hydrographic surveying vessel 200B may be laterally inverted with respect to the equivalent component of the hydrographic surveying vessel 700. In this case, it will be understood that the hydrographic surveying vessel 700 may connect to the

towing system in a manner similar to, or the same as that described with respect to the hydrographic surveying vessel 200. That is, the hydrographic surveying vessel 700 may comprise a towing connector assembly like that described with reference to the hydrographic surveying vessel 200.

[00241] The second hydrographic surveying vessel 200B comprises a second hull. The second hydrographic surveying vessel 200B comprises a second marine manoeuvring system that is configured to be connected to the second hull. The second hydrographic surveying vessel 200B comprises a second acoustic wave generator. The second hydrographic surveying vessel 200B may comprise a second acoustic wave generator portion. The second acoustic wave generator portion may comprise a second keel. The second hydrographic surveying vessel 200B comprises a second towing connector assembly. The second towing connector assembly comprises a second towing connector. The second towing connector comprises a plurality of second towing connector mounting portions. The second towing connector assembly comprises a plurality of second connector elements.

[00242] A first end of the second marine manoeuvring system is connected to the second hull. A second end of the second marine manoeuvring system is connected to the second acoustic wave generator. A second end of the second marine manoeuvring system is connected to the second acoustic wave generator portion. The second end of the second marine manoeuvring system is further away from the second hull than the first end of the second marine manoeuvring system when the second marine manoeuvring system is connected to the second hull.

[00243] Each second connector element is connected to one of the second towing connector mounting portions. One or more of the second connector elements are connected to a respective second vessel tow mounting portion of the second hydrographic surveying vessel.

[00244] The hydrographic surveying system 201 comprises a towing vessel 203. The towing vessel 203 is configured to tow one or more parts of the hydrographic surveying system 201.

[00245] The hydrographic surveying system 201 comprises a towing system 205. The towing system 205 is connected to the hydrographic surveying vessel 200, 700 and the second hydrographic surveying vessel 200B, thereby operatively linking the hydrographic surveying vessel 200, 700 and the second hydrographic surveying vessel 200B.

[00246] The towing system 205 comprises a first towing element 207. The first towing element 207 is operably connected to the towing connector assembly 256 of the hydrographic surveying vessel 200, 700. In particular, the first towing element 207 is operably connected to the towing connector 258. The first towing element 207 may be connected to the towing connector 258 at one end of the first towing element 207. The first towing element 207 may engage with the towing connector 258 at a pulley. The first towing element 207 is operably connected to the towing vessel 203. In particular, the first towing element 207 is connected to the towing vessel 203 at an opposite end to the end at which it is connected to the hydrographic

surveying vessel 200, 700. The towing vessel 203 is therefore operably connected to the hydrographic surveying vessel 200, 700 via the first towing element 207. The first towing element 207 may be referred to as a first tow rope. The first towing element 207 may be in the form of a cable.

[00247] A communication line may run along the first towing element 207. In some embodiments, the communication line is integrated into the first towing element 207. The communication line enables data transfer between the hydrographic surveying vessel 200, 700 and the towing vessel 203. In particular, communication between the sensing system and the towing vessel 203 may be enabled via the communication line. Similarly, communication between the acoustic wave generator 246, 746 and the towing vessel 203 may be enabled via the communication line.

[00248] A length of the first towing element 207 may be adjustable. For example, the first towing element 207 may be connected to a winch of the towing vessel 203. The winch may be operable to adjust the length of the first towing element 207 that extends off the towing vessel 203 and therefore, the distance between the hydrographic surveying vessel 200, 700 and the towing vessel 203.

[00249] The towing system 205 comprises a second towing element 209. The second towing element 209 is operably connected to the towing connector assembly of the second hydrographic surveying vessel 200B. In particular, the second towing element 209 is operably connected to the towing connector of the second hydrographic surveying vessel 200B. The second towing element 209 may be connected to the towing connector at one end of the second towing element 209. The second towing element 209 may engage with the towing connector at a pulley. The second towing element 209 is operably connected to the towing vessel 203. In particular, the second towing element 209 is connected to the towing vessel 203 at an opposite end to the end at which it is connected to the second hydrographic surveying vessel 200B. The towing vessel 203 is therefore operably connected to the second hydrographic surveying vessel 200B via the first towing element 207. The hydrographic surveying vessel 200, 700 and the second hydrographic surveying vessel 200B are therefore also operably connected via the first towing element 207, the towing vessel 203 and the second towing element 209. The second towing element 209 may be referred to as a second tow rope. The second towing element 209 may be in the form of a cable.

[00250] A second communication line may run along the second towing element 209. In some embodiments, the second communication line is integrated into the second towing element 209. The second communication line enables data transfer between the second hydrographic surveying vessel and the towing vessel 203. In particular, communication between a sensing system of the second hydrographic surveying vessel and the towing vessel 203 may be enabled via the second communication line. Similarly, communication between the second acoustic wave generator and the towing vessel 203 may be enabled via the communication line.

[00251] A length of the second towing element 209 may be adjustable. For example, the second towing element 209 may be connected to a winch of the towing vessel 203. The winch may be operable to adjust the length of the second towing element 209 that extends off the towing vessel 203 and therefore, the distance between the second hydrographic surveying vessel and the towing vessel 203.

[00252] The towing system 205 comprises a third towing element 211. The third towing element 211 is operably connected to the towing connector assembly 256 of the hydrographic surveying vessel 200, 700. In some embodiments, the third towing element 211 is connected directly to the towing connector assembly 256. In some embodiments, the third towing element 211 is connected to the first towing element 207. The third towing element 211 may be connected to the first towing element 207 near where the first towing element 207 connects to the towing connector assembly 256.

[00253] The third towing element 211 is operably connected to the towing connector assembly of the second hydrographic surveying vessel 200B. In some embodiments, the third towing element 211 is connected directly to the towing connector assembly of the second hydrographic surveying vessel 200B. In some embodiments, the third towing element 211 is connected to the second towing element 209. The third towing element 211 may be connected to the second towing element 209 near where the second towing element 209 connects to the towing connector assembly of the second hydrographic surveying vessel 200B. Relative movement between the hydrographic surveying vessel 200, 700 and the second hydrographic surveying vessel 200B is constrained by the third towing element 211.

[00254] A third communication line may run along the third towing element 211. In some embodiments, the third communication line is integrated into the third towing element 211. The third communication line enables data transfer between two or more of the hydrographic survey vessel 200, 700, the second hydrographic surveying vessel 200B and the towing vessel 203.

[00255] A length of the third towing element 211 may be adjustable. For example, the third towing element 211 may be connected to a winch. The winch may be on the towing vessel 203 (e.g. an excess length of the third towing element 211 may run along one or both of the first towing element 207 and the second towing element 209, to the towing vessel 203). The winch may be operable to adjust the length of the third towing element 211 and therefore, the distance between the hydrographic surveying vessel 200, 700 second hydrographic surveying vessel 200B.

[00256] In operation, the towing vessel 203 moves across the marine environment 264 in a movement direction 266. The first towing element 207 and the second towing element 209 extend behind the towing vessel 203 as it moves. The towing vessel 203 tows the hydrographic surveying vessel 200, 700 as it moves. The towing vessel 203 tows the second hydrographic surveying vessel 200B as it moves.

[00257] The marine manoeuvring system 206 is configured to manoeuvre the hydrographic surveying vessel 200, 700 through the marine environment 264. In particular, the marine manoeuvring system 206 is configured to manoeuvre the hydrographic surveying vessel 200, 700 with respect to the towing vessel 203 as the hydrographic surveying vessel 200, 700 is towed by the towing vessel 203. The marine manoeuvring system 206 is configured to manoeuvre the hydrographic surveying vessel 200, 700 such that it is maintained in a lateral position with respect to the towing vessel 203 as it is towed by the towing vessel 203. In other words, the marine manoeuvring system 206 is configured to influence the heading of the hydrographic surveying vessel 200, 700.

[00258] The marine manoeuvring system 206 is configured to bias the hydrographic surveying vessel 200, 700 in a first direction 276 in response to movement through the water of the marine environment 264. The first direction 276 is a lateral direction. It may therefore be said that the marine manoeuvring system 206 is configured to laterally bias movement of the hydrographic surveying vessel 200, 700. In particular, the manoeuvring elements 224 are configured to bias the hydrographic surveying vessel 200, 700 in the first direction 276. The marine manoeuvring system 206 therefore influences the heading of the hydrographic surveying vessel 200, 700 such that the hydrographic surveying vessel 200, 700 is directed towards the lateral position with respect to the towing vessel 203 as it is towed by the towing vessel 203. When the hydrographic surveying vessel 200, 700 is being towed by the towing vessel 203, the first towing element 207 extends away from the towing vessel 203 at a towing angle 268. The towing angle 268 may be influenced by one or more of the speed of the towing vessel 203, the configuration of the marine manoeuvring system 206, the length of the first towing element 207, the length of the second towing element 209 and the length of the third towing element 211.

[00259] The second marine manoeuvring system is configured to manoeuvre the second hydrographic surveying vessel 200B through the marine environment 264. In particular, the second marine manoeuvring system is configured to manoeuvre the second hydrographic surveying vessel with respect to the towing vessel 203 as the second hydrographic surveying vessel is towed by the towing vessel 203. The second marine manoeuvring system is configured to manoeuvre the second hydrographic surveying vessel such that it is maintained in a second lateral position with respect to the towing vessel as it is towed by the towing vessel 203. In other words, the second marine manoeuvring system influences the heading of the second hydrographic surveying vessel 200B.

[00260] The second marine manoeuvring system is configured to bias the second hydrographic surveying vessel in a second direction 278 in response to movement through the water of the marine environment 264. The second direction 278 is a lateral direction. It may therefore be said that the second marine manoeuvring system is configured to laterally bias movement of the second hydrographic surveying vessel 200B. In particular, the second manoeuvring elements of the second marine manoeuvring system are configured to bias the

second hydrographic surveying vessel 200B in the second direction 278. The second direction 278 is different to the first direction 276. The second direction 278 may be an opposite direction to the first direction 276. The second marine manoeuvring system is configured to influence the heading of the second hydrographic surveying vessel 200B such that the second hydrographic surveying vessel 200B is maintained in the second lateral position with respect to the towing vessel 203 as it is towed by the towing vessel 203. When the second hydrographic surveying vessel 200B is being towed by the towing vessel 203, the second towing element 209 extends away from the towing vessel 203 at a second towing angle 268B. The second towing angle 268B may be influenced by one or more of the speed of the towing vessel 203, the configuration of the second marine manoeuvring system, the length of the first towing element 207, the length of the second towing element 209 and the length of the third towing element 211.

[00261] The towing vessel 203 itself may include an acoustic wave generator. Alternatively, the towing vessel 203 may tow an acoustic wave generator directly behind it (e.g. on another cable). This third acoustic wave generator may be on a third hydrographic surveying vessel (not shown) that is similar to, or the same as the hydrographic surveying vessel 200, 700 in one or more aspects. The towing vessel 203 may therefore be capable of performing a hydrographic survey of a respective swath using acoustic waves generated by the acoustic wave generator of the towing vessel 203. The swath of the towing vessel 203 may be referred to as a first swath 270. The first swath 270 is shown in Figure 12.

[00262] The acoustic wave generator 246, 746 of the hydrographic surveying vessel 200, 700 is also capable of enabling a hydrographic survey of a respective swath to be conducted using acoustic waves generated by the acoustic wave generator 246, 746. The acoustic wave generator 246, 746 emits acoustic waves that are reflected by the marine environment 264 and detected by the acoustic wave receiver of the towing vessel 203. As the hydrographic surveying vessel 200, 700 is maintained in the lateral position with respect to the towing vessel 203, the swath of the hydrographic surveying vessel 200, 700 is laterally offset with respect to the towing vessel 203. The swath of the hydrographic surveying vessel 200, 700 is also laterally offset with respect to the first swath. The swath of the hydrographic surveying vessel 200, 700 may be referred to as a second swath 272.

[00263] Similarly, the acoustic wave generator of the second hydrographic surveying vessel 200B is capable of enabling a hydrographic survey of a respective swath to be conducted using acoustic waves generated by the acoustic wave generator of the second hydrographic surveying vessel 200B. The second acoustic wave generator emits acoustic waves that are reflected by the marine environment 264 and detected by the acoustic wave receiver of the towing vessel 203. As the hydrographic surveying vessel 200B is maintained in the second lateral position with respect to the towing vessel 203, the swath of the second hydrographic surveying vessel 200B is laterally offset with respect to the towing vessel 203. The

swath of the second hydrographic surveying vessel is also laterally offset with respect to the first swath. The swath of the second hydrographic surveying vessel may be referred to as a third swath 274. The third swath 274 is laterally offset from the towing vessel 203 and/or the first swath 270 in an opposite direction to the second swath 272.

[00264] In some embodiments, there is a region of overlap 284 between the swath 270 of the towing vehicle 203 and the swath 272 of the hydrographic surveying vessel 200, 700. The extent of this overlap 284 is controllable by controlling the length of one or more of the first towing element 207, the second towing element 209 and the third towing element 211. This overlap 284 may also be controlled by controlling the physical configuration of the manoeuvring elements of the respective hydrographic surveying vessel. There may also be an overlap 286 between the swath 270 of the towing vehicle 203 and the swath 274 of the second hydrographic surveying vessel 200B.

[00265] The data collected as a result of each of the hydrographic surveying vessel 200, 700, the second hydrographic surveying vessel 200B and the towing vessel 203 having a respective acoustic wave generator can be combined into a single hydrographic survey data set. The total effective swath of the hydrographic surveying system 201 may be considered to be the distance between an outer lateral boundary 280 of the second swath (i.e. of the swath of the hydrographic surveying vessel 200, 700) and an outer lateral boundary 282 of the third swath (i.e. the swath of the second hydrographic surveying vessel). The total effective swath of the hydrographic surveying system is significantly larger than any of the individual swaths 270, 272, 274.

Advantages

[00266] The hydrographic surveying vessel 200, 700 described herein provides a number of significant advantages when compared to existing hydrographic surveying vessels. As described herein, the hydrographic surveying vessel 200, 700 may be used in tandem with a towing vessel 203 and one or more other hydrographic surveying vessels of the same or similar design, to significantly increase the total effective swath of a particular pass of the marine environment 246, 746. As shown in Figure 12, the use of the hydrographic surveying vessel 200, 700 provides a significant increase in the swath of a single pass of the towing vessel 203. In some embodiments, the hydrographic surveying vessel 200, 700 may enable a doubling of the swath of the towing vessel 203 (where the towing vessel 203 also includes its own associated acoustic wave generator). The hydrographic surveying system 201 described herein includes the use of a second hydrographic surveying vessel 200B. The use of an additional hydrographic surveying vessel of the same or similar design enables a further increase in the swath of a single pass of the marine environment 264. The illustrated hydrographic surveying system 201 enables, or almost enables, a tripling of the swath of a single pass of the marine environment 264. This can result in the ability to perform hydrographic surveys significantly more efficiently. The towing vessel 203 does not need to perform as many

passes of the marine environment 246, 746 to survey it. This reduces the time taken to perform a survey and the costs involved with performing the survey by enabling more efficient use of the towing vessel 203.

[00267] The hydrographic surveying vessel 200, 700 is a fully integrated design. That is, the hydrographic surveying vessel 200, 700 may be constructed and housed in a fully constructed form, ready for use. This simplifies the launch and recovery of the hydrographic surveying vessel 200, 700 as no additional components/vessels are required to be launched for the hydrographic surveying vessel 200, 700 to function. The launch and recovery of the hydrographic surveying vessel 200, 700 can be undertaken by a crane connected to the towing connector 258.

[00268] As described herein, a plurality of hydrographic surveying vessels can be used simultaneously. Although the hydrographic surveying system 201 is described as including two hydrographic surveying vessels 200, 700, 200B, it will be appreciated that in some embodiments, it may include a different number of hydrographic surveying vessels. For example, it may include three hydrographic surveying vessels. The hydrographic surveying vessel 200, 700 and the towing system 205 include a relatively low number of moving parts. The reliability of the hydrographic surveying vessel 200, 700 and/or the towing system 205 may therefore be better than that of other designs.

Hydrographic Surveying System 301

[00269] Figures 16 and 17 show a hydrographic surveying system 301, according to some embodiments of the present disclosure. In particular, Figures 16 and 17 show the hydrographic surveying system 301 in a marine environment 364. The hydrographic surveying system 301 comprises a hydrographic surveying vessel 300. The hydrographic surveying system 301 comprises a marine manoeuvring vessel 400. The hydrographic surveying system 301 comprises a second hydrographic surveying vessel 300B. The hydrographic surveying system 301 comprises a second marine manoeuvring vessel 400B. The hydrographic surveying system 301 comprises a towing system 305.

Marine Manoeuvring Vessel 400

[00270] Figure 13 shows a marine manoeuvring vessel 400, according to some embodiments of the disclosure. One or more features of the marine manoeuvring vessel 400 may be the same as, or similar to, one or more features of the hydrographic surveying vessel 200, described herein. One or more features of the marine manoeuvring vessel 400 may be different to one or more features of the hydrographic surveying vessel 200, described herein. One or more features of the marine manoeuvring vessel 400 may be the same as, or similar to, one or more features of the hydrographic surveying vessel 700, described herein. One or more features of the marine manoeuvring vessel 400 may be different to one or more features of the hydrographic surveying vessel 700, described herein. For example, the marine manoeuvring vessel 400 may not include an acoustic wave generator described with reference to the

hydrographic surveying vessel 700. Further, the marine manoeuvring system of the marine manoeuvring vessel 400 may be the same as, or similar to, the marine manoeuvring system 706 of the hydrographic surveying vessel 700.

[00271] The marine manoeuvring vessel 400 comprises a hull 402. The hull 402 may be referred to as a marine manoeuvring vessel hull 402. The hull 402 may be referred to as a hull of the marine manoeuvring vessel 400. The marine manoeuvring vessel hull 402 extends from a front 402A to a rear 402B. The marine manoeuvring vessel hull 402 comprises a plurality of hull walls 404. The hull walls 404 may be referred to as marine manoeuvring vessel hull walls 404. The marine manoeuvring vessel hull walls 404 define an internal volume of the marine manoeuvring vessel hull 402. The marine manoeuvring vessel hull 402 may comprise one or more hull openings that provide access to the internal volume of the marine manoeuvring vessel hull 402 from outside the marine manoeuvring vessel hull 402. The hull openings may be capped to inhibit water ingress during use of the marine manoeuvring vessel 400.

[00272] The marine manoeuvring vessel 400 comprises a manoeuvring system 406. The manoeuvring system 406 may be referred to as a marine manoeuvring system 406. Thus, the marine manoeuvring vessel 400 may be said to comprise a marine manoeuvring system 406. One or more features of the marine manoeuvring system 406 may be the same as, or similar to, one or more of the features of the marine manoeuvring system 206 described herein. One or more features of the marine manoeuvring system 406 may be different to the marine manoeuvring system 206 described herein. One or more features of the marine manoeuvring system 406 may be the same as, or similar to, one or more of the features of the marine manoeuvring system 706 described herein. One or more features of the marine manoeuvring system 406 may be different to the marine manoeuvring system 706 described herein.

[00273] The marine manoeuvring system 406 extends between a first end portion 408 and a second end portion 410. The first end portion 408 is connected to the marine manoeuvring vessel hull 402. The marine manoeuvring system 406 comprises a first end body 412. In particular, the first end portion 408 comprises the first end body 412. The first end body 412 defines at least part of a first end of the marine manoeuvring system 406. In the illustrated embodiment, the first end body 410 defines the first end of the marine manoeuvring system 406.

[00274] The first end body 412 comprises a first end plate. The first end plate extends between a first end plate surface 414 and a second end plate surface 416. The first end plate surface 414 is an upper surface of the first end plate. The second end plate surface 416 is a lower surface of the first end plate. The second end plate surface 416 may be considered an inner surface of the first end body 412. A thickness of the first end plate is the distance between the first end plate surface 414 and the second end plate surface 416 at one or more points of the first end plate. The first end plate surface 414 is parallel to the second end plate

surface 416. The thickness of the first end plate is less than a width of the first end plate and a length of the first end plate.

[00275] The marine manoeuvring system 406 comprises a second end body 418. In particular, the second end portion 410 comprises the second end body 418. The second end body 418 defines at least part of a second end of the marine manoeuvring system 406. In the illustrated embodiment, the second end body 418 defines the second end the marine manoeuvring system 406.

[00276] The second end body 418 comprises a second end plate. The second end plate extends between a third end plate surface 420 and a fourth end plate surface 422. The third end plate surface 420 is an upper surface of the first end plate. The third end plate surface 420 may be considered an inner surface of the second end body 418. The fourth end plate surface 422 is a lower surface of the second end plate. A thickness of the second end plate is the distance between the third end plate surface 420 and the fourth end plate surface 422 at one or more points of the second end plate. The third end plate surface 420 is parallel to the fourth end plate surface 422. The thickness of the second end plate is less than a width of the second end plate and a length of the second end plate.

[00277] The marine manoeuvring system 406 comprises a plurality of manoeuvring elements 424. One or more of the manoeuvring elements 424 extends from a first manoeuvring element end 426 to a second manoeuvring element end 428. In the illustrated embodiment, each manoeuvring element 424 extends from a respective first manoeuvring element end 426 to a respective second manoeuvring element end 428.

[00278] One or more of the manoeuvring elements 424 is connected to the first end body 412 at the first manoeuvring element end 426. In the illustrated embodiment, each of the manoeuvring elements 424 is connected to the first end body 412 at its respective first manoeuvring element end 426. The manoeuvring elements 424 are fixedly connected to the first end body 412. One or more of the manoeuvring elements 424 may, for example, be welded to the first end body 412.

[00279] One or more of the manoeuvring elements 424 is connected to the second end body 418 at the second manoeuvring element end 428. In the illustrated embodiment, each of the manoeuvring elements 424 is connected to the second end body 418 at its respective second manoeuvring element end 428. The manoeuvring elements 424 are fixedly connected to the second end body 418. One or more of the manoeuvring elements 424 may, for example, be welded to the second end body 418.

[00280] One or more of the manoeuvring elements 424 extends orthogonally with respect to the first end body 412. In particular, each manoeuvring element 424 extends orthogonally with respect to the second end plate surface 416 of the first end plate. One or more of the manoeuvring elements 424 extends orthogonally with respect to the second end body 418. In

particular, each manoeuvring element 424 extends orthogonally with respect to the third end plate surface 420 of the second end plate.

[00281] The manoeuvring elements 424 are vanes. The manoeuvring elements 424 are configured to influence a heading of the marine manoeuvring vessel 400 in use. Each manoeuvring element 424 extends from a leading edge 425 to a trailing edge 427. A thickness of the manoeuvring elements 424 may be defined as a distance between a first face 429 of the respective manoeuvring element 424 and a second face 431 of the respective manoeuvring element 424. In some embodiments, the thickness of one or more of the manoeuvring elements 424 is constant across the manoeuvring element 424. In some embodiments, the thickness of one or more of the manoeuvring elements 424 changes across the manoeuvring element 424. The thickness of each manoeuvring element 424 is relatively low compared to the orthogonal dimensions of the respective manoeuvring element 424.

[00282] Each manoeuvring element 424 curves along its length as it extends from its leading edge 424 to its trailing edge 427. The manoeuvring elements 424 are arranged in a cascade, with a fluid gap being provided between adjacent manoeuvring elements 424. The curvature of one or more of the manoeuvring elements 424 and/or an angle that one or more of the manoeuvring elements 424 is disposed at relative to a longitudinal direction of the marine manoeuvring vessel hull 402 can impact the extent to which the marine manoeuvring system 406 influences the heading of the marine manoeuvring vessel 400.

[00283] It will be appreciated that in some embodiments, the manoeuvring system 406 may comprise fixed manoeuvring elements like the fixed manoeuvring elements 724A described herein. Further, the manoeuvring system 406 may comprise moveable manoeuvring elements like the moveable manoeuvring elements 724B described herein. The manoeuvring elements, first end body 412 and/or second end body 418 may define one or more channels, as described herein.

[00284] The first end portion 408 comprises a hull connecting portion 430. In particular, the first end body 412 comprises the hull connecting portion 430. The hull connecting portion 430 enables the marine manoeuvring vessel hull 402 to be connected to the first end portion 408 of the marine manoeuvring system 406. The hull connecting portion 430 is shaped such that it generally matches a profile of the marine manoeuvring vessel hull 402. In the illustrated embodiment, the first end portion 408 comprises a plurality of hull connecting portions 430. Each hull connecting portion 430 enables the marine manoeuvring vessel hull 402 to be connected to the first end portion 408 of the marine manoeuvring system 406. In the illustrated embodiment, each hull connecting portion 430 forms a generally C-shaped portion that matches part of the cylindrical shape of the marine manoeuvring vessel hull 402.

[00285] The marine manoeuvring vessel hull 402 is connected to the marine manoeuvring system 406 using a hull connection system 432. The illustrated marine manoeuvring vessel 400 comprises a hull connection system 432 for each hull connecting portion 430. In some

embodiments, one or more of the hull connection systems 432 comprises a rigid hull connection mechanism. The hull connection mechanism is configured to connect the marine manoeuvring vessel hull 402 to the marine manoeuvring system 406. The hull connection mechanism may comprise one or more rigid bodies, each configured to extend around at least a portion of the marine manoeuvring vessel hull 402. One or more of the rigid bodies may connect to a respective hull connecting portion 430, thereby securing the marine manoeuvring vessel hull 402 with respect to the marine manoeuvring system 406. In some embodiments, one or more of the hull connection systems 432 comprises a hull connection strap. Each hull connection strap may cooperate with a respective hull connecting portion 430 to enable the marine manoeuvring vessel hull 402 to be connected to the marine manoeuvring system 406. Each hull connection system 432 may comprise a strap securing system (not shown) to secure a respective hull connection strap in place to retain the marine manoeuvring vessel hull 402 to the marine manoeuvring system 406.

[00286] The marine manoeuvring vessel 400 comprises one or more marine manoeuvring vessel tow mounting portions 454. The illustrated embodiment comprises a plurality of marine manoeuvring vessel tow mounting portions 454. In particular, the illustrated marine manoeuvring vessel 400 comprises four marine manoeuvring vessel tow mounting portions 454. The marine manoeuvring system 406 comprises one or more of the marine manoeuvring vessel tow mounting portions 454. In the illustrated embodiment, the first end portion 408 of the marine manoeuvring system 406 comprises a number of the marine manoeuvring vessel tow mounting portions 454. In particular, the first end portion 408 of the marine manoeuvring system 406 comprises two of the marine manoeuvring vessel tow mounting portions 454. The second end portion 410 of the marine manoeuvring system 406 comprises a number of the marine manoeuvring vessel tow mounting portions 454. In particular, the second end portion 410 of the marine manoeuvring system 406 comprises two of the marine manoeuvring vessel tow mounting portions 454.

[00287] The marine manoeuvring vessel 400 comprises a towing connector assembly 456. The towing connector assembly 456 may be referred to as a marine manoeuvring vessel towing connector assembly 456. The marine manoeuvring vessel towing connector assembly 456 may be referred to as a bridle. The marine manoeuvring vessel towing connector assembly 456 is configured to be connected to the towing system 405.

[00288] The marine manoeuvring vessel towing connector assembly 456 comprises a marine manoeuvring vessel towing connector 458. The marine manoeuvring vessel towing connector 458 comprises one or more towing connector bodies. In the illustrated embodiment, the marine manoeuvring vessel towing connector 458 comprises a plurality of connected towing connector bodies. Each of the towing connector bodies is rigid. One or more of the towing connector bodies is pivotally connected to one or more other towing connector body.

[00289] The marine manoeuvring vessel towing connector 458 comprises a plurality of marine manoeuvring vessel towing connector mounting portions 460. The marine manoeuvring vessel towing connector 458 comprises a plurality of connector elements 462. The connector elements 462 may be referred to as marine manoeuvring vessel connector elements 462. One or more of the marine manoeuvring vessel tow mounting portions 454 enable connection of a respective marine manoeuvring vessel connector element 462 thereto. One or more of the marine manoeuvring vessel connector elements 462 is configured to be connected to one of the marine manoeuvring vessel towing connector mounting portions 460. In particular, one or more of the marine manoeuvring vessel connector elements 462 is connected to one of the marine manoeuvring vessel towing connector mounting portions 460 at one end. In other words, one or more of the marine manoeuvring vessel connector elements 462 is connected to one of the marine manoeuvring vessel towing connector mounting portions 460 at a first end. One or more of the marine manoeuvring vessel connector elements 462 is connected to one of the marine manoeuvring vessel tow mounting portions 454 at another end. In other words, one or more of the marine manoeuvring vessel connector elements 462 is connected to one of the marine manoeuvring vessel tow mounting portions 454 at a second end. One or more of the marine manoeuvring vessel connector elements 462 is both connected to the marine manoeuvring vessel towing connector 458 at its first end and a respective marine manoeuvring vessel tow mounting portion 454 of the marine manoeuvring vessel 400 at its second end.

[00290] In some embodiments, the marine manoeuvring vessel 400 does not comprise a sensing system. However, in some embodiments, the marine manoeuvring vessel 400 may comprise a marine manoeuvring vessel sensing system (not shown). The sensing system comprises a motion reference unit (MRU). The MRU is configured to generate motion data. The motion data is time series data indicative of a value of one or more motion parameters associated with the marine manoeuvring vessel 400. The motion data comprises roll angle data. The roll angle data is indicative of a roll angle of the marine manoeuvring vessel 400 across a time window of operation of the marine manoeuvring vessel 400. The motion data comprises pitch angle data. The pitch angle data is indicative of a pitch angle of the marine manoeuvring vessel 400 across the time window of operation. The motion data comprises heave angle data. The heave angle data is indicative of a heave angle of the marine manoeuvring vessel 400 across the time window of operation.

[00291] The marine manoeuvring vessel sensing system comprises a Global Navigation Satellite System (GNSS) module. The GNSS module is configured to generate GNSS data. The GNSS data is time series data. The GNSS data is indicative of a heading of the marine manoeuvring vessel 400 across the time window of operation of the marine manoeuvring vessel 400. The GNSS data is indicative of a longitude of the marine manoeuvring vessel 400 across the time window of operation. The GNSS data is indicative of a latitude of the marine manoeuvring vessel 400 across the time window of operation.

[00292] At least part of the sensing system may be housed within the marine manoeuvring vessel hull 402. For example, the MRU may be housed within the marine manoeuvring vessel hull 402. The GNSS module may be housed within the marine manoeuvring vessel hull 402. One or more parts of the MRU and/or the GNSS module may extend outside the marine manoeuvring vessel hull 402. For example, an antenna of the GNSS module may extend out of the marine manoeuvring vessel hull 402. At least part of the sensing system may be mounted externally to the marine manoeuvring vessel hull 402. For example, the MRU may be mounted to an exterior of the marine manoeuvring vessel hull 402. The GNSS module may be mounted to an exterior of the marine manoeuvring vessel hull 402.

Hydrographic Surveying Vessel 300

[00293] Figures 14 and 15 show a hydrographic surveying vessel 300, according to some embodiments of the present disclosure. The hydrographic surveying vessel 300 comprises a hull 302. The hull 302 may be referred to as a hydrographic surveying vessel hull 302. The hull 302 may be referred to as a hull of the hydrographic surveying vessel 300. The hydrographic surveying vessel hull 302 extends from a front 302A to a rear 302B. The hydrographic surveying vessel hull 302 comprises a plurality of hull walls 304. The hull walls 304 may be referred to as hydrographic surveying vessel hull walls 304. The hull walls 304 define an internal volume of the hydrographic surveying vessel hull 302. The hydrographic surveying vessel hull 302 may comprise one or more hull openings that provide access to the internal volume of the hydrographic surveying vessel hull 302 from outside the hull 302. The hull openings may be capped to inhibit water ingress during use of the hydrographic surveying vessel 300.

[00294] The hydrographic surveying vessel 300 comprises a mast 381. The mast 381 extends outwards from the hydrographic surveying vessel hull 302. The mast 381 extends upwards when the hydrographic surveying vessel 300 is in use.

[00295] The hydrographic surveying vessel 300 comprises an acoustic wave generator portion 344. The acoustic wave generator portion 344 is mounted at an underside of the hydrographic surveying vessel 300. The acoustic wave generator portion 344 is mounted to the hydrographic surveying vessel hull 302. In particular, the acoustic wave generator portion 344 is mounted to an underside of the hydrographic surveying vessel hull 302.

[00296] The acoustic wave generator portion 344 comprises an acoustic wave generator 346. The acoustic wave generator 346 is configured to generate acoustic waves in a fluid around the acoustic wave generator 346. In this case, the acoustic wave generator 346 generates acoustic waves in the water that surrounds the acoustic wave generator 346 in use.

[00297] The hydrographic surveying vessel 300 comprises an acoustic wave receiver. The acoustic wave receiver is configured to detect acoustic waves that are emitted by the acoustic wave generator 346 and reflected by a portion of the marine environment 364. The acoustic wave generator 346 may comprise the acoustic wave receiver.

[00298] The acoustic wave generator 346 comprises a multibeam echosounder. In the illustrated embodiment, the acoustic wave generator 346 is in the form of a multibeam echosounder. In some embodiments, the acoustic wave generator 346 may comprise, or be in the form of, a single beam echosounder. In some embodiments, the acoustic wave generator 346 may comprise, or be in the form of, a side scan sonar system.

[00299] The hydrographic surveying vessel 300 comprises a keel 348. In particular, the acoustic wave generator portion 344 comprises the keel 348. The keel 348 is in the form of an elongate body. The keel 348 extends from a first keel end 350 to a second keel end 352. The first keel end 350 is a front end of the keel 348. The acoustic wave generator 346 is connected to the keel 348. In particular, the acoustic wave generator 346 is removably connected to the keel 348. The keel 348 enabled the removable connection of the acoustic wave generator 346 to the hull 302. In the illustrated embodiment, the acoustic wave generator 346 is connected to the keel 348. The keel 348 is connected to the hydrographic surveying vessel hull 302. In some embodiments, the keel 348 is integrally formed with the hull 302. The keel 348 extends from an upper end 353 to a lower end 355. The keel 348 connects to the hydrographic surveying vessel hull 302 at its upper end 353. The keel 348 connects to the acoustic wave generator 346 at its lower end 355. A distance between the upper end 353 and the lower end 355 of the keel 348 is greater than a distance between the first keel end 350 and the second keel end 352. The keel 346 may define a channel through which one or more cables connecting the acoustic wave generator 346 and an associated controller can be connected. This configuration may be as described with reference to the hydrographic surveying vessel 700. Specifically, the hull 302 may house the acoustic wave generator controller. The acoustic wave generator controller may communicate with the acoustic wave generator 346 via one or more cables that pass through the channel of the keel 348.

[00300] The hydrographic surveying vessel 300 comprises an acoustic wave generator connecting portion (not shown). In particular, the hydrographic surveying vessel hull 302 comprises the acoustic wave generator connecting portion. The acoustic wave generator connecting portion is configured to enable the acoustic wave generator portion 344 to be connected to the hydrographic surveying vessel hull 302.

[00301] In some embodiments, the acoustic wave generator 346 may directly connect to the hydrographic surveying vessel hull 302. That is, some embodiments may not include the keel 348.

[00302] The lower end 355 of the keel 348 is further away from the hydrographic surveying vessel hull 302 than the upper end 353 of the keel 348. In the illustrated embodiment, the acoustic wave generator 346 is further away from the hydrographic surveying vessel hull 302 than the upper end 353 of the keel 348. The acoustic wave generator 346 is further away from the hydrographic surveying vessel hull 302 than the lower end 355 of the keel 348. The acoustic wave generator 346 is disposed on an opposite side of the keel 348 as the hydrographic

surveying vessel hull 302. In other words, acoustic wave generator 346 is further away from the hydrographic surveying vessel hull 302 than the keel 348 is.

[00303] The hydrographic surveying vessel 300 comprises one or more tow mounting portions 354. The tow mounting portions 354 may be referred to as hydrographic surveying vessel tow mounting portions 354. The illustrated embodiment comprises a plurality of hydrographic surveying vessel tow mounting portions 354. The hydrographic surveying vessel hull 302 comprises one or more hydrographic surveying vessel tow mounting portions 354. The keel 348 may comprise one or more hydrographic surveying vessel tow mounting portions 354. The acoustic wave generator 346 may comprise one or more hydrographic surveying vessel tow mounting portions 354. The hydrographic surveying vessel tow mounting portions 354 facilitate a connection between the hydrographic surveying vessel 300 and a towing system 305.

[00304] The hydrographic surveying vessel 300 comprises a towing connector assembly 356. The towing connector assembly 356 may be referred to as a bridle.

[00305] The towing connector assembly 356 comprises a plurality of connector elements 362. One or more of the connector element 362 is connected to one or more of the hydrographic surveying vessel tow mounting portions 354. In the illustrated embodiment, each connector element 362 connects to a respective hydrographic surveying vessel tow mounting portions 354 at an end portion of the respective connector element 362.

[00306] One or more of the connector elements 362 meet at a junction 358. The junction 358 may be in the form of a towing connector 358. The towing connector 358 may comprise one or more towing connector bodies. The towing connector 358 may comprise a plurality of connected towing connector bodies. Each of the towing connector bodies may be rigid. One or more of the towing connector bodies may be pivotally connected to one or more other towing connector body. The towing connector 358 may comprise a plurality of towing connector mounting portions (not shown).

[00307] One or more of the hydrographic surveying vessel tow mounting portions 354 may enable connection of a respective connector element 362 thereto. One or more of the connector elements 362 is connected to one of the towing connector mounting portions. In particular, one or more of the connector elements 362 is connected to one of the towing connector mounting portions at one end. In other words, one or more of the connector elements 362 is connected to one of the towing connector mounting portions at a first end. One or more of the connector elements 362 is connected to one of the hydrographic surveying vessel tow mounting portions 354 at another end. In other words, one or more of the connector elements 362 is connected to one of the hydrographic surveying vessel tow mounting portions 354 at a second end. One or more of the connector elements 362 is both connected to the towing connector 358 at its first end and a respective hydrographic surveying vessel tow mounting portion 354 of the hydrographic surveying vessel 300 at its second end.

[00308] The hydrographic surveying vessel 300 comprises a sensing system (not shown). The sensing system comprises a motion reference unit (MRU). The MRU is configured to generate motion data. The motion data is time series data indicative of a value of one or more motion parameters associated with the hydrographic surveying vessel 300. The motion data comprises roll angle data. The roll angle data is indicative of a roll angle of the hydrographic surveying vessel 300 across a time window of operation of the hydrographic surveying vessel 300. The motion data comprises pitch angle data. The pitch angle data is indicative of a pitch angle of the hydrographic surveying vessel 300 across the time window of operation. The motion data comprises heave angle data. The heave angle data is indicative of a heave angle of the hydrographic surveying vessel 300 across the time window of operation.

[00309] The sensing system comprises a Global Navigation Satellite System (GNSS) module. The GNSS module is configured to generate GNSS data. The GNSS data is time series data. The GNSS data is indicative of a heading of the hydrographic surveying vessel 300 across the time window of operation of the hydrographic surveying vessel 300. The GNSS data is indicative of a longitude of the hydrographic surveying vessel 300 across the time window of operation. The GNSS data is indicative of a latitude of the hydrographic surveying vessel 300 across the time window of operation.

[00310] At least part of the sensing system may be housed within the hydrographic surveying vessel hull 302. For example, the MRU may be housed within the hydrographic surveying vessel hull 302. The GNSS module may be housed within the hydrographic surveying vessel hull 302. One or more parts of the MRU and/or the GNSS module may extend outside the hydrographic surveying vessel hull 302. For example, an antenna of the GNSS module may extend out of the hydrographic surveying vessel hull 302. In the illustrated embodiment, the antenna of the GNSS module extends through the mast 381. At least part of the sensing system may be mounted externally to the hydrographic surveying vessel hull 302. For example, the MRU may be mounted to an exterior of the hydrographic surveying vessel hull 302. The GNSS module may be mounted to an exterior of the hydrographic surveying vessel hull 302.

[00311] The hydrographic surveying vessel 300 comprises an acoustic wave generator controller. The acoustic wave generator controller is configured to control the acoustic wave generator 346. The acoustic wave generator controller is housed within the housing 302.

[00312] The hydrographic surveying vessel 300 comprises a network interface (not shown). The network interface is configured to enable the hydrographic surveying vessel 300 to communicate with other computing devices using one or more communication networks. The hydrographic surveying vessel 300 is configured to communicate with other computing devices using a communication network. The hydrographic surveying vessel 300 is configured to transmit data using the communication network.

[00313] The hydrographic surveying vessel 300 comprises a power system (not shown). The power system is housed within the housing 302. The power system comprises a plurality of

batteries. The power system powers one or more components of the hydrographic surveying vessel 300. For example, the power system may power the motion reference unit, the GNSS system, the acoustic wave generator controller, the network interface and/or the acoustic wave generator 346. In some embodiments, at least some of the power system may be mounted outside the housing.

[00314] In some embodiments, the power system comprises a direct electrical connection to a towing vessel. This direct electrical connection may be the same as, or similar to, the electrical connection described with reference to the cable 255 of hydrographic surveying vessel 200.

[00315] The hydrographic surveying vessel 300 comprises a computing device (not shown). The computing device comprises at least one processor. The computing device comprises memory. The memory stores program instructions. The memory may comprise or be in the form of one or more non transitory computer readable medium. The at least one processor is configured to execute the program instructions. The computing device is configured to communicate with one or more of the other systems described herein. For example, the computing device is configured to communicate with one or more of the acoustic wave generator controller, the acoustic wave generator 346, the acoustic wave receiver, the power system, the motion reference unit, the sensing system, the GNSS module and the network interface. The computing device may control, or enable control of at least one of the acoustic wave generator controller, the acoustic wave generator 346, the acoustic wave receiver, the power system, the motion reference unit, the sensing system, the GNSS module and the network interface. The computing device may store data generated by, or using, at least one of the acoustic wave generator controller, the acoustic wave generator 346, the acoustic wave receiver, the power system, the motion reference unit, the sensing system, the GNSS module and the network interface. In some embodiments, the computing device comprises the acoustic wave generator controller. For example, the acoustic wave generator controller may be a software module that is executed by the computing device.

[00316] In some embodiments, one or more of the GNSS module, the MRU, the computing device, the network interface and the acoustic wave generator 346 are part of an integrated unit. That is, in some embodiments, the hydrographic surveying vessel 300 comprises a sensing unit that comprises one or more of the GNSS module, the MRU, the computing device, the network interface and the acoustic wave generator 346. This sensing unit may be referred to as the acoustic wave generator 346. That is, each of the components of the sensing unit may be part of a combined unit that is mounted to the second end body 318 of the marine manoeuvring system 306, as described with reference to the acoustic wave generator 346.

[00317]

Second Hydrographic Surveying Vessel 300B

[00318] The hydrographic surveying system 301 comprises a second hydrographic surveying vessel 300B. One or more components of the second hydrographic surveying vessel 300B may

be similar to, or the same as one or more components of the hydrographic surveying vessel 300. One or more components of the second hydrographic surveying vessel 300B may be a mirror image of the equivalent component of the hydrographic surveying vessel 300. One or more components of the second hydrographic surveying vessel 300B may be similar to, or the same as one or more components of the hydrographic surveying vessels 200, 700 described herein. One or more components of the second hydrographic surveying vessel 300B may be a mirror image of the equivalent component of the hydrographic surveying vessels 200, 700 described herein.

Second Marine Manoeuvring Vessel 400B

[00319] The hydrographic surveying system 301 comprises a second marine manoeuvring vessel 400B. One or more components of the second marine manoeuvring vessel 400B may be similar to, or the same as one or more components of the marine manoeuvring vessel 400. For example, one or more components of the second marine manoeuvring vessel 400B may be a mirror image of the equivalent component of the marine manoeuvring vessel 400. That is, one or more components of the second marine manoeuvring vessel 400B may be laterally inverted with respect to the equivalent component of the marine manoeuvring vessel 400.

[00320] One or more components of the second marine manoeuvring vessel 400B may be similar to, or the same as one or more components of the hydrographic surveying vessels 200, 700 described herein. One or more components of the second marine manoeuvring vessel 400B may be a mirror image of the equivalent component of the hydrographic surveying vessels 200, 700 described herein.

[00321] The second hydrographic surveying vessel 300B and the second marine manoeuvring vessel 400B are operatively connected. In particular, the second hydrographic surveying vessel 300B and the second marine manoeuvring vessel 400B are operatively connected via the towing system 305.

Towing System 305

[00322] The hydrographic surveying system 301 comprises a towing vessel 303. The towing vessel 303 is configured to tow one or more parts of the hydrographic surveying system 301.

[00323] As described herein, the hydrographic surveying system 301 comprises a towing system 305. The towing system 305 is connected to the hydrographic surveying vessel 300. The towing system 305 is connected to the second hydrographic surveying vessel 300B. The towing system 305 is connected to the marine manoeuvring vessel 400. The towing system 305 is connected to the second marine manoeuvring vessel 400B.

[00324] As described herein, the hydrographic surveying vessel tow mounting portions 354 facilitate a connection between the hydrographic surveying vessel 300 and the towing system 305. Further, the marine manoeuvring vessel towing connector assembly 456 is connected to the towing system 305. The hydrographic surveying vessel 300 and the marine manoeuvring vessel 400 are operably connected via the towing system 305. At least in part by

virtue of this connection, movement of the marine manoeuvring vessel 400 causes movement of the hydrographic surveying vessel 300.

[00325] The towing system 305 comprises a first towing element 307. The first towing element 307 is operably connected to the marine manoeuvring vessel 400. In particular, the first towing element 307 is operably connected to the towing connector assembly 456 of the marine manoeuvring vessel 400, at a first portion of the towing element 307. The first towing element 307 is operably connected to the marine manoeuvring vessel towing connector 458. The first towing element 307 may be connected to the marine manoeuvring vessel towing connector 458 at or near one end of the first towing element 307. The first towing element 307 may be connected to the marine manoeuvring vessel towing connector 458 at a pulley.

[00326] The first towing element 307 is operably connected to the towing vessel 303. In particular, the first towing element 307 is operably connected to the towing vessel 303 at a second portion of the first towing element 307. The second portion may be at an opposite end to the end at which the first towing element 307 is connected to the marine manoeuvring vessel 400. The towing vessel 303 is therefore operably connected to the marine manoeuvring vessel 400 via the first towing element 307. Movement of the towing vessel 303 therefore causes movement of the marine manoeuvring vessel 400. The first towing element 307 may be referred to as a first tow rope. The first towing element 307 may be in the form of a cable.

[00327] A communication line may run along the first towing element 307. In some embodiments, the communication line is integrated into the first towing element 307. The communication line enables data transfer between the marine manoeuvring vessel 400 and the towing vessel 303. In particular, communication between the sensing system and the towing vessel 303 may be enabled via the communication line.

[00328] A length of the first towing element 307 may be adjustable. For example, the first towing element 307 may be connected to a winch of the towing vessel 303. The winch may be operable to adjust the length of the first towing element 307 that extends off the towing vessel 303 and therefore, the distance between the marine manoeuvring vessel 400 and the towing vessel 303.

[00329] The towing system 305 comprises a second towing element 309. The second towing element 309 is operably connected to the second marine manoeuvring vessel 400B. In particular, the second towing element 309 is operably connected to the towing connector assembly of the second marine manoeuvring vessel 400B, at a first portion of the second towing element 309. The second towing element 309 is operably connected to the marine manoeuvring vessel towing connector of the second marine manoeuvring vessel 400B. The second towing element 309 may be connected to the marine manoeuvring vessel towing connector at or near one end of the second towing element 309. The second towing element 309 may be connected to the marine manoeuvring vessel towing connector at a pulley.

[00330] The second towing element 309 is operably connected to the towing vessel 303. In particular, the second towing element 309 is operably connected to the towing vessel 303 at a second portion of the second towing element 309. The second portion may be at an opposite end to the end at which the second towing element 309 is connected to the second marine manoeuvring vessel 400B. The towing vessel 303 is therefore operably connected to the second marine manoeuvring vessel 400B via the second towing element 309. Movement of the towing vessel 303 therefore causes movement of the second marine manoeuvring vessel 400B. The second towing element 309 may be referred to as a second tow rope. The second towing element 309 may be in the form of a cable.

[00331] A communication line may run along the second towing element 309. In some embodiments, the communication line is integrated into the second towing element 309. The communication line enables data transfer between the second marine manoeuvring vessel 400B and the towing vessel 303. In particular, communication between the sensing system and the towing vessel 303 may be enabled via the communication line.

[00332] A length of the second towing element 309 may be adjustable. For example, the second towing element 309 may be connected to a winch of the towing vessel 303. The winch may be operable to adjust the length of the second towing element 309 that extends off the towing vessel 303 and therefore, the distance between the marine manoeuvring vessel 400 and the towing vessel 303.

[00333] The towing system 305 comprises a third towing element 311. The third towing element 311 is operably connected to the towing connector assembly 456 of the marine manoeuvring vessel 400. In some embodiments, the third towing element 311 is connected directly to the towing connector assembly 456 of the marine manoeuvring vessel 400. In the illustrated embodiment, the third towing element 311 is connected to the first towing element 307. The third towing element 311 is connected to the first towing element 307 at a junction. The third towing element 311 may be connected to the first towing element 307 near where the first towing element 307 connects to the towing connector assembly 456 of the marine manoeuvring vessel 400.

[00334] The third towing element 311 is operably connected to the towing connector assembly of the second marine manoeuvring vessel 400B. In some embodiments, the third towing element 311 is connected directly to the towing connector assembly of the second marine manoeuvring vessel 400B. In the illustrated embodiment, the third towing element 311 is connected to the second towing element 309. The third towing element 311 is connected to the second towing element 309 at a junction. The third towing element 311 may be connected to the second towing element 309 near where the second towing element 309 connects to the towing connector assembly of the second marine manoeuvring vessel 400B. Relative movement between the marine manoeuvring vessel 400 and the second marine manoeuvring vessel 400B is constrained by the third towing element 311. Relative movement between the

hydrographic surveying vessel 300 and the second hydrographic surveying vessel 300B is constrained by the third towing element 311.

[00335] A third communication line may run along the third towing element 311. In some embodiments, the third communication line is integrated into the third towing element 311. The third communication line enables data transfer between two or more of the hydrographic survey vessel 300, the second hydrographic surveying vessel 300B, the marine manoeuvring vessel 400, the second marine manoeuvring vessel 400B and the towing vessel 303.

[00336] A length of the third towing element 311 may be adjustable. For example, the third towing element 311 may be connected to a winch. The winch may be on the towing vessel 303 (e.g. an excess length of the third towing element 311 may run along one or both of the first towing element 307 and the second towing element 309, to the towing vessel 303). The winch may be operable to adjust the length of the third towing element 311 and therefore, the distance between the marine manoeuvring vessel 400 and the second marine manoeuvring vessel 400B.

[00337] As described herein, the hydrographic surveying vessel 300 comprises a towing connector assembly 356. The towing connector assembly 356 is connected to the towing system 305. The towing connector assembly 356 facilitates a connection between the hydrographic surveying vessel 300 and the towing system 305. The towing connector assembly 356 of the hydrographic surveying vessel 300 connects to the towing system 305 at a different point to the marine manoeuvring vessel 400. In particular, the towing connector assembly 356 connects to the third towing element 311.

[00338] In operation, the towing vessel 303 moves across the marine environment 364 in a movement direction 366. The first towing element 307 and the second towing element 309 extend behind the towing vessel 303 as it moves. The towing vessel 303 tows the marine manoeuvring vessel 400 as it moves. The towing vessel 303 tows the second marine manoeuvring vessel 400B as it moves. As described herein, the hydrographic surveying vessel 300 is operably connected to the marine manoeuvring vessel 400 via the third towing element 311 and the first towing element 307. The towing vessel 303 therefore also tows the hydrographic surveying vessel 300 as it moves. Similarly, the second hydrographic surveying vessel 300B is operably connected to the second marine manoeuvring vessel 400B via the third towing element 311 and the second towing element 309. The towing vessel 303 therefore also tows the second hydrographic surveying vessel 300B as it moves.

[00339] The marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 through the marine environment 364. In particular, the marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 with respect to the towing vessel 303 as the marine manoeuvring vessel 400 and the hydrographic surveying vessel 300 are towed by the towing vessel 303. The marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 such that it is maintained in a lateral position with respect to the towing vessel 303 as it is towed

by the towing vessel 303. In other words, the marine manoeuvring vessel 400 is configured to influence the heading of the hydrographic surveying vessel 300.

[00340] The marine manoeuvring system 406 of the marine manoeuvring vessel 400 is configured to bias the hydrographic surveying vessel 300 in a first direction 376 in response to movement through the water of the marine environment 364. The first direction 376 is a lateral direction. It may therefore be said that the marine manoeuvring vessel 400 is configured to laterally bias movement of the hydrographic surveying vessel 300. In particular, the manoeuvring elements 424 are configured to bias the hydrographic surveying vessel 300 in the first direction 376. The marine manoeuvring vessel 400 therefore influences the heading of the hydrographic surveying vessel 300 such that the hydrographic surveying vessel 300 is directed towards the lateral position with respect to the towing vessel 303 as it is towed by the towing vessel 303. When the hydrographic surveying vessel 300 is being towed by the towing vessel 303, the first towing element 307 extends away from the towing vessel 303 at a towing angle 368. The towing angle 368 may be influenced by one or more of the speed of the towing vessel 303, the configuration of the marine manoeuvring system 406, the length of the first towing element 307, the length of the second towing element 309 and the length of the third towing element 311.

[00341] The second marine manoeuvring vessel 400B is configured to similarly manoeuvre the second hydrographic surveying vessel 300B through the marine environment 364. The second marine manoeuvring vessel 400B is configured to manoeuvre the second hydrographic surveying vessel 300B such that it is maintained in a second lateral position with respect to the towing vessel 303 as it is towed by the towing vessel 303.

[00342] The second marine manoeuvring system is configured to bias the second hydrographic surveying vessel 300B in a second direction 378 in response to movement through the water of the marine environment 364. The second direction 378 is a lateral direction. The second direction 378 is different to the first direction 376. The second direction 378 may be an opposite direction to the first direction 376.

[00343] The third towing element 311 constrains relative movement between the marine manoeuvring vessel 400, the second marine manoeuvring vessel 400B, the hydrographic surveying vessel 300 and the second hydrographic surveying vessel 300B. Specifically, the third towing element 311 limits the extent to which the marine manoeuvring vessel 400 and the second marine manoeuvring vessel 400B can separate. This also therefore limits the extent to which the hydrographic surveying vessel 300 and the second hydrographic surveying vessel 300B can separate, in use.

[00344] The towing vessel 303 itself may include an acoustic wave generator. Alternatively, the towing vessel 303 may tow an acoustic wave generator directly behind it (e.g. on another cable). This third acoustic wave generator may be on a third hydrographic surveying vessel (not shown) that is similar to, or the same as the hydrographic surveying vessel 300 in one or more

aspects. The towing vessel 303 may therefore be capable of performing a hydrographic survey of a respective swath using acoustic waves generated by the acoustic wave generator of the towing vessel 303.

[00345] The data collected as a result of each of the hydrographic surveying vessel 300, the second hydrographic surveying vessel 300B and the towing vessel 303 having a respective acoustic wave generator can be combined into a single hydrographic survey data set. The total effective swath of the hydrographic surveying system 301 may be considered to be the distance between an outer lateral boundary of the swath of the hydrographic surveying vessel 300 and an outer lateral boundary of the swath of the second hydrographic surveying vessel 300B.

Hydrographic Surveying System 501

[00346] Figures 18 and 19 show a hydrographic surveying system 501, according to some embodiments of the present disclosure. In particular, Figures 18 and 19 show the hydrographic surveying system 501 in a marine environment 564. Figure 20 is an upper perspective view of a part of the hydrographic surveying system 501. Figure 21 is a lower perspective view of the part of the hydrographic surveying system 501 that is shown in Figure 20, showing a representation of the part of the hydrographic surveying system 501 from under water.

[00347] The hydrographic surveying system 501 comprises a hydrographic surveying vessel 300. The hydrographic surveying system 501 comprises a marine manoeuvring vessel 400. The hydrographic surveying system 501 comprises a second hydrographic surveying vessel 300B. The hydrographic surveying system 501 comprises a second marine manoeuvring vessel 400B. The hydrographic surveying system 501 comprises a towing system 505.

Marine Manoeuvring Vessel 400

[00348] The hydrographic surveying system 501 comprises the marine manoeuvring vessel 400 described with reference to the hydrographic surveying system 301. It will be appreciated that one or more aspects of the marine manoeuvring vessel 400 of the hydrographic surveying system 501 may be different to the marine manoeuvring vessel 400 described with reference to the hydrographic surveying system 301. In the embodiment illustrated in Figures 20 and 21, the marine manoeuvring vessel 400 comprises a connecting member 571. Rather than the marine manoeuvring system 406 directly connecting to the marine manoeuvring vessel hull 402, in this embodiment, the connecting member 571 acts as an intermediate structural component between the marine manoeuvring vessel hull 402 and the marine manoeuvring system 406. That is, the marine manoeuvring system 406 is connected to one end of the connecting member 571. The marine manoeuvring vessel hull 402 is connected to another end of the connecting member 571. The connecting member 571 is a rigid member.

Hydrographic Surveying Vessel 300

[00349] The hydrographic surveying system 501 comprises the hydrographic surveying vessel 300 described with reference to the hydrographic surveying system 301. It will be

appreciated that one or more aspects of the hydrographic surveying vessel 300 of the hydrographic surveying system 501 may be different to one or more aspects of the hydrographic surveying vessel 300 described with reference to the hydrographic surveying system 301.

Second Marine Manoeuvring Vessel 400B

[00350] The hydrographic surveying system 501 comprises the second marine manoeuvring vessel 400B described with reference to the hydrographic surveying system 301. It will be appreciated that one or more aspects of the second marine manoeuvring vessel 400B of the hydrographic surveying system 501 may be different to one or more aspects of the second marine manoeuvring vessel 400B described with reference to the hydrographic surveying system 301.

Second Hydrographic Surveying Vessel 300B

[00351] The hydrographic surveying system 501 comprises the second hydrographic surveying vessel 300B described with reference to the hydrographic surveying system 301. It will be appreciated that one or more aspects of the second hydrographic surveying vessel 300B of the hydrographic surveying system 501 may be different to one or more aspects of the hydrographic surveying vessel 300 described with reference to the hydrographic surveying system 301.

Towing System 505

[00352] The hydrographic surveying system 501 comprises a towing vessel 503. The towing vessel 503 is configured to tow one or more parts of the hydrographic surveying system 501.

[00353] As described herein, the hydrographic surveying system 501 comprises a towing system 505. The towing system 505 is a modification on the towing system 305. As a result, the person skilled in the art would recognise that much of the description of the towing system 305 is also applicable to the towing system 505. The towing system 505 is connected to the hydrographic surveying vessel 300. The towing system 505 is connected to the second hydrographic surveying vessel 300B. The towing system 305 is connected to the marine manoeuvring vessel 400. The towing system 305 is connected to the second marine manoeuvring vessel 400B.

[00354] As described herein, the hydrographic surveying vessel tow mounting portions 354 facilitate a connection between the hydrographic surveying vessel 300 and the towing system 505. Further, the marine manoeuvring vessel towing connector assembly 456 is connected to the towing system 505. The hydrographic surveying vessel 300 and the marine manoeuvring vessel 400 are operably connected via the towing system 505. At least in part by virtue of this connection, movement of the marine manoeuvring vessel 400 causes movement of the hydrographic surveying vessel 300.

[00355] The towing system 505 comprises a first towing element 507. The first towing element 507 is operably connected to the hydrographic surveying vessel 300, at a first portion

of the first towing element 507. The first towing element 507 is operably connected to the towing connector assembly 356. The first towing element 507 may be connected to the towing connector assembly 356 of the hydrographic surveying vessel 300 at a junction 557. The first towing element 507 may be connected to the towing connector assembly 356 at or near one end of the first towing element 507.

[00356] The first towing element 507 is operably connected to the marine manoeuvring vessel 400. The first towing element 507 is operably connected to the marine manoeuvring vessel 400 at a second portion of the first towing element 507. The marine manoeuvring vessel towing connector 458 may comprise an intermediate marine manoeuvring vessel connector element 462A. The intermediate marine manoeuvring vessel connector element 462A may extend from the marine manoeuvring vessel towing connector 458 to a junction with the first towing element 307. In the illustrated embodiment, the intermediate marine manoeuvring vessel connector element 462A meets the first towing element 507 at the junction 557. It will be appreciated however, that it may meet the first towing element 507 at a junction at another point along the first towing element's 507 length.

[00357] The first towing element 507 is operably connected to the towing vessel 503. In particular, the first towing element 507 is operably connected to the towing vessel 503 at another portion of the first towing element 507. The other portion may be at an opposite end to the end at which the first towing element 507 is connected to the hydrographic surveying vessel 300. The towing vessel 503 is therefore operably connected to the hydrographic surveying vessel 300 via the first towing element 507. The towing vessel 503 is also operably connected to the marine manoeuvring vessel 400 via the first towing element 507. Movement of the towing vessel 503 therefore causes movement of the hydrographic surveying vessel 300. Movement of the towing vessel 503 also causes movement of the marine manoeuvring vessel 400. The first towing element 507 may be referred to as a first tow rope. The first towing element 507 may be in the form of a cable.

[00358] A communication line may run along the first towing element 507. In some embodiments, the communication line is integrated into the first towing element 507. The communication line enables data transfer between the hydrographic surveying vessel 300, the marine manoeuvring vessel 400 and the towing vessel 503.

[00359] A length of the first towing element 507 may be adjustable. For example, the first towing element 507 may be connected to a winch of the towing vessel 503. The winch may be operable to adjust the length of the first towing element 507 that extends off the towing vessel 503 and therefore, the distance between one or both of the hydrographic survey vessel 300, the marine manoeuvring vessel 400 and the towing vessel 503.

[00360] The towing system 505 comprises a second towing element 509. The second towing element 509 is operably connected to the second hydrographic surveying vessel 300B, at a first portion of the second towing element 509. The second towing element 509 is operably

connected to the towing connector assembly of the second hydrographic surveying vessel 300B. The second towing element 509 may be connected to the towing connector assembly of the second hydrographic surveying vessel 300B at a junction 557B. The second towing element 509 may be connected to the second towing connector assembly at or near one end of the second towing element 509.

[00361] The second towing element 509 is operably connected to the second marine manoeuvring vessel 400B. The second towing element 509 is operably connected to the second marine manoeuvring vessel 400B at a second portion of the second towing element 509. The marine manoeuvring vessel towing connector may comprise an intermediate marine manoeuvring vessel connector element 462B. The intermediate marine manoeuvring vessel connector element 462A may extend from the marine manoeuvring vessel towing connector to a junction with the second towing element 509. In the illustrated embodiment, the intermediate marine manoeuvring vessel connector element 462B meets the second towing element 509 at the junction 557B. It will be appreciated however, that it may meet the second towing element 509 at a junction at another point along the second towing element's 509 length.

[00362] The second towing element 509 is operably connected to the towing vessel 503. In particular, the second towing element 509 is operably connected to the towing vessel 503 at another portion of the second towing element 509. The other portion may be at an opposite end to the end at which the second towing element 509 is connected to the second hydrographic surveying vessel 300B. The towing vessel 503 is therefore operably connected to the second hydrographic surveying vessel 300B via the second towing element 509. The towing vessel 503 is also operably connected to the second marine manoeuvring vessel 400B via the second towing element 509. Movement of the towing vessel 503 therefore causes movement of the second hydrographic surveying vessel 300B. Movement of the towing vessel 503 also causes movement of the second marine manoeuvring vessel 400B. The second towing element 509 may be referred to as a second tow rope. The second towing element 509 may be in the form of a cable.

[00363] Lateral movement between the pairs of hydrographic survey vessels and marine manoeuvring vessels is only constrained by the first towing element 507 and the second towing element 509 in this embodiment, as there is no third towing element.

[00364] A communication line may run along the second towing element 509. In some embodiments, the communication line is integrated into the second towing element 509. The communication line enables data transfer between the second hydrographic surveying vessel 300B, the second marine manoeuvring vessel 400B and the towing vessel 503.

[00365] A length of the second towing element 509 may be adjustable. For example, the second towing element 509 may be connected to a winch of the towing vessel 503. The winch may be operable to adjust the length of the second towing element 509 that extends off the

towing vessel 503 and therefore, the distance between one or both of the second hydrographic surveying vessel 300B, the second marine manoeuvring vessel 400B and the towing vessel 503.

[00366] In operation, the towing vessel 503 moves across the marine environment 564 in a movement direction 566. The first towing element 507 and the second towing element 509 extend behind the towing vessel 503 as it moves. The towing vessel 503 tows the hydrographic surveying vessel 300 as it moves. The towing vessel 503 tows the second hydrographic surveying vessel 300B as it moves. As described herein, the marine manoeuvring vessel 400 is operably connected to the hydrographic surveying vessel 300 via the first towing element 507. The towing vessel 303 therefore also tows the marine manoeuvring vessel 400 as it moves. Similarly, the second the marine manoeuvring vessel 400B is operably connected to the second hydrographic surveying vessel 300B via the second towing element 309. The towing vessel 303 therefore also tows the second the marine manoeuvring vessel 400B as it moves.

[00367] The marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 through the marine environment 564. In particular, the marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 with respect to the towing vessel 503 as the marine manoeuvring vessel 400 and the hydrographic surveying vessel 300 are towed by the towing vessel 503. The marine manoeuvring vessel 400 is configured to manoeuvre the hydrographic surveying vessel 300 such that it is maintained in a lateral position with respect to the towing vessel 503 as it is towed by the towing vessel 503. In other words, the marine manoeuvring vessel 400 is configured to influence the heading of the hydrographic surveying vessel 300.

[00368] The marine manoeuvring system 406 of the marine manoeuvring vessel 400 is configured to bias the hydrographic surveying vessel 300 in a first direction 576 in response to movement through the water of the marine environment 564. The first direction 576 is a lateral direction. It may therefore be said that the marine manoeuvring vessel 400 is configured to laterally bias movement of the hydrographic surveying vessel 300. In particular, the manoeuvring elements 424 are configured to bias the hydrographic surveying vessel 300 in the first direction 576. The marine manoeuvring vessel 400 therefore influences the heading of the hydrographic surveying vessel 300 such that the hydrographic surveying vessel 300 is directed towards the lateral position with respect to the towing vessel 503 as it is towed by the towing vessel 503. When the hydrographic surveying vessel 300 is being towed by the towing vessel 503, the first towing element 507 extends away from the towing vessel 503 at a towing angle 568. The towing angle 568 may be influenced by one or more of the speed of the towing vessel 503, the configuration of the marine manoeuvring system 406, the length of the first towing element 507 and the length of the second towing element 509.

[00369] The second marine manoeuvring vessel 400B is configured to similarly manoeuvre the second hydrographic surveying vessel 300B through the marine environment 564. The second marine manoeuvring vessel 400B is configured to manoeuvre the second hydrographic

surveying vessel 300B such that it is maintained in a second lateral position with respect to the towing vessel 503 as it is towed by the towing vessel 503.

[00370] The second marine manoeuvring system is configured to bias the second hydrographic surveying vessel 300B in a second direction 578 in response to movement through the water of the marine environment 564. The second direction 578 is a lateral direction. The second direction 578 is different to the first direction 576. The second direction 578 may be an opposite direction to the first direction 576.

[00371] The towing vessel 503 itself may include an acoustic wave generator. Alternatively, the towing vessel 503 may tow an acoustic wave generator directly behind it (e.g. on another cable). This third acoustic wave generator may be on a third hydrographic surveying vessel (not shown) that is similar to, or the same as the hydrographic surveying vessel 300 in one or more aspects. The towing vessel 503 may therefore be capable of performing a hydrographic survey of a respective swath using acoustic waves generated by the acoustic wave generator of the towing vessel 503.

[00372] The data collected as a result of each of the hydrographic surveying vessel 300, the second hydrographic surveying vessel 300B and the towing vessel 503 having a respective acoustic wave generator can be combined into a single hydrographic survey data set. The total effective swath of the hydrographic surveying system 501 may be considered to be the distance between an outer lateral boundary of the swath of the hydrographic surveying vessel 300 and an outer lateral boundary of the swath of the second hydrographic surveying vessel 300B.

Advantages

[00373] The hydrographic surveying systems 301, 501 described herein provides a number of significant advantages when compared to existing hydrographic surveying systems. As described herein, the hydrographic surveying vessel 300 and the marine manoeuvring vessel 400 may be used in tandem with a towing vessel 303, 503 and one or more other hydrographic surveying vessel/ marine manoeuvring vessel of the same or similar design, to significantly increase the total effective swath of a particular pass of the marine environment 346, 546. The use of the hydrographic surveying systems 301, 501 provides a significant increase in the swath of a single pass of the towing vessel 303, 503. In some embodiments, the hydrographic surveying systems 301, 501 may enable a doubling or a tripling of the swath of the towing vessel 303, 503. This can result in the ability to perform hydrographic surveys significantly more efficiently. The towing vessel 303, 503 does not need to perform as many passes of the marine environment 346, 546 to survey it. This reduces the time taken to perform a survey and the costs involved with performing the survey by enabling more efficient use of the towing vessel 303, 503.

[00374] As described herein, a plurality of hydrographic surveying vessels can be used simultaneously. Although the hydrographic surveying system 301, 501 is described as including two hydrographic surveying vessels 300, 300B, it will be appreciated that in some

embodiments, it may include a different number of hydrographic surveying vessels. For example, it may include three hydrographic surveying vessels. The hydrographic surveying vessel 300, the marine manoeuvring vessel 400 and the towing system 305, 505 include a relatively low number of moving parts. The reliability of the hydrographic surveying vessel 300, the marine manoeuvring vessel 400 and/or the towing system 305, 505 may therefore be better than that of other designs.

[00375] Further, as the hydrographic surveying vessel 300 and the marine manoeuvring vessel 400 are separated, different hydrographic surveying vessels can be interchanged with different marine manoeuvring vessels as required by a particular survey. This modular nature of the hydrographic surveying systems 301, 501 enables them to be used across a wider range of surveys with greater flexibility.

Hydrographic Surveying Vessel 800

[00376] Figure 25 shows a hydrographic surveying vessel 800, according to some embodiments of the present disclosure. Figures 23 and 24 show a hydrographic surveying system 801, according to some embodiments of the present disclosure. In particular, Figures 23 and 24 show the hydrographic surveying system 801 in a marine environment 864.

[00377] One or more features of the hydrographic surveying vessel 800 may be the same as, or similar to, one or more features of the hydrographic surveying vessels 200, 700 described herein. One or more features of the hydrographic surveying vessel 800 may be different to one or more features of the hydrographic surveying vessels 200, 700 described herein.

[00378] The hydrographic surveying vessel 800 comprises a hull 802. The hull 802 extends from a front 802A to a rear 802B. The hull 802 comprises a plurality of hull walls 804. The hull walls 804 define an internal volume of the hull 802. The hull 802 may comprise one or more hull openings that provide access to the internal volume of the hull 802 from outside the hull 802. The hull openings may be capped to inhibit water ingress during use of the hydrographic surveying vessel 800.

[00379] The hydrographic surveying vessel 800 comprises a mast 881. The mast 881 extends outwards from the hull 802. The mast 881 extends upwards when the hydrographic surveying vessel 800 is in use.

[00380] The hydrographic surveying vessel 800 comprises a manoeuvring system 806. The manoeuvring system 806 may be referred to as a marine manoeuvring system 806. Thus, the hydrographic surveying vessel 800 may be said to comprise a marine manoeuvring system 806. The marine manoeuvring system 806 comprises a marine manoeuvring system body 812. The marine manoeuvring system 806 extends between a first end portion 808 and a second end portion 810. In particular, the marine manoeuvring system body 812 extends between the first end portion 808 and the second end portion 810. The first end portion 808 is disposed near to the hull 802. The first end portion 808 defines at least part of a first end of the marine manoeuvring system 806. The second end portion 810 defines at least part of a second end of

the marine manoeuvring system 806. The marine manoeuvring system 806 is in the form of a rudder. The marine manoeuvring system 806 is operatively connected to the hull 802.

[00381] The hydrographic surveying vessel 800 comprises an acoustic wave generator portion 844. The acoustic wave generator portion 844 comprises an acoustic wave generator 846. The acoustic wave generator 846 is configured to generate acoustic waves in a fluid around the acoustic wave generator 846. In this case, the acoustic wave generator 846 generates acoustic waves in the water that surrounds the acoustic wave generator 846 in use.

[00382] The hydrographic surveying vessel 800 comprises an acoustic wave receiver. The acoustic wave receiver is configured to detect acoustic waves that are emitted by the acoustic wave generator 846 and reflected by a portion of the marine environment 864. The acoustic wave generator 846 may comprise the acoustic wave receiver.

[00383] The acoustic wave generator 846 comprises a multibeam echosounder. In the illustrated embodiment, the acoustic wave generator 846 is in the form of a multibeam echosounder. In some embodiments, the acoustic wave generator 846 may comprise, or be in the form of, a single beam echosounder. In some embodiments, the acoustic wave generator 846 may comprise, or be in the form of, a side scan sonar system.

[00384] The hydrographic surveying vessel 800 comprises an elongate member 848. The elongate member 848 is in the form of a keel 848. In particular, the acoustic wave generator portion 844 comprises the keel 848. The keel 848 is in the form of an elongate body. The keel 848 extends in a longitudinal direction from a first keel end 850 to a second keel end 852. The acoustic wave generator 846 is connected to the keel 848. In particular, the acoustic wave generator 846 is removably connected to the keel 848. The keel 848 enables the removable connection of the acoustic wave generator 846. The keel 848 is configured to be connected to the marine manoeuvring system 206.

[00385] The hull 802 comprises an acoustic wave generator connecting portion. The acoustic wave generator connecting portion enables the acoustic wave generator portion 844 to be connected to the hull 802. In other words, the acoustic wave generator portion 844 is configured to be connected to the hull 802. The acoustic wave generator 846 connects to the second keel end 852. The first keel end 850 connects to the hull 802.

[00386] In some embodiments, the acoustic wave generator 846 may directly connect to the hull 802. That is, some embodiments may not include the keel 848.

[00387] In the illustrated embodiment, the second keel end 852 is further away from the hull 802 than the first keel end 850. The acoustic wave generator 846 is further away from the hull 802 than the first keel end 850. The acoustic wave generator 846 is further away from the hull 802 than the second keel end 852. The acoustic wave generator 846 is further away from the hull 802 than the keel 848. The acoustic wave generator 846 is disposed on an opposite side of the keel 848 as the hull 802.

[00388] The keel 848 may define a channel through which one or more cables connecting the acoustic wave generator 846 and an associated controller can be connected. This configuration may be as described with reference to the hydrographic surveying vessel 700. Specifically, the hull 802 may house the acoustic wave generator controller. The acoustic wave generator controller may communicate with the acoustic wave generator 846 via one or more cables that pass through the channel of the keel 848.

[00389] The hydrographic surveying vessel 800 comprises one or more tow mounting portions 854. The tow mounting portions 854 enable things such as tow ropes to be connected to the hydrographic surveying vessel 800. The illustrated embodiment comprises a plurality of tow mounting portions 854. In particular, the illustrated hydrographic surveying vessel 800 comprises two tow mounting portions 854. The hull 802 comprises one or more of the tow mounting portions 854. The keel 848 may comprise one or more tow mounting portions 854. The acoustic wave generator 846 may comprise one or more tow mounting portions 854.

[00390] The hydrographic surveying vessel 800 comprises a towing connector assembly 856. The towing connector assembly 856 may be referred to as a bridle. The towing connector assembly 856 may comprise a towing connector 858. The towing connector 858 may be as described with respect to other towing connectors herein.

[00391] The towing connector assembly 856 comprises a plurality of connector elements 862. One or more of the tow mounting portions 854 enable connection of a respective connector element 862 thereto. One or more of the connector elements 862 is connected to the towing connector 858.

[00392] The hydrographic surveying vessel 800 comprises a sensing system.

[00393] The sensing system comprises a motion reference unit (MRU). The MRU is configured to generate motion data. The motion data is time series data indicative of a value of one or more motion parameters associated with the hydrographic surveying vessel 800. The motion data comprises roll angle data. The roll angle data is indicative of a roll angle of the hydrographic surveying vessel 800 across a time window of operation of the hydrographic surveying vessel 800. The motion data comprises pitch angle data. The pitch angle data is indicative of a pitch angle of the hydrographic surveying vessel 800 across the time window of operation. The motion data comprises heave angle data. The heave angle data is indicative of a heave angle of the hydrographic surveying vessel 800 across the time window of operation.

[00394] The sensing system comprises a Global Navigation Satellite System (GNSS) module. The GNSS module is configured to generate GNSS data. The GNSS data is time series data. The GNSS data is indicative of a heading of the hydrographic surveying vessel 800 across the time window of operation of the hydrographic surveying vessel 800. The GNSS data is indicative of a longitude of the hydrographic surveying vessel 800 across the time window of operation. The GNSS data is indicative of a latitude of the hydrographic surveying vessel 800 across the time window of operation.

[00395] The sensing system comprises an altimeter. The altimeter is configured to indicate an altitude of the hydrographic surveying vessel 800.

[00396] The sensing system comprises an accelerometer. The accelerometer is configured to generate an acceleration output indicative of an acceleration of the hydrographic surveying vessel 800.

[00397] The sensing system comprises a gyroscope. The gyroscope is configured to generate gyroscopic data indicative of an orientation of the hydrographic surveying vessel 800.

[00398] The sensing system comprises a magnetometer. The magnetometer is configured to generate magnetic field data that is indicative of an azimuth orientation of the hydrographic surveying vessel 800.

[00399] The sensing system comprises an imaging module. The imaging module is configured to generate image data that is associated with a region around the hydrographic surveying vessel 800. The imaging module may comprise a visible spectrum imaging module. The visible spectrum imaging module may be configured to generate visible spectrum imaging data. The imaging module may comprise a light detection and ranging (LIDAR) module. The LIDAR module may be configured to generate LIDAR data. The imaging module may comprise a radio detecting and ranging (RADAR) module. The RADAR module may be configured to generate RADAR data. The image data may comprise one or more of the visible spectrum image data, the LIDAR data and the RADAR data.

[00400] The hydrographic surveying vessel 800 may comprise a control system (not shown). Alternatively, the hydrographic surveying system 801 may comprise the control system. In such a case, the control system may be associated with the hydrographic surveying vessel. For example, the control system may be a remote control. The remote control may be on the vessel towing the hydrographic surveying vessel 800. The control system is configured to control, or enable control of, the marine manoeuvring system 806 to influence a heading of the hydrographic surveying vessel 800. The control system may control the marine manoeuvring system 806 based at least in part on sensing system data determined using the sensing system.

[00401] The control system comprises an actuator. The actuator is configured to actuate one or more component of the hydrographic surveying vessel 800. The actuator is connected to the marine manoeuvring system 806. The actuator actuates the marine manoeuvring system 806. In particular, the actuator actuates the rudder within a range of motion of the rudder. The actuator may be in the form of an electric motor.

[00402] The control system may comprise a remote control interface. The remote control interface may enable an operator to control one or more aspect of the hydrographic surveying vessel 800. For example, the remote control interface may enable the operator to control the actuator.

[00403] In some embodiments, the control system may autonomously control the hydrographic surveying vessel 800. The control system may control the actuator based at least in part on the sensing system data.

[00404] The control system may comprise an electric motor. The electric motor may be operatively connected to the marine manoeuvring system 806. The electric motor may rotate the marine manoeuvring system 806 within a range of motion. In particular, the electric motor may rotate the rudder within a range of motion, thereby influencing the heading of the hydrographic surveying vessel 800.

[00405] At least part of the sensing system may be housed within the hull 802. For example, the MRU may be housed within the hull 802. The GNSS module may be housed within the hull 802. One or more parts of the MRU and/or the GNSS module may extend outside the hull 802. For example, an antenna of the GNSS module may extend out of the hull 802. In the illustrated embodiment, the antenna of the GNSS module extends through the mast 881. At least part of the sensing system may be mounted externally to the hull 802. For example, the MRU may be mounted to an exterior of the hull 802. The GNSS module may be mounted to an exterior of the hull 802.

[00406] At least part of the control system (e.g. the actuator) may be housed in the hull 804.

[00407] In some embodiments, one or more of the GNSS module, the MRU and the acoustic wave generator 846 are part of an integrated unit. That is, in some embodiments, the hydrographic surveying vessel 800 comprises a sensing unit that comprises one or more of the GNSS module, the MRU and the acoustic wave generator 846. This sensing unit may be referred to as the acoustic wave generator 846.

Hydrographic Surveying System 801

[00408] Figures 23 and 24 show a hydrographic surveying system 801, according to some embodiments of the present disclosure. The hydrographic surveying system 801 comprises the hydrographic surveying vessel 800 described with reference to Figure 24. The hydrographic surveying system 801 comprises a second hydrographic surveying vessel 800B. One or more components of the second hydrographic surveying vessel 800B may be similar to, or the same as one or more components of the hydrographic surveying vessel 800.

Towing System 805

[00409] The hydrographic surveying system 801 comprises a towing vessel 803. The towing vessel 803 is configured to tow one or more parts of the hydrographic surveying system 801.

[00410] As described herein, the hydrographic surveying system 801 comprises a towing system 805. The towing system 805 is connected to the hydrographic surveying vessel 800. The towing system 805 is connected to the second hydrographic surveying vessel 800B. The towing system 805 is connected to the towing vessel 803. Thus, the towing system 805 is configured to operatively link the hydrographic surveying vessels 800, 800B and the towing vessel 803.

[00411] The tow mounting portions 854 facilitate a connection between the hydrographic surveying vessel 800 and the towing system 805.

[00412] The towing system 805 comprises a first towing element 807. The first towing element 807 is operably connected to the hydrographic surveying vessel 800. The first towing element 807 is connected to the hydrographic surveying vessel 800 at a first portion of the first towing element 807. The first towing element 807 is connected to the towing vessel 803 at a second portion of the first towing element 807. The first towing element 807 may connect to the towing connector assembly 856. For example, it may connect to the towing connector 858. Alternatively, the first towing element 807 may be considered a connector element 862 of the towing connector assembly 856.

[00413] The first towing element 807 is operably connected to the towing connector assembly 856. The first towing element 207 is connected to the towing connector assembly 856 at a junction 857. The first towing element 207 is connected to the towing connector assembly 856 at one end of the first towing element 207. The first towing element 207 may be connected to the towing connector 258 at a pulley. In some embodiments, the first towing element 807 is connected to one or more of the tow mounting portions 854 of the hydrographic surveying vessel 800.

[00414] The first towing element 807 is operably connected to the towing vessel 803. In particular, the first towing element 207 is connected to the towing vessel 803 at an opposite end to the end at which it is connected to the hydrographic surveying vessel 800. The towing vessel 803 is therefore operably connected to the hydrographic surveying vessel 800 via the first towing element 807. The first towing element 807 may be referred to as a first tow rope. The first towing element 807 may be in the form of a cable.

[00415] A communication line may run along the first towing element 807. In some embodiments, the communication line is integrated into the first towing element 807. The communication line enables data transfer between the hydrographic surveying vessel 800 and the towing vessel 803. In particular, communication between the sensing system and the towing vessel 803 may be enabled via the communication line. Similarly, communication between the acoustic wave generator 846 and the towing vessel 803 may be enabled via the communication line.

[00416] A length of the first towing element 807 may be adjustable. For example, the first towing element 807 may be connected to a winch of the towing vessel 803. The winch may be operable to adjust the length of the first towing element 807 that extends off the towing vessel 803 and therefore, the distance between the hydrographic surveying vessel 800 and the towing vessel 803.

[00417] The towing system 805 comprises a second towing element 809. The second towing element 809 is connected to the hydrographic surveying vessel 800 at one end and a junction with the first towing element 857 at a second end. In this case, the junction is

junction 857. The second towing element 809 may connect to one of the tow mounting portions 854. In some embodiments, the second towing element 809 may be considered a connector element 862 of the towing connector assembly 856.

[00418] The towing system 805 comprises a third towing element 811. The third towing element 811 is operably connected to the second hydrographic surveying vessel 800B. The third towing element 811 is connected to the second hydrographic surveying vessel 800B at a first portion of the third towing element 811. The third towing element 811 is connected to the towing vessel 803 at a second portion of the third towing element 811.

[00419] The third towing element 811 is operably connected to the towing connector assembly 856. The third towing element 811 is connected to the towing connector assembly 856 at a junction 857B. The third towing element 811 is connected to the towing connector assembly 856 at one end of the third towing element 811. The third towing element 811 may be connected to the towing connector 258 at a pulley. In some embodiments, the third towing element 811 is connected to one or more of the tow mounting portions 854 of the hydrographic surveying vessel 800.

[00420] The third towing element 811 is operably connected to the towing vessel 803. In particular, the third towing element 811 is connected to the towing vessel 803 at an opposite end to the end at which it is connected to the second hydrographic surveying vessel 800B. The towing vessel 803 is therefore operably connected to the second hydrographic surveying vessel 800B via the third towing element 811. The third towing element 811 may be referred to as a third tow rope. The third towing element 811 may be in the form of a cable.

[00421] A communication line may run along the third towing element 811. In some embodiments, the communication line is integrated into the third towing element 811. The communication line enables data transfer between the second hydrographic surveying vessel 800B and the towing vessel 803. In particular, communication between the sensing system and the towing vessel 803 may be enabled via the communication line. Similarly, communication between the acoustic wave generator 846 and the towing vessel 803 may be enabled via the communication line.

[00422] A length of the third towing element 811 may be adjustable. For example, the third towing element 811 may be connected to a winch of the towing vessel 803. The winch may be operable to adjust the length of the third towing element 811 that extends off the towing vessel 803 and therefore, the distance between the second hydrographic surveying vessel 800B and the towing vessel 803.

[00423] The towing system 805 comprises a fourth towing element 813. The fourth towing element 813 connected to the hydrographic surveying vessel 800 at one end and a junction with the second towing element 811 at a second end. In this case, the junction is junction 857. The fourth towing element 813 may connect to one of the tow mounting portions 854 of the second

hydrographic surveying vessel 800. In some embodiments, the fourth towing element 813 may be considered a connector element 862 of the towing connector assembly 856.

[00424] In operation, the towing vessel 803 moves across the marine environment 864 in a movement direction 866. The first towing element 807 and the third towing element 811 extend behind the towing vessel 803 as it moves. The towing vessel 803 tows the hydrographic surveying vessel 800 as it moves. The towing vessel 803 tows the second hydrographic surveying vessel 800B as it moves.

[00425] The control system may be used to control the rudder to enable accurate lateral positioning of the hydrographic surveying vessel 800. In some embodiments, the remote control interface is used to control the rudder.

[00426] In some embodiments, the control system may autonomously control the rudder. For example, a desired position of the hydrographic surveying vessel 800 can be set and the control system will control the rudder to adjust the heading of the hydrographic surveying vessel 800 such that the hydrographic surveying vessel 800 is directed towards the desired lateral position. In the illustrated embodiment, the hydrographic surveying vessel 800 is directed in a first direction 876.

[00427] It may therefore be said that the marine manoeuvring system 806 is configured to laterally bias movement of the hydrographic surveying vessel 800. The marine manoeuvring system 806 of the marine manoeuvring vessel 800 is configured to bias the marine manoeuvring vessel 800 in a first direction 876 in response to movement through the water of the marine environment 864. The first direction 876 is a lateral direction. In some embodiments, the rudder is fixed in place prior to use. Thus, the marine manoeuvring system 806 may not be adjustable when in use in the water. In some embodiments, the marine manoeuvring system 806 is moveable in use as described herein.

[00428] The control system of the second hydrographic surveying vessel 800B may also be used to control the rudder to enable accurate lateral positioning of the second hydrographic surveying vessel 800B. In some embodiments, a second remote control interface is used to control the rudder.

[00429] In some embodiments, the control system may autonomously control the rudder. For example, a desired position of the second hydrographic surveying vessel 800B can be set and the control system will control the rudder to adjust the heading of the second hydrographic surveying vessel 800B such that the second hydrographic surveying vessel 800B is directed towards the desired lateral position. In the illustrated embodiment, the second hydrographic surveying vessel 800B is directed in a second direction 878. It may therefore be said that the marine manoeuvring system 806 is configured to laterally bias movement of the second hydrographic surveying vessel 800B. The marine manoeuvring system of the second marine manoeuvring vessel 800 is configured to bias the second marine manoeuvring vessel 800B in a

second direction 877 in response to movement through the water of the marine environment 864. The second direction 878 is a lateral direction.

[00430] The control systems enable control of the marine manoeuvring system 806 of each of the hydrographic surveying vessels 800, 800B to maintain a separation that is consistent with the requirements of the survey being undertaken.

[00431] The towing vessel 803 itself may include an acoustic wave generator. Alternatively, the towing vessel 803 may tow an acoustic wave generator directly behind it (e.g. on another cable). This third acoustic wave generator may be on a third hydrographic surveying vessel (not shown) that is similar to, or the same as the hydrographic surveying vessel 800 in one or more aspects. The towing vessel 803 may therefore be capable of performing a hydrographic survey of a respective swath using acoustic waves generated by the acoustic wave generator of the towing vessel 803.

Advantages

[00432] As described with reference to other embodiments herein, the hydrographic surveying vessel 800 provides a number of significant advantages when compared to existing hydrographic surveying vessels. The hydrographic surveying vessel 800 may be used in tandem with a towing vessel 803 and one or more other hydrographic surveying vessels of the same or similar design, to significantly increase the total effective swath of a particular pass of the marine environment 864. In some embodiments, the hydrographic surveying vessel 800 may enable a doubling of the swath of the towing vessel 803 (where the towing vessel 803 also includes its own associated acoustic wave generator). The hydrographic surveying system 801 described herein includes the use of a second hydrographic surveying vessel 800. The use of an additional hydrographic surveying vessel of the same or similar design enables a further increase in the swath of a single pass of the marine environment 864. The illustrated hydrographic surveying system 801 enables, or almost enables, a tripling of the swath of a single pass of the marine environment 864. This can result in the ability to perform hydrographic surveys significantly more efficiently. The towing vessel 803 does not need to perform as many passes of the marine environment 864 to survey it. This reduces the time taken to perform a survey and the costs involved with performing the survey by enabling more efficient use of the towing vessel 803.

[00433] The hydrographic surveying vessel 800 is a fully integrated design. That is, the hydrographic surveying vessel 800 may be constructed and housed in a fully constructed form, ready for use. This simplifies the launch and recovery of the hydrographic surveying vessel 800 as no additional components/vessels are required to be launched for the hydrographic surveying vessel 800 to function. The launch and recovery of the hydrographic surveying vessel 800 can be undertaken by a crane.

[00434] As described herein, a plurality of hydrographic surveying vessels can be used simultaneously. Although the hydrographic surveying system 801 is described as including two

hydrographic surveying vessels 800, 800B, it will be appreciated that in some embodiments, it may include a different number of hydrographic surveying vessels. For example, it may include three hydrographic surveying vessels. The hydrographic surveying vessel 800 and the towing system 805 include a relatively low number of moving parts. The reliability of the hydrographic surveying vessel 800 and/or the towing system 805 may therefore be better than that of other designs.

[00435] In the claims which follow and in the preceding description, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e., to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the disclosure.

CLAIMS

1. A hydrographic surveying vessel comprising:
 - a hull;
 - a marine manoeuvring system; and
 - an acoustic wave generator;wherein:
 - a first end portion of the marine manoeuvring system is configured be connected to the hull; and
 - a second end portion of the marine manoeuvring system is configured to be connected to the acoustic wave generator, the second end portion of the marine manoeuvring system being further away from the hull than the first end portion when the marine manoeuvring system is connected to the hull.
2. The hydrographic surveying vessel of claim 1, further comprising an acoustic wave generator controller, the acoustic wave generator controller being:
 - housed within the hull; and
 - in communication with the acoustic wave generator, thereby enabling the acoustic wave generator controller to control the acoustic wave generator.
3. The hydrographic surveying vessel of claim 1 or claim 2, further comprising a sensing system, the sensing system comprising:
 - a motion reference unit that is configured to generate motion data, the motion data being time series data indicative of a roll angle, a pitch angle and a heave angle of the hydrographic surveying vessel; and
 - a Global Navigation Satellite System (GNSS) module configured to generate GNSS data that is indicative of a heading, a latitude and a longitude of the hydrographic surveying vessel.
4. The hydrographic surveying vessel of any one of claims 1 to 3, further comprising a network interface that is configured to enable communication between the hydrographic surveying vessel and another computing device.
5. The hydrographic surveying vessel of any one of claims 1 to 4, further comprising a power system, at least part of the power system being housed within the housing.
6. The hydrographic surveying vessel of any one of claims 1 to 5, wherein the marine manoeuvring system comprises:
 - a first end body;

a second end body; and
a plurality of manoeuvring elements.

7. The hydrographic surveying vessel of claim 6, wherein:
the first end body defines at least part of a first end of the marine manoeuvring system;
and
the second end body defines at least part of a second end of the marine manoeuvring system.
8. The hydrographic surveying vessel of claim 6 or claim 7, wherein one or more of the manoeuvring elements:
extends from a first manoeuvring element end to a second manoeuvring element end;
is connected to the first end body at the first manoeuvring element end; and
is connected to the second end body at the second manoeuvring element end.
9. The hydrographic surveying vessel of any one of claims 6 to 8, wherein:
the first end body comprises a first end plate; and
the second end body comprises a second end plate.
10. The hydrographic surveying vessel of any one of claims 6 to 9, wherein one or more of the manoeuvring elements extends orthogonally with respect to an inner surface of the first end body and an inner surface of the second end body.
11. The hydrographic surveying vessel of any one of claims 6 to 10, wherein the manoeuvring elements are vanes that are configured to influence a heading of the hydrographic surveying vessel in a fluid.
12. The hydrographic surveying vessel of any one of claims 6 to 11, wherein the first end body comprises a hull connecting portion that is configured to enable the hull to be connected to the first end body.
13. The hydrographic surveying vessel of any one of claims 6 to 12, wherein the second end body comprises an acoustic wave generator connecting portion that is configured to enable the acoustic wave generator to be connected to the second end body.
14. The hydrographic surveying vessel of any one of claims 6 to 13, wherein the acoustic wave generator is disposed on an opposite side of the second end body to the manoeuvring elements.

15. The hydrographic surveying vessel of any one of claims 6 to 14, wherein the acoustic wave generator is disposed on an opposite side of the manoeuvring elements to the hull, when the hull is connected to the marine manoeuvring system.
16. The hydrographic surveying vessel of any one of claims 6 to 15, wherein the marine manoeuvring system defines a channel that is configured to receive a cable.
17. The hydrographic surveying vessel of claim 16, when dependent on claim 2, further comprising the cable, wherein the acoustic wave generator controller communicates with the acoustic wave generator using the cable.
18. The hydrographic surveying vessel of claim 16 or claim 17, wherein one of the manoeuvring elements defines at least part of the channel, the part of the channel defined by the manoeuvring element extending from a first manoeuvring element end of the manoeuvring element to a second manoeuvring element end of the manoeuvring element.
19. The hydrographic surveying vessel of claim 18, wherein:
the first end body defines a first part of the channel, the first part of the channel extending from a first end face of the first end body to a second end face of the first end body; and
the part of the channel that is defined by the manoeuvring element is an intermediate part of the channel.
20. The hydrographic surveying vessel of claim 18 or claim 19, wherein:
the second end body defines a second part of the channel, the second part of the channel extending from a first end face of the second end body to a second end face of the second end body.
21. The hydrographic surveying vessel of any one of claims 6 to 20, wherein the plurality of manoeuvring elements comprises:
a fixed manoeuvring element; and
a movable manoeuvring element.
22. The hydrographic surveying vessel of claim 21, when dependent on claim 16, wherein the fixed manoeuvring element defines an intermediate part of the channel.

23. The hydrographic surveying vessel of claim 22, wherein the intermediate part of the channel extends from a first manoeuvring element end of the fixed manoeuvring element to a second manoeuvring element end of the fixed manoeuvring element.
24. The hydrographic surveying vessel of claim 16 or claim 17, wherein the marine manoeuvring system comprises an elongate element that extends between the first end body and the second end body, the elongate element defining at least part of the channel.
25. The hydrographic surveying vessel of claim 24, wherein:
the first end body defines a first part of the channel, the first part of the channel extending from a first end face of the first end body to a second end face of the first end body; and
the elongate element defines a second part of the channel, the second part of the channel extending along the length of the elongate element.
26. The hydrographic surveying vessel of claim 25, wherein the second end body defines a third part of the channel, the third part of the channel extending from a first end face of the second end body to a second end face of the second end body.
27. The hydrographic surveying vessel of claim 26, wherein the first part of the channel, the second part of the channel and the third part of the channel are coaxial.
28. The hydrographic surveying vessel of any one of claims 24 to 27, wherein the elongate element is closer to a trailing end of the marine manoeuvring system than a leading end of the marine manoeuvring system.
29. The hydrographic surveying vessel of any one of claims 24 to 28, wherein at least part of the elongate element is closer to the trailing end of the marine manoeuvring system than each of the manoeuvring elements.
30. The hydrographic surveying vessel of any one of claims 24 to 29, wherein the elongate element is laterally offset with respect to a rearmost manoeuvring element.
31. The hydrographic surveying vessel of any one of claims 1 to 30, wherein the acoustic wave generator is closer to a leading end of the marine manoeuvring system than a trailing end of the marine manoeuvring system.
32. The hydrographic surveying system of claim 31, wherein the acoustic wave generator is mounted to a leading quarter of the marine manoeuvring system.

33. The hydrographic surveying vessel of any one of claims 1 to 32, wherein the housing comprises a cable gland that is configured to:
- enable a cable to pass from outside the housing into the housing; and
 - inhibit water ingress.
34. The hydrographic surveying vessel of any one of claims 1 to 33, further comprising one or more vessel tow mounting portions, each vessel tow mounting portion being configured to enable connection of a connector element.
35. The hydrographic surveying vessel of claim 34, further comprising a towing connector assembly, the towing connector assembly comprising:
- a towing connector comprising a plurality of towing connector mounting portions; and
 - a plurality of connector elements;
- wherein:
- one or more of the connector elements is configured to be connected to one of the towing connector mounting portions at one end; and
 - one or more of the connector elements are configured to be connected to one of the vessel tow mounting portions at another end.
36. The hydrographic surveying vessel of any one of claims 1 to 35, wherein the acoustic wave generator comprises a multibeam echosounder.
37. A hydrographic surveying system comprising:
- the hydrographic surveying vessel of any one of claims 1 to 38;
 - a second hydrographic surveying vessel; and
 - a towing system that is configured to connect to the hydrographic surveying vessel and the second hydrographic surveying vessel, thereby operably linking the hydrographic surveying vessel and the second hydrographic surveying vessel.
38. The hydrographic surveying system of claim 37, wherein:
- the second hydrographic surveying vessel comprises:
 - a second hull;
 - a second marine manoeuvring system;
 - a second acoustic wave generator; and
 - a second towing connector assembly, the second towing connector assembly
- comprising:

a second towing connector comprising a plurality of second towing connector mounting portions; and

a plurality of second connector elements;

a first end of the second marine manoeuvring system is configured to be connected to the second hull;

a second end of the second marine manoeuvring system is configured to be connected to the second acoustic wave generator, the second end of the second marine manoeuvring system being further away from the second hull than the first end when the second marine manoeuvring system is connected to the second hull; and

each second connector element is configured to be connected to one of the second towing connector mounting portions at one end; and

one or more of the second connector elements are configured to be connected to a respective second vessel tow mounting portion of the second hydrographic surveying vessel at another end.

39. The hydrographic surveying system of claim 38, wherein:

the marine manoeuvring system is configured to bias the hydrographic surveying vessel in a first direction in response to movement through a fluid in a movement direction;

the second marine manoeuvring system is configured to bias the second hydrographic surveying vessel in a second direction in response to movement through the fluid in the movement direction;

the first direction is different to the second direction.

40. The hydrographic surveying system of claim 28 or claim 29, when dependent on claim 35 wherein the towing system comprises:

a first towing element that is configured to be operably connected to the towing connector;

a second towing element that is configured to be operably connected to the second towing connector; and

a third towing element that is configured to be operably connected to the hydrographic surveying vessel at one end and the second hydrographic surveying vessel at another end, such that relative movement between the hydrographic surveying vessel and the second hydrographic surveying vessel is constrained.