

Naval surface vehicle with pivoting instrumented arm

The present invention relates to the field of naval surface vehicles used for taking measurements relating to sea water or fresh water and to their cartography or else underwater detections and observations.

A particularly advantageous application of the invention therefore relates to hydrographic measurements. Naturally, the invention can also be used in other applications, for example for the detection of submarine objects.

Conventionally, such vehicles comprise a body, means of propulsion, and measurement or detection sensors mounted in cavities provided in the bottom of the said body.

To carry out these measurements or detections, the naval surface vehicle is usually towed close to the subaquatic zone that has to be studied and then placed in the water. It then rejoins the subaquatic zone at high speed and passes over this zone at reduced speed for the acquisition of data.

When the naval vehicle is placed on the towing vessel, because of their arrangement the sensors may sustain damage likely to distort or even prevent the measurements to be taken. Such damage may also occur in the event of impacts with floating objects when the naval vehicle moves at high speed on the surface on the water.

Once the vehicle is placed in the water, it is no longer possible to replace the sensors if they are damaged. Similarly, if other types of measurements finally have to be taken for the study of the subaquatic zone, it is no longer possible to install other sensors.

Moreover, the sensor or sensors may partially protrude from their cavities thus forming appendages on the bottom of the body. This increases the risk of damaging these sensors and increases the resistance to the forward progress of the vehicle, notably when moving at high speed.

Patent US 5,008,863 discloses a naval surface vehicle comprising a hull, two parallel arms mounted so as to rotate on the

hull about a horizontal axis by means of a cross-beam, and a wing mounted at the bottom end of the arms and inside which sonars are provided to make it possible to take subaquatic measurements.

5 The naval vehicle described in this patent has the drawback of having a relatively large lateral space requirement when the arms mounted laterally on either side of the hull are in a low position making it possible to take the subaquatic measurements. Moreover, during the taking of these measurements, which usually takes place at reduced speed, the vehicle may be subjected to unintended lateral
10 movements that can distort the measurements taken by the sonars provided inside the wing extending transversely between the arms.

The object of the present invention is to remedy these drawbacks.

15 More particularly, the object of the present invention is to provide a naval surface vehicle which can be easily transported without risk of damaging the sensor means, having a reduced resistance to the forward progress and suitable for allowing easy replacement of the sensor means even when the vehicle is already in the water.

20 A further object of the invention is to provide a naval surface vehicle suitable for carrying out subaquatic measurements or detections and is low-cost, easy to use and easy to maintain.

A further object of the present invention is to provide a naval surface vehicle having a reduced space requirement and making it
25 possible to obtain reliable measurements.

In one embodiment, the naval surface vehicle comprises a body, means for the propulsion of the body, at least one sensor means, and at least one means for supporting the sensor means mounted on the body. The supporting means can move relative to the said body
30 between a first position in which the sensor means is situated beneath a water line of the body, and more generally of the vehicle, and a second position in which the sensor means is situated above the said waterline. The supporting means is situated in a longitudinal mid-plane of the body. The supporting means extends substantially

vertically beyond a bottom surface of the body in the first position and is dimensioned so as to form a stabilizing drift of the vehicle.

Advantageously, the sensor means is situated above a top surface of the body in the second position of the supporting means.

5 In one embodiment, the supporting means is mounted so as to rotate on the body about an axis substantially horizontal, transverse or perpendicular to the mid-plane of the body. The body may comprise a longitudinal slot inside which is attached a shaft for articulating the supporting means and inside which the said supporting means partly
10 extends. The supporting means pivots inside the slot.

In another embodiment, the supporting means is telescopic and provided with an end that can move in translation relative to the body which supports the sensor means.

15 Preferably, the supporting means can advantageously be situated at the opposite end from the propulsion means when considering the longitudinal direction of the body. The sensor means can be mounted at one end of the supporting arm.

In one embodiment, the vehicle comprises means for actuating the supporting means. The actuation means may comprise an electric
20 motor and a wheel-and-worm reduction gear forming a member for irreversibly immobilizing the supporting means in the first and second positions of the said arm. Naturally, any other means for operating the supporting means could be used, for example a linear cylinder or the like. The vehicle may also comprise at least one sensor for detecting
25 the position of the supporting means relative to the body and a control unit capable of controlling the operation of the actuation means depending on the detected position of the supporting means.

In one embodiment, the vehicle comprises a plate supporting the sensor means and mounted on the supporting means. The plate can
30 be mounted at one end of the supporting means. The plate is advantageously able to rotate relative to the supporting means about a longitudinal axis of the said supporting means. The vehicle may comprise a control unit capable of determining an angular orientation of the plate relative to the supporting means depending on a

theoretical route to be followed by the vehicle and capable of maintaining, by closed-loop control, the angular orientation of the plate on the theoretical route to be followed. The plate may also be able to rotate relative to the supporting means about an axis that is transverse to the said supporting means.

By virtue of the invention, when the naval surface vehicle is in the water, the supporting means can be moved from the active low position of the sensor means in which the said means are situated below the waterline of the vehicle to an inactive high position in which the sensor means are situated above the waterline. This is notably the case when the measurement campaign or campaigns are complete, or else when the sensor means has or have to be replaced in order to carry out another measurement campaign different to those that have just be completed. The sensor-holding plate may be specific to the sensor means. To replace these sensor means, the plate needs to be replaced by another similar plate on which the new sensor means have been mounted. In the inactive position of the sensor means, the supporting means is raised, and in the active position, the supporting means is lowered.

When the vehicle moves at high speed with the sensor means in the high position, neither the sensor means nor the supporting means protrude from the submerged surface of the body, which makes it possible to offer reduced resistance to the forward progress and to make the vehicle easier to manoeuvre. In the raised position of the supporting means, the vehicle may also be mounted on a towing vessel with a limited risk of damage to the sensor means.

Moreover, when the measurements are taken in the subaquatic zone to be studied, measurements which are carried out at reduced speed, the supporting means which extends substantially vertically beyond the bottom submerged surface of the body is dimensioned so as to form a center-board or a drift making it possible to stabilize the vehicle and to prevent undesirable lateral movements that can distort the measurements taken. This can be particularly useful when there is a heavy swell. The section of the supporting means is adapted so that

the said means is sufficiently rigid to generate no vibration or additional roll relative to the body in order to obtain good reliability for the measurements taken. As an indication, the supporting means may be designed to withstand counter-currents of seven knots and in the other directions of two knots. The supporting means is advantageously streamlined from the hydrodynamic point of view. The stabilizing drop keel or drift helps to maintain the selected route. Moreover, the arrangement of the supporting means in the longitudinal mid-plane of the vehicle is advantageous because that makes it possible to limit the roll phenomena in the sensor or sensors.

In order to obtain reliable measurements, it is also preferable that the eddies caused by the propulsion means do not reach the zone in which the sensor means is or are submerged in the low position. For this purpose, the supporting means can be mounted on the body in a forward zone of the body at the opposite end, in the longitudinal direction, to the rear zone where the propulsion means are provided. Advantageously, the supporting means is placed between the forward third and quarter of the body.

Moreover, mounting the sensor means on a plate that can rotate relative to the supporting means about a longitudinal axis of the said means extending substantially vertically in the lowered position makes it possible, during the measurement campaigns, to maintain the orientation of the plate and of the sensors on the selected route despite the wind, the swell and any surface currents that may lead to holding the vehicle so that its longitudinal axis is slightly offset from the said route.

The present invention will be better understood on reading the detailed description of an embodiment taken as a non-limiting example and illustrated by the appended drawing in which:

- Figures 1 and 2 are schematic side views of a naval surface vehicle according to the invention,
- Figure 3 is a partial exploded view in perspective of the vehicle of Figures 1 and 2.

Figures 1 to 3 show a naval surface vehicle or craft, designated by the general reference number 10, and suitable for taking hydrographic measurements or else for detecting submarine objects.

5 The vehicle 10 comprises mainly a body 12, of generally elongate shape, propulsion means 14 situated in an after zone 16 or poop of the said body, sensors 18, 19 and 20, and an arm 22 for supporting the said sensors that is rotatably articulated in a forward zone 24 or prow of the body. The sensors 18 to 20 are attached to the free end of the supporting arm 22 by means of a plate 26 as will be
10 described in greater detail below.

The sensors may, for example, be multibeam echo-sounders making it possible to obtain bathymetric readings of the submarine reliefs, sediment sounders suitable for identifying the nature of the sea bottom, sonic depth-finders, detectors of submarine objects, etc. As an
15 indication, the sensor 18 may for example be an acoustic velocimeter, the sensor 19 an inertial position and altitude sensor, and the sensor 20 a sonar. The sensors 18 to 20 are in this instance three in number. Naturally, it is possible to provide a different number of sensors on the supporting arm 22 and other types of sensors.

20 The supporting arm 22 is mounted on the body 12 so as to rotate about a substantially horizontal geometric axis extending transversely to the longitudinal mid-plane of the said body. It can be moved between a raised position in which the sensors 18 to 20 are situated above a waterline 28 of the vehicle as shown in Figure 1, and
25 a lowered position in which the sensors are situated below the said waterline illustrated in Figure 2. The waterline 28 is shown schematically in dashed lines on the figures.

More precisely, in the raised position of the supporting arm 22, the sensors 18 to 20 are situated vertically above a top surface 12a of the body 12, the end of the said arm extending to protrude beyond the
30 said surface. This position is adapted during the high-speed movement of the vehicle 10 so as to offer reduced resistance to the forward progress and to make manoeuvring easier. Moreover, during a measurement campaign at sea, if one of the sensors 18 to 20 fails or

else if other types of measurements have to be taken, it is possible to replace them easily by raising the arm into this position. In this raised position, the supporting arm 22 extends vertically upwards. In the lowered position of the said arm, the sensors 18 to 20 are situated
 5 vertically below a submerged bottom surface 12b of the body 12 forming a bottom, the end of the supporting arm 22 protruding from the said bottom surface so as to form a drift. This tends to stabilize the vehicle when measurement campaigns are carried out at reduced speed. In this position, the illustrated supporting arm 22 extends substantially
 10 vertically. "Substantially vertically" in this instance means an angle formed between the lengthwise axis or longitudinal axis 29 of the supporting arm 22 and a vertical axis which is less than 30°.

In order to allow the supporting arm 22 to pivot, the body 12 comprises, in the forward zone 24, a longitudinal slot 30 extending
 15 from the forward end over the whole height of the said body. The slot 30 allows the supporting arm 22 to be housed and to pivot. The slot 30 and the arm 22 are situated in the longitudinal mid-plane of the body 12.

To obtain the rotation of the arm 22, an articulation shaft 32 is
 20 provided inside the slot. The arm 22 is rotatably connected with the articulation shaft 32. The supporting arm 22 is rotatably articulated on the body 12 at the opposite end from the propulsion means 14, considering the longitudinal direction of the said body. In the low position of the supporting arm 22, the sensors 18 to 20 are thus
 25 prevented from being situated in the stream of water churned up by the propulsion means 14.

In order to allow the articulation shaft 32 and the supporting arm 22 to be rotated, the vehicle 10 comprises an electric motor 34 with a vertical axis associated with a coaxial reduction gear 36 itself
 30 connected to a wheel-and-worm reduction gear 38 suitable for coupling the articulation shaft 32 into the hollow shaft of the said reduction gear so that the shaft 32 extends substantially horizontally. The motor 34 and the reduction gears 36, 38 are mounted in a housing (not visible) arranged in the forward zone 24 of the body 12. To

prevent the reduction gear 38 from rotating, a flange 40 is provided and attached to the body 12.

5 The articulation shaft 32 extends into a through-recess 42 of the supporting arm 22 created in its thickness and situated at the end opposite to that on which the plate 26 is placed. Provided on either side of the arm 22, resting against the latter, are annular sealed rings 44, 46 mounted around the articulation shaft 32. A first bearing 48 is mounted on the articulation shaft 32 between the supporting arm 22 and the flange 40, a second bearing 50 being placed on the said shaft 10 32 on the opposite side of the arm 22 from the bearing 48. The bearings 48, 50 are respectively attached, for example by screwing, to annular flanges 52, 54 mounted around the articulation shaft 32, the said flanges being secured to the body 12 for example by welding.

15 So as to reduce the hydrodynamic drag forces on the plate 26 when the supporting arm 22 is in the lowered position, streamlining elements 56, 58 are provided around the said plate and are attached to one another. The plate 26 is thus encapsulated inside these streamlining elements 56, 58. The sensors 18 to 20 are attached to the plate 26 by any appropriate means. The plate 26 is mounted at the end 20 of the supporting arm 22 with the ability to rotate about the longitudinal axis 29 of the said arm. This ability to rotate is illustrated by the arrows referenced 60. For this purpose, a motor (not shown) is mounted inside the streamlining elements 56, 58. This ability for the plate 26 to rotate about the axis 29, which is orthogonal to the 25 geometric axis around which the arm 22 pivots, is advantageous because, during the measurement campaigns, it makes it possible to maintain the orientation of the sensors 18 to 20 on the selected route even in the presence of wind, swell and surface currents which may make it necessary to steer the vehicle 10 so that its axis is slightly 30 offset from the said route. The cables allowing the powering of the sensors 18 to 20 and of the motor are attached and extend inside the arm 22.

Advantageously, the plate 26 can also be mounted on the arm 22 with the ability to rotate about a horizontal axis 62 which is

orthogonal or transverse to the axis 29 and parallel to the geometric axis around which the arm 22 pivots. This rotation of the plate can be carried out manually or in a motorized manner when the supporting arm 22 is in the raised position so as to correct the horizontality of the vehicle 10. This ability to rotate is illustrated by the arrows referenced 64.

The vehicle 10 is also provided with an electric control unit (not shown) capable of controlling the operation of the motor 34 and of the motor allowing the rotation of the plate 26 relative to the arm 22, and end-of-travel sensors (not shown) making it possible to detect when the supporting arm 22 has reached the raised and lowered positions.

The control unit comprises, stored in memory, all the hardware and software means for controlling the operation of the motor 34 based on the measurements taken by the end-of-travel sensors. To replace these sensors, it could be possible to provide as an alternative a sensor for detecting the angular position of the arm 22. A sensor coupled to the electric motor 34 is also provided to make it possible to detect any obstacle preventing the arm 22 from pivoting. This detection may, for example, be achieved by controlling the electric power-supply current of the motor 34.

The control unit also makes it possible to determine a mean direction to be provided for the plate 26 depending on the route to be followed by the vehicle 10 and to maintain this position by closed-loop control by controlling, as necessary, the angular movement of the plate 26 relative to the arm 22 about the axis 29 so that the sensors 18 to 20 are oriented on the route to be followed even in the presence of wind, swell or surface currents. In other words, the control unit makes it possible to determine the angular orientation to be provided for the plate 26 relative to the arm 22 depending on the predetermined theoretical route to be followed by the vehicle 10 to reach the desired geographic point. The control unit also makes it possible to maintain by closed-loop control, by controlling the motor associated with the plate, the angular orientation of the said plate on the theoretical route

to be followed, even when the longitudinal axis of the vehicle 10 must be slightly offset relative to this theoretical route to be followed, for example in the presence of wind, swell or possible surface currents.

5 For this purpose, the vehicle 10 is fitted with a positioning means, for example of the GPS type, making it possible at all times to ascertain the real route followed by the vehicle. At each moment, the control unit can determine the angular difference that there is between the theoretical route to be followed and the real route followed by the vehicle. The control unit can therefore determine the angular
10 orientation that the plate 26 must take to stay oriented on the theoretical route to be followed to reach the desired geographical point, then control the angular movement of the plate about the axis 29 by operating the motor associated with the said plate.

15 The control unit can make it possible to automatically control the trajectory of the vehicle 10 and the movement of the arm 22 in predefined navigation conditions, for example when the vehicle is stopped or when it is sailing at reduced speed. Alternatively, it may be possible to control the movement of the vehicle 10 and the pivoting of the arm 22 remotely by an operator, or else to provide for an operator
20 to be directly present on the vehicle 10 acting at a control station.

The invention provides a naval surface vehicle comprising an instrumented arm mounted so as to rotate on the body or hull so as to be able to be moved from an extreme high position in which the said arm and the sensor means are situated above the waterline so as not to
25 increase the resistance to the forward progress of the vehicle during a phase of approaching the subaquatic zone to be studied, to an extreme low position in which at least a portion of the said arm and the sensor means are situated below the waterline.

Moreover, the use of an electric motor associated with a wheel-
30 and-worm reduction gear to rotate the supporting arm and to place the sensors in the water is advantageous because the reduction gear forms a means for immobilizing the supporting arm in the raised position and in the lowered position. It is therefore not necessary to provide additional means for this purpose. More precisely, the reduction gear

forms an irreversible immobilization means having an infinite number of positions making it possible to hold the arm without the provision of power. In other words, the reduction gear forms a safety device preventing any movement of the arm if the motor should lose its electric power supply.

5 In a variant embodiment, it is possible, without departing from the context of the present invention, to provide other types of design for the means for supporting the sensor or sensors. For example, a telescopic arm can be provided in which one end comprising the
10 sensors can move in translation relative to the body so as to allow the said means to pass between a high position above the waterline of the vehicle and a low position situated below the said line.

CLAIMS

1. Naval surface vehicle comprising a body (12), means (14) for the propulsion of the body, at least one sensor means (18), and at least one means (22) for supporting the sensor means mounted on the body and being able to move relative to the said body between a first position in which the sensor means is situated beneath a waterline (28) of the vehicle and a second position in which the sensor means is situated above the said waterline, characterized in that the supporting means (22) is situated in a longitudinal mid-plane of the body, and in that the said supporting means extends substantially vertically beyond a bottom surface (12b) of the body in the first position and is dimensioned so as to form a stabilizing drift of the vehicle.

2. Vehicle according to Claim 1, in which the sensor means (18) is situated above a top surface (12a) of the body in the second position of the supporting means.

3. Vehicle according to Claim 1 or 2, in which the supporting means (22) is mounted so as to rotate on the body about an axis substantially transverse to a longitudinal mid-plane of the said body.

4. Vehicle according to Claim 3, in which the body (12) comprises a longitudinal slot (30) inside which is attached a shaft (32) for articulating the supporting means and inside which the said supporting means partly extends.

5. Vehicle according to Claim 1 or 2, in which the supporting means is telescopic and provided with an end that can move in translation relative to the body supporting the sensor means.

6. Vehicle according to any one of the preceding claims, comprising a plate (26) supporting the sensor means (18) and mounted on the supporting means (22).

7. Vehicle according to Claim 6, in which the plate (26) is mounted at one end of the supporting means (22).

8. Vehicle according to Claim 6 or 7, in which the plate (26) is able to rotate relative to the supporting means (22) about a longitudinal axis (29) of the said supporting means.

9. Vehicle according to Claim 8, comprising a control unit capable of determining an angular orientation of the plate relative to the supporting means and depending on a theoretical route to be followed by the vehicle and capable of maintaining, by closed-loop control, the angular orientation of the plate on the said theoretical route.

10. Vehicle according to any one of Claims 6 to 9, in which the plate (26) can rotate relative to the supporting means (22) about an axis that is transverse to the said supporting means.

11. Vehicle according to any one of the preceding claims, in which the supporting means (22) is situated longitudinally at the opposite end from the propulsion means (14).

12. Vehicle according to any one of the preceding claims, comprising means (34, 36, 38) for actuating the supporting means.

13. Vehicle according to Claim 12, in which the actuation means comprise an electric motor (34) and a wheel-and-worm reduction gear (38) forming a member for immobilizing the supporting means in the first and second positions.

14. Vehicle according to Claim 12 or 13, comprising at least one sensor for detecting the position of the supporting means (22) relative to the body and a control unit capable of controlling the operation of the actuation means (34, 36, 38) depending on the detected position.

15. Supporting means for the production of a naval vehicle according to any one of the preceding claims.