

MULTITASKING WATERCRAFT

Field of the Invention

The present invention relates to the field of watercrafts. More particularly, the invention relates to a multitasking watercraft that is transportable and reconfigurable.

Background of the Invention

Small sized watercrafts have the advantage of being able to approach inaccessible in-water regions, such as for inspecting the underwater substructure of a bridge, participating in a military maneuver, or entering a narrow space, while also being able to operate in shallow waters and in open seas. Such vehicles may be berthed at a port or onboard a larger ship while waiting to be dispatched to perform their dedicated task at the site of a mission, or may locally berthed in order to arrive quickly to an anticipated mission area..

Stability is a primary design consideration for watercrafts. It would therefore be desirable to configure a watercraft with good maneuverability and stability, yet with sufficiently small dimensions so as to be able to be transported to an operation zone within a container, for example by truck, helicopter, or ship.

Catamarans or trimarans are noted for their stability by virtue of the relatively large spacing between hulls; however, they cannot be transported in a container due to their large vehicle width.

Watercrafts having a single planing hull are well suited to advance at high speeds by virtue of the hydrodynamic lift for supporting the vehicle weight that is developed when the hull is lifted above the water at high speeds. However at low speeds, the hydrodynamic lift is correspondingly reduced and the planing-hull vehicle suffers from a lack of stability, being supported primarily by buoyant

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forces. Such a planing-hull vehicle is at a significant risk of capsizing during a mission, when loads are lowered from, or raised onto, a side of the vehicle.

US 2006/0236909 discloses an articulated boat including a pair of pontoons and a central cabin connected by a pair of struts. Motors that may be operated by remote control change the elevation between the central cabin and the pontoons.

US 7,278,364 discloses an attack and reconnaissance marine vessel that has an upper hull, two propulsion hulls, and two segmented struts for coupling the propulsion hulls to the upper hull and for reconfiguring the vessel. In one configuration, the vessel can be folded for launch and recovery. In a second configuration, the struts can be extended for cruising and surveillance. In a third configuration, the struts can be extended laterally from the upper hull to provide a minimum-draft configuration for approaching a beach.

As the propulsion hulls are constantly in contact with the water, the deficiencies associated with hydrofoils are also present in this prior art vessel, namely collisions with a submerged object that could lead to capsizing due to the resulting instability, excessive frictional drag, and cavitation when cruising at high speeds. Further drawbacks of this configuration include a small payload, a complicated power transmission system, and lack of combustion air intake to the propulsion system when the propulsion hulls are completely submerged.

It is an object of the present invention to provide a transportable watercraft that is stable both at low speeds and at high speeds.

It is an additional object of the present invention to provide a transportable watercraft with a large payload, to facilitate various marine or maritime missions.

Other objects and advantages of the invention will become apparent as the description proceeds.

Summary of the Invention

The present invention is directed to a high speed, small sized planning-hull watercraft which is able to reach stability levels of a multi-hull vessel when required to perform a specific task, without compromising the benefits of the planing hull characteristics during high speed operation. Thus the watercraft is able to arrive at, and depart, a mission area at high speeds and within minimum time, and to perform its dedicated tasks at low speeds and with high stability as required for these tasks.

Typical tasks that are performable by the watercraft include surveillance and firefighting at sea, for which a weighted, high rise mast that challenges the stability of the watercraft is required. The watercraft of the present invention is also able to be engaged in various tasks such as towing, launching and recovery of underwater equipment, which are dependent upon improved stability with respect to what is achievable by prior art high speed watercraft in order to ensure success of the operation and survivability of the watercraft.

Accordingly, a transportable multitasking watercraft comprises a single planing hull for generating planing conditions, and one or more displaceable stabilizers provided with a buoyant element and operatively connected to said hull by arm means, said one or more stabilizers configured to maintain watercraft stability when submerged in a body of water and the speed of said watercraft is less than a planing inducing speed, wherein said watercraft has a length of no greater than 20 m, e.g. no greater than 12 m, and a length to beam ratio of at least 4.5 so as to be temporarily storable within a marine container when being transported to a desired operation zone.

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In one aspect, the one or more displaceable stabilizers is removable from the body of water when the watercraft advances along the water body at high speeds of over 20 knots, to generate planing conditions and to provide the watercraft with the required hydrodynamic stability at high speeds.

In one aspect, the speed of the watercraft is less than a planing inducing speed of 15 knots when the one or more stabilizers are submerged in the body of water.

In one aspect, the arm means comprises one or more articulated arms, each link of said arms being extendable or pivotable.

In one aspect, the arm means comprises one or more extendable or retractable arms.

In one aspect, the one or more arms of each stabilizer is settable to a fully folded condition when the watercraft operates in a high speed mode.

In one aspect, the one or more stabilizers is settable to a safety mode when the watercraft is subjected to predetermined reduced stability conditions, the one or more stabilizers being suitably positionable during said safety mode so as to achieve an unaided righting operation following capsizing of the watercraft. The one or more stabilizers is positioned during the safety mode such that the corresponding buoyant element thereof is vertically spaced from, and aligned with, the center of gravity of the watercraft. Subsequent movement of the watercraft after capsizing produces a righting arm to the one or more stabilizers, whose product with the buoyancy force provided by the one or more stabilizers induces a righting producing moment which is greater than the capsizing producing moment that is a product of the moment arm to the hull and the buoyancy force provided by the hull, whereby to achieve the unaided righting operation.

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In one aspect, the watercraft further comprises a drive mechanism and an actuator associated with the one or more stabilizers for displacing the one or more stabilizers to one of the high speed mode position, safety mode position, and stability mode position.

In one aspect, the watercraft further comprises control equipment for automatically displacing the one or more stabilizers in response to sensed conditions.

In one aspect, the watercraft further comprises control equipment for remotely displacing the one or more stabilizers in response to sensed conditions.

In one aspect, the watercraft further comprises one or more carriers removably securable to the hull, from each of which a payload is dischargeable in order to facilitate performance of a watercraft related task. The one or more carriers is insertable within a recessed payload bay formed within the hull. Each of the one or more carriers has a local controller that is in data communication with a main processor of the watercraft, and is configured to make an electrical connection with said main processor to facilitate data communication therewith when secured to the hull.

In one aspect, the watercraft comprises equipment interactable with a selected payload in such a way to facilitate performance of a watercraft related task selected from the group of launching said selected payload, discharging said selected payload into the sea, recovery of previously launched equipment or objects from the sea back into a payload bay or onboard the watercraft.

Brief Description of the Drawings

In the drawings:

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- Fig. 1 is a perspective view of a watercraft according to one embodiment of the present invention, positioned in the safety mode;
- Fig. 2 is a rear view of the watercraft of Fig. 1;
- Fig. 3 is side view of the watercraft of Fig. 1, when stowed and stored in a container;
- Fig. 4 is a perspective view of the watercraft of Fig. 1, positioned in the high speed mode;
- Fig. 5 is a rear view of the watercraft of Fig. 4;
- Fig. 6 is a perspective view of the watercraft of Fig. 1, positioned in the safety speed mode;
- Fig. 7 is a rear view of the watercraft of Fig. 6;
- Figs. 8 and 9 are rear views of the watercraft of Fig. 6 at different stages of an unaided righting operation;
- Fig. 10 is a method for automatically changing the watercraft's mode of operation, in response to detected in-transit and surrounding conditions;
- Figs. 11-13 are a perspective view of a watercraft according to another embodiment of the invention, set to the stability mode, high speed mode, and safety mode, respectively;
- Fig. 14 is a perspective view of one type of a payload when discharged and extended from a carrier;
- Fig. 15 is a perspective view of the watercraft of Fig. 1, showing another type of a payload when discharged and extended from a carrier;
- Fig. 16 is a perspective view of the watercraft of Fig. 1, showing another type of a payload when protruding over its starboard side in order to conduct underwater surveillance;
- Fig. 17 is a side view of the watercraft of Fig. 1, showing a sonar detector in an underwater operational position connected thereto; and
- Fig. 18 is a top view of Fig. 17.

Detailed Description of Preferred Embodiments

The present invention is an elongated multitasking watercraft that is of sufficiently small dimensions so as to be temporarily storable within a standard marine container, to facilitate transportation to an operation zone. In order to compensate for the lack of stability at low speeds, or when stationary, due to its small dimensions, and particularly due to its small breadth, the watercraft is provided with one or more displaceable stabilizers that terminate with a buoyant element to achieve stability and safety at both low speeds and high speeds.

Fig. 1 illustrates a watercraft generally indicated by numeral 10, according to one embodiment of the present invention. Watercraft 10, which may be any suitable small sized vehicle having a length of less than 20 m, such as a high speed, rigid hull boat, a cigarette boat, or a rigid inflatable boat (RIB), has an elongated hull 5 in which is formed a central recessed payload bay 7 for storing a selected payload or in which may be seated an operator or other passengers. Bay 7 divides hull 5 into fore section 6 and aft section 9. Watercraft 10 also comprises an elongated stabilizer 14 provided with a buoyant element and having a longitudinal axis substantially parallel to the longitudinal axis of hull 5, when fully deployed in a stability mode as illustrated. Two articulated, high strength arms 16 and 17 connect stabilizer 14 to fore section 6 and aft section 9, respectively, to assist in displacing the stabilizer when actuated. Each link of arms 16 and 17 may be controllably extendible or retractable, and may be hydraulically, pneumatically or electrically actuated.

Watercraft 10 is afforded good roll stability at low speeds of less than 12 knots when stabilizer 14 is introduced into the surrounding water during the stability mode. Due to the low roll angles and high directional stability that are achievable, various operations may be performed with increased reliability such as lowering underwater equipment into the sea from a side of the aft of hull 5, deploying a high rise collapsible mast (HRCM) for increased surveillance

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capabilities, carrying out towing operations and deploying a dynamic positioning system when global positioning of the vehicle is required. The depth to which stabilizer 14 is submerged may be controlled by selectively or controllably displacing one or more links of the arms 16 and 17.

An inverted U-shaped mast 8, sometimes referred to as an A-frame, on which is mounted on-board, water resistant vehicle equipment 12 protruding from aft section 9. Mast 8 may be vertically displaceable. The vehicle equipment 12 may include navigation equipment, surveillance equipment, communication equipment, control equipment, and command equipment for use during manned, remote, or autonomous unmanned operation. The propulsion system is housed within aft section 9, and may be accessed through a door in bay 7. The propulsion system may be any type well known to those skilled in the art, including but not limited to a diesel propulsion system, a hybrid propulsion system, and an electric propulsion system. A drive mechanism for displacing mast 8 and arms 16 and 17 may be housed within fore section 6 or aft section 9.

Fig. 2 illustrates a rear view of watercraft 10. Hull 5 is shown to be a planing hull that has two planing surfaces 21 and 22 defining a V shape with a deadrise ranging from 0 to 18 degrees. This configuration provides on one hand good planing characteristics at high speeds above 20 knots, while ensuring on the other hand sufficient seakeeping in rough seas. The hull lacks any appendages that would cause in-water disturbances. The provision of stabilizer 14 ensures watercraft stability during the performance of various low speed operations that cause prior art planing-hull watercraft to capsize.

Fig. 3 illustrates watercraft 10 in a stowed condition such that stabilizer 14 is compactly positioned above hull 5. As shown, watercraft 10 is suitably dimensioned so that, when in the stowed condition, it may be retained within a standard marine container 20, e.g. having a length of approximately 12 m, a

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width of approximately 2.4 m, and a height of approximately 2.6 m, for transportation to an operation zone, whereat watercraft 10 is quickly unloaded from container 20, set to a deployed operational condition for carrying out a required task, and launched. The watercraft may be launched from a mother ship, a port pier, or at or above a water surface, e.g. the sea shore.

The ability to transport a watercraft within a standard marine container is applicable to a watercraft with an overall maximum length of 12 meters. However, the concept of enhancing low speed stability of high speed planing watercraft by retractable or foldable side stabilizers is applicable to watercraft of up to a length of approximately 20 meters and a length to beam ratio of greater than 4.5.

In order to accommodate the size limitations of container 20, mast 8 may also be set to a stowed condition, as shown, by disengaging upper mast portion 18 from fixed lower mast portion 19 and angularly displacing upper mast portion 18, which is pivotally connected to fixed lower mast portion 19. Upper mast portion 18 may be angularly displaced manually or by means of an actuator. An interconnecting element for removably connecting upper mast portion 18 and lower mast portion 19, such as a pin, is engaged or disengaged manually to verify safe operation.

In addition to the stability mode, the watercraft can also operate in a high speed mode and in a safety mode, depending on the disposition of the stabilizer.

Figs. 4 and 5 illustrate watercraft 10 when stabilizer 14 is positioned in the high speed mode whereby links 26 and 27 of each of arms 16 and 17 are fully folded and stabilizer 14 is therefore located below the mast platform 29. During the high speed mode, planing cruising conditions are generated while minimizing hydraulic drag and the risk of collision with a submerged object since stabilizer

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14 is completely removed from the water. Since arms 16 and 17 are fully folded, aerodynamic drag is also minimized.

Figs. 6 and 7 illustrate an upright watercraft 10 when stabilizer 14 is positioned in the safety mode whereby distal link 27 is pivoted relative to the fully folded position shown in Fig. 5, while the position of proximal link 26 remains unchanged, and stabilizer 14 is therefore located above the mast platform 29, close to the lateral centerline of hull 5. The safety mode is preferably activated when there are at least moderate wave conditions, for example when the sea state is 3 or the wave height is at least 90 cm. During the safety mode, the watercraft will be assured of being righted after capsizing.

An unaided righting operation is made possible by virtue of the displaced position of stabilizer 14. At this displaced position, the buoyant element of stabilizer 14 is assured of being vertically spaced from the watercraft's center of gravity. Thus if watercraft 10 were to capsize as shown in Fig. 8, the buoyant element of stabilizer 14 would be located below, and aligned with, the watercraft's center of gravity CG. Any subsequent movement of watercraft 10 would cause the buoyant element to be laterally spaced from center of gravity CG, as shown in Fig. 9. This lateral spacing defines a righting arm RA to the stabilizer 14, whose product with the buoyancy force B_s provided by the stabilizer induces a righting producing moment which is greater than the capsizing producing moment that is a product of the moment arm MA to hull 5 and the buoyancy force B_H provided by the hull. It is to be noted that an unaided righting operation is infeasible in prior art watercraft due to the lack of a buoyant element vertically spaced from the hull.

Fig. 10 illustrates a method for automatically changing the watercraft's mode of operation, in response to detected in-transit and surrounding conditions. An autonomous, automatically operated watercraft is of great utility when the watercraft has to access dangerous surroundings, for example to monitor

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contaminated seawater during an occurrence of an oil spill or radioactive contamination, and to participate in a firefighting operation with respect to a spreading fire resulting from an offshore gas explosion by use of high rise water cannons.

In step 31, the watercraft speedily advances in an intended direction, for example when involved in an evasive action or in order to arrive on time at a targeted destination, and operates in the high speed mode while the stabilizer is set to a completely folded condition. The watercraft's main processor receives inputs from a plurality of sensors in step 33 for detecting various types of data such as speed, position and direction of watercraft, watercraft pitch and roll data, meteorological data including wind speed and detection of precipitation or fog, local wave height data, and watercraft engine performance data. Upon determining from the sensed data that the watercraft is being subjected to predetermined reduced stability conditions that can potentially cause a capsizing event, the stabilizer is automatically displaced to the safety mode position in step 35 while the watercraft is allowed to continue to advance at high speed to its destination. If, however, the sensed data is indicative that the watercraft is being subjected to predetermined excessively reduced stability conditions, the watercraft is commanded in step 37 to abort its mission and return to base, or to the closest safe port. When the watercraft arrives at its destination, or reduces its speed to a predetermined low level, the stabilizer is automatically displaced to the stability mode position in step 39, to ensure that various tasks will be reliability performed without risk of capsizing despite the normal instability of the planing hull at low speeds, particularly when the hull is loaded at one end. The stabilizer is further commanded in step 41 to become additionally submerged during the stability mode if high wave conditions, or other reduced stability conditions, are determined.

The stabilizer may be similarly displaced by remote control in response to telemetered data that is received at a control station. The watercraft may also be manned, allowing an operator to steer the watercraft and to planing-hull decide when to displace the stabilizer in accordance with received data readings.

In another embodiment of the invention illustrated in Figs. 11-13, a watercraft 50 may be provided with two displaceable stabilizers 54 and 55, in order to facilitate operation in the stability mode, high speed mode, and safety mode, whether automatically, remotely or locally operated, as described hereinabove. The two stabilizers 54 and 55 may be synchronized for displacement in unison, or may be separately displaced.

Along the periphery of watercraft 50 may be provided a plurality of inflatable tubes 59, to further increase the watercraft's seakeeping characteristics. Tubes 59 may be manually, remotely or automatically inflated or deflated, depending on the surrounding conditions.

As described above, one of the significant aspects of the present invention is the ability to perform various tasks at low speeds with the planing-hull watercraft while maintaining craft stability despite uneven loading conditions.

In another embodiment of the invention, these tasks are made possible by deploying removable and dischargeable payload carriers that are insertable within the central bay of the watercraft. Each of the carriers has a local controller that is in data communication with the watercraft's main processor, and is configured to make an electrical connection to facilitate the data communication when properly inserted within the bay. A single carrier may be employed. If so desired, two or more carriers may be positioned by a side by side relationship, or alternatively may be positioned one on top of the other. When a controller is

commanded, the corresponding payload is automatically discharged or retracted from the carrier.

Fig. 14 illustrates a high-rise antenna 61 that is retractable from carrier 63, for conducting day and night reconnaissance. After enough data has been acquired, the local controller is commanded to cause antenna 61 to become retracted and carrier 63 to be set to a closed condition. The stabilizer is then displaced to the high speed mode, allowing the watercraft to quickly advance to another location.

Carrier 63 fixedly received in the payload bay of watercraft 10 is illustrated in Fig. 15 and is shown to be in an opened condition while the payload 64 is fully extended.

In Fig. 16, a payload 67 is shown to be protruding over the starboard side of watercraft 10 in order to conduct underwater surveillance with sonar equipment, without compromising the stability of watercraft 10 by virtue of the deployment of stabilizer 14.

As shown in Figs. 17 and 18, the watercraft is capable of autonomous or remote launching of various sensing and activating payloads such as underwater sonar detectors, Underwater Remotely Operated Vehicles (ROV), mine detectors, torpedoes and missiles. Launching equipment is interactable with a selected payload in such a way to facilitate performance of a desired task. Following completion of the task, the watercraft is capable of recovering the equipment into its payload bay.

A sonar detector 72 is shown in an underwater operational position after being launched from watercraft 10. Sonar detector 72 is connected by cable 76 to pivotal A-Frame 74 located at the stern of watercraft 10. The launching equipment 78 for selectively displacing cable 76 and ejecting sonar detector 72 from payload bay

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77, within which sonar detector 72 is normally stored, is retained within payload bay 77 and covered by A-Frame 74. A controller 79 for pivotally displacing A-Frame 74 and operating launching equipment 78, locally or remotely, is also retained within payload bay 77. Following completion of the task, sonar detector 72 is raised onboard by winches and returned to a carrier within payload bay 77.

While some embodiments of the invention have been described by way of illustration, it will be apparent that the invention can be carried out with many modifications, variations and adaptations, and with the use of numerous equivalents or alternative solutions that are within the scope of persons skilled in the art, without exceeding the scope of the claims.

CLAIMS

1. A transportable multitasking watercraft, comprising a single planing hull for generating planing conditions, and one or more displaceable stabilizers provided with a buoyant element and operatively connected to said hull by arm means, said one or more stabilizers configured to maintain watercraft stability when submerged in a body of water and the speed of said watercraft is less than a planing inducing speed, wherein said watercraft has a length of no greater than 20 m and a length to beam ratio of at least 4.5 so as to be temporarily storable within a container when being transported to a desired operation zone.
2. The watercraft according to claim 1, wherein the one or more displaceable stabilizers is removable from the body of water when the watercraft advances along the water body at high speeds of over 20 knots.
3. The watercraft according to claim 2, wherein the arm means comprises one or more articulated arms, each link of said arms being extendable or pivotable.
4. The watercraft according to claim 2, wherein the arm means comprises one or more extendable or retractable arms.
5. The watercraft according to claim 3, wherein the one or more arms of each stabilizer is settable to a fully folded condition when the watercraft operates in a high speed mode.
6. The watercraft according to claim 5, wherein the one or more stabilizers is settable to a safety mode when the watercraft is subjected to predetermined reduced stability conditions, the one or more stabilizers being suitably

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positionable during said safety mode so as to achieve an unaided righting operation following capsizing of the watercraft.

7. The watercraft according to claim 6, wherein the one or more stabilizers is positioned during the safety mode such that the corresponding buoyant element thereof is vertically spaced from, and aligned with, the center of gravity of the watercraft.

8. The watercraft according to claim 7, wherein subsequent movement of the watercraft after capsizing produces a righting arm to the one or more stabilizers, whose product with the buoyancy force provided by the one or more stabilizers induces a righting producing moment which is greater than the capsizing producing moment that is a product of the moment arm to the hull and the buoyancy force provided by the hull, whereby to achieve the unaided righting operation.

9. The watercraft according to claim 6, further comprising a drive mechanism and an actuator associated with the one or more stabilizers for displacing the one or more stabilizers to one of the high speed mode position, safety mode position, and stability mode position.

10. The watercraft according to claim 9, further comprising control equipment for automatically displacing the one or more stabilizers in response to sensed conditions.

11. The watercraft according to claim 10, further comprising control equipment for remotely displacing the one or more stabilizers in response to sensed conditions.

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12. The watercraft according to claim 1, further comprising one or more carriers removably securable to the hull, from each of which a payload is dischargeable in order to facilitate performance of a watercraft related task.

13. The watercraft according to claim 12, wherein the one or more carriers is insertable within a recessed payload bay formed within the hull.

14. The watercraft according to claim 12, wherein each of the one or more carriers has a local controller that is in data communication with a main processor of the watercraft, and is configured to make an electrical connection with said main processor to facilitate data communication therewith when secured to the hull.

15. The watercraft according to claim 12, further comprising equipment interactable with a selected payload in such a way to facilitate performance of a watercraft related task selected from the group of launching said selected payload, discharging said selected payload into the sea, recovery of previously launched equipment or objects from the sea back into a payload bay or onboard the watercraft.

16. The watercraft according to claim 1, wherein the speed of the watercraft is less than a planing inducing speed of 15 knots when the one or more stabilizers are submerged in the body of water.