A tugboat's power is typically stated by its engine's horsepower and its overall bollard pull. The largest commercial harbour tugboats in the 2000s-2010s, used for towing container ships or similar, had around 60-65 tons of bollard pull, which is considered as 15 tons above "normal" tugboats.

Tugboats are highly manoeuvrable, and various propulsion systems have been developed to increase manoeuvrability and safety. Most tugboats are propeller-driven. Kort nozzles have been added to increase thrust per kW/hp. Nozzle-rudders omit the need for a conventional rudder. Tugboats are typically provided with a so-called Z-drive or (azimuth thruster) which is a pod that can rotate 360° allowing for rapid changes in the thrust direction.

In addition or as an alternative tugboats have been provided with a Voith-Schneider propeller (VSP), also known as a cycloidal drive which is a specialized marine propulsion system. The VSP is highly manoeuvrable, being able to change the direction of its thrust almost instantaneously. It is widely used on tugboats. From a circular plate, rotating around a vertical axis, a circular array of vertical blades (in the shape of hydrofoils) protrude out of the bottom of the boat. Each blade can rotate itself around a vertical axis. The internal gear changes the angle of attack of the blades in sync with the rotation of the plate, so that each blade can provide thrust in any direction, very similar to the collective pitch control and cyclic in a helicopter.

Operational costs for tugboat operations i.e. vessel assist operations consist for a major part of expenses to crew. There is therefore a desire to reduce the expenses for operating tugboats.

SUMMARY

Embodiments of the present invention seek to provide a system that overcomes or at least reduces the problems indicated above.

The foregoing and other objects are achieved by the features of the independent claims. Further implementation forms are apparent from the dependent claims, the description and the figures.

According to a first aspect, there is provided a system for assisting a marine vessel to maneuver, said system comprising: at least one tugboat suitable for assisting said marine vessel to maneuver, said tugboat comprising: a towing line attached to the tugboat at one end and attachable to the marine vessel at another end; a towing line force sensor; and a remote control unit configured for wirelessly controlling the operation of said at least one tugboat from a position remote from said at least one tugboat in dependence on sensor data from the towing line force sensor, said remote control unit being configured to transmit thrust commands wirelessly to said at least one tugboat in the form of a vector in relation to the hull of the assisted marine vessel, and said tugboat being configured to carry out thrust commands wirelessly received from said remote control unit with a required tension in the towing line.

By providing a remote-controlled tugboat and a remote control unit it becomes possible to operate a tugboat without a crew and thus save costs and do away with the need for crew accommodation and facilities on the tugboat.

In a first possible implementation form of the first aspect,

the remote control unit is configured to transmit follow the assisted marine vessel instructions to the at least one tugboat and the tugboat being configured to follow the assisted marine vessel, preferably autonomously, even more preferable at a constant distance to the assisted marine vessel.

In a second possible implementation form of the first aspect,

the control unit is configured to allow a pilot or other human operator to enter and send instructions to the tugboat.

In a third possible implementation form of the first aspect,

the at least one tugboat comprises:

a communication device configured to wirelessly receive instructions received from the remote control unit; and

a controller configured to execute the instructions received by the communication device.

In a fourth possible implementation form of the first aspect,

the remote control unit comprises a user interface configured to receive input from a pilot or other human operator, the user interface preferably including a touchscreen.

In a fifth possible implementation form of the first aspect,

the remote control unit comprises a wireless receiver and transmitter.

In a sixth possible implementation form of the first aspect,

the tugboat comprises a plurality of sensors, including the towing line force sensor and a position sensor, and the controller and communication device are configured to wirelessly transmit information from the plurality of sensors to the remote control unit.

In a seventh possible implementation form of the first aspect,

the remote control unit is configured to reproduce the information from the sensors on board of the tugboat.

In an eighth possible implementation form of the first aspect,

the remote control unit is a portable control unit suitable for a pilot or other human operator to bring on board of the assisted marine vessel.

In a ninth possible implementation form of the first aspect,

the remote control unit comprises an inbuilt or associated position sensor or position beacon.

In a tenth possible implementation form of the first aspect, the tugboat is provided with a sensor for locating the position sensor or the position beacon.

In an eleventh possible implementation form of the first aspect, the towing line force sensor is configured to sense a size and/or direction of a pulling force that the tugboat applies to the towing line or to the assisted marine vessel via the bow of the tugboat, and wherein the remote control unit is configured to inform the pilot or human operator of the size and/or direction of the pulling force as detected by the towing line force sensor.

In a twelfth possible implementation form of the first aspect, the tugboat is unmanned.

According to second aspect, there is provided a method for assisting a marine vessel to maneuver, the method comprising: wirelessly controlling a tugboat from a remote position, the tugboat having a towing line attached to the tugboat at one end and attached to the marine vessel at another end, and a towing line force sensor; transmitting a thrust command, in the form of a vector in relation to the hull of the marine vessel, from a remote control unit at said remote position to said tugboat in dependence of sensor data from the towing line force sensor; receiving said thrust command at said tugboat; and carrying out said thrust command with said tugboat, using a controller on said tugboat, by applying thrust of a magnitude and direction to the hull of said marine vessel in accordance with the thrust command received by the tugboat from said remote position, and with a required tension in the towing line.

In a second possible implementation form of the second aspect, the method comprises sending instructions and/or control signals wirelessly from the remote position to the tugboat and receiving the instructions and/or control signals with a receiver on the tugboat.

In a third possible implementation form of the second aspect, the method comprises wirelessly sending sensor data from sensors, including the towing line force sensor, on the tugboat to a receiver at the remote position.

In a fourth possible implementation form of the second aspect, the method comprises reproducing the sensor data wirelessly send by the tugboat via a user interface at the remote position.

In a fifth possible implementation form of the second aspect, the tugboat is provided with a positioning system and the method comprises wirelessly sending the position of the tugboat by the positioning system to the remote position.

In a sixth possible implementation form of the second aspect, the method comprises the marine vessel wirelessly sending the location of the marine vessel, preferably wirelessly sending the location of a specific position on the marine vessel, to the tugboat.

In a seventh possible implementation form of the second aspect, the tugboat is unmanned.

These and other aspects of the invention will be apparent from the embodiment(s) described below.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present disclosure, the invention will be explained in more detail with reference to the example embodiments shown in the drawings, in which:

Fig. 1 is a side view of an assisted vessel and a plurality of tugboats during an assist operation,

Fig. 2 is a top view of the assisted vessel and plurality of tugboats of Fig. 1 during an assist operation with one additional tugboat on the side of the assisted vessel,

CLAIMS

1. A system for assisting a marine vessel to maneuver, said system comprising:

at least one tugboat suitable for assisting said marine vessel to maneuver, said tugboat comprising:

a towing line attached to the tugboat at one end and attachable to the marine vessel at another end;

a towing line force sensor; and

a remote control unit configured for wirelessly controlling the operation of said at least one tugboat from a position remote from said at least one tugboat in dependence on sensor data from the towing line force sensor,

said remote control unit being configured to transmit thrust commands wirelessly to said at least one tugboat in the form of a vector in relation to the hull of the assisted marine vessel, and said tugboat being configured to carry out a thrust commands wirelessly received from said remote control unit with a required tension in the towing line.

2. A system according to claim 1, wherein said remote control unit is configured to transmit follow the assisted marine vessel instructions to said at least one tugboat and said tugboat being configured to follow the assisted marine vessel, preferably autonomously, even more preferable at a constant distance to the assisted marine vessel.

3. A system according to claim 1 or 2, wherein said at least one tugboat comprises:

a communication device configured to wirelessly receive instructions received from said remote control unit, and

a controller configured to execute the instructions received by the communication device.

4. A system according to any one of claims 1 to 3, wherein said remote control unit comprises a user interface configured to receive input from a pilot or other human operator, said user interface preferably including a touchscreen.

5. A system according to claim 3 or 4, wherein said tugboat comprises a plurality of sensors, including the towing line force sensor and a position sensor, and wherein said controller and said communication device are

configured to wirelessly transmit information from said plurality of sensors to said remote control unit.

6. A system according to any one of claims 1 to 5, wherein said remote control unit comprises an inbuilt or associated position sensor or position beacon.

7. A system according to claim 6, wherein said tugboat is provided with a sensor for locating said position sensor or said position beacon.

8. A system according to any one of claims 1 to 7, wherein the towing line force sensor is configured to sense a size and/or direction of a pulling force that the tugboat applies to the towing line or to said assisted marine vessel via the bow of the tugboat, and wherein said remote control unit is configured to inform the pilot or human operator of the size and/or direction of the pulling force as detected by the towing line force sensor.

9. A method for assisting a marine vessel to maneuver, said method comprising:

wirelessly controlling a tugboat from a remote position, the tugboat having a towing line attached to the tugboat at one end and attached to the marine vessel at another end, and a towing line force sensor;

transmitting a thrust command in the form of a vector in relation to the hull of the marine vessel from a remote control unit at said remote position to said tugboat in dependence of sensor data from the towing line force sensor;

receiving said thrust command at said tugboat, and

carrying out said thrust command with said tugboat using a controller on said tugboat by applying thrust of a magnitude and direction to the hull of said marine vessel in accordance with the thrust command received by the tugboat from said remote position and with a required tension in the towing line.

10. A method according to claim 9, further comprising:

issuing a follow marine vessel command from said remote position to said tugboat and

said tugboat following said marine vessel in accordance with instructions received from said remote position,

preferably said tugboat following said marine vessel at a constant

distance and even more preferably said tugboat following said assisted marine vessel at a constant distance and a constant relative position with respect to said marine vessel.

11. A method according to claim 9 or 10, further comprising wirelessly sending sensor data from sensors, including the towing line force sensor, on said tugboat to a receiver at said remote position.

12. A method according to claim 11, further comprising reproducing the sensor data wirelessly sent by said tugboat via a user interface at said remote position.