Summary

[0010] According to an embodiment of the present invention, a launch and recovery system (LARS) is provided for launching an autonomous underwater vehicle (AUV) into the water and recovering back the AUV from the water after completing a task or mission.

[0011] Advantageously the LARS has a cage-like capture device, which is compact, easy to store or handle. The capture device is dimensioned to capture and secure an AUV. The capture device is constructed of two rigid jaws that are pivotedly joined; as there is no flexible feature where the configuration of the capture device may be swayed or disturbed by water currents.

[0012] In one embodiment, a launch and recovery system (LARS) is provided and as defined in the claims 1-~~14~~13.

[0013] In another embodiment, a method of launching and recovering an autonomous underwater vehicle is provided and as defined in the claims ~~15-16~~14-15.

Brief Description of the Drawings

[0014] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0015] FIG. 1 illustrates a launch and recovery system (LARS) according to an embodiment of the invention, which is mounted on a surface vessel, a suspension and retrieval (SAR) apparatus, a docking apparatus and a capture device;

[0016] FIG. 2A illustrates the SAR apparatus is pivoted to an extended position and the docking apparatus is outboard from the surface vessel, whilst FIG. 2B illustrates the docking apparatus is lowered to an underwater depth for launching and recovering;

launching the AUV 30 into a body of water or recovering the AUV from the water. The surface vessel 10 may be manned or unmanned. The LARS 100 may be operated manually from the control console 114 or switched to automatic control at the control console 114. Automatic control may even be carried out remotely from another location.

[0024] The AUV 30 is a self-propelling type and may be suitable for any kind of applications. The AUV is generally equipped with sensors, cameras, antennae and the like to conduct underwater inspection, underwater investigation, serve military applications, study underwater marine life, and so on.

[0025] FIG. 1 shows the skid 112 of the SAR apparatus 105 being mounted on the surface vessel 10. As shown in FIG. 1, the frame 110 is in its home position, and is pivotable to the extended position by a pair of linear actuators 120. The SAR apparatus 105 also includes a hoist winch 130 suspended from the frame 110, a hoist rope 132, and an electric umbilical cord 140 (more clearly shown in FIGs. 2A-2B) that carries electric power and electric signals between the docking system 200 and the SAR apparatus 105. Advantageously, with the hoist winch 130 being suspended from the frame 110, operation of the hoist winch 130 is independent from operation of the frame 110, and the umbilical cord 140 need only to be kept at a minimal tension by a tension reel 142 mounted near the control console 114, as seen in FIG. 2A. In another embodiment, the tension reel 142 is manually operated via a handle 144.

[0026] In an alternative embodiment, the hoist winch 130 is connected to the docking apparatus 200 whilst a free end of the hoist rope 132 is attached to the frame 110.

[0027] FIGs. 2A-2B show the frame 110 is pivoted to the extended position such that the docking apparatus 200 and capture device 280 are a predetermined distance L away from the surface vessel 10. At this predetermined distance L, the docking apparatus 200, capture device 280 and AUV 30 are a clear distance away from the surface vessel 10 and accidental contact with the surface vessel caused by water swells and currents or swinging of the hoist rope 132 is prevented.

CLAIMS:

1. A launch and recovery system (LARS) for launching an autonomous underwater vehicle (AUV) into a body of water and recovering back the AUV from the water, the LARs comprising:

a suspension and retrieval (SAR) apparatus mountable on a surface vessel;

a docking apparatus suspended from the SAR apparatus; and

a capture device connected to the docking apparatus for engaging and securing the AUV, wherein the capture device is a cage-like structure made up of ~~a lower jaw pivotedly joined to an upper jaw,~~ an upper jaw having a 3D taper form, defining a large front end transitioning to a semi-circular elongate prismatic rear end, and a lower jaw pivotedly joined to the upper jaw at the semi-circular elongate prismatic rear end by a pivot joint;

so that opening of the capture device provides a large exit area for non-contact with the AUV and operating the docking apparatus to move the capture device clear from the AUV during launch, or opening the capture device to provide a large entrance area for a front end of the AUV to enter therein, operating the docking apparatus to substantially locate the AUV inside the capture device and closing the lower jaw to secure the AUV inside the capture device during recovery.

2. The LARS according to claim 1, further comprising a hoist winch suspended on the SAR apparatus and a free end of an associated rope is terminated on a chassis of the docking apparatus.

3. The LARS according to claim 1 or 2, wherein the SAR apparatus is pivotable between a home position inboard the surface vessel and an extended position outboard of the surface vessel.

~~4. The LARS according to any one of claims 1-3, wherein the cage-like capture device comprises:~~

~~the upper jaw having a 3D taper form, from a large front end to a semi-circular elongate prismatic rear end; and~~

~~the lower jaw pivotedly joined to the upper jaw at the semi-circular elongate prismatic rear end by a pivot joint.~~

45. The LARS according to ~~claim 4~~any one of claims 1-3, further comprising a plurality of rubber pads disposed in spaced orientation around an inside of the semi-circular elongate prismatic rear end of the capture device to fit the front end of the AUV.

56. The LARS according to ~~claim 4~~any one of claims 1-4, further comprising cross bars disposed across the lower jaw at both the front end and rear end, with the cross bars having rubber sleeves to provide cushioned contact with the AUV.

67. The LARS according to any one of claims ~~4-6~~1-5, wherein the taper form of the upper jaw is arranged to make tangential or gliding contact with the front end of the AUV.

78. The LARS according to any one of claims ~~4-7~~1-6, further comprising a pair of electric winches disposed on the upper jaw whilst associated wire cables are terminated at the lower jaw, so that the pair of winches are operable to close the lower jaw against the upper jaw for securing the AUV inside the capture device.

89. The LARS according to any one of claims ~~4-7~~1-6, further comprising a pair of linear actuators linking the lower jaw to the upper jaw, so that the linear actuators are operable to open and close the capture device during engagement or release of the AUV.

9~~10~~. The LARS according to any one of the preceding claims, further comprising:

two or more floatation devices to provide substantially neutral or slight buoyancy when the capture device is submerged in water.

10~~11~~. The LARS according to any one of claims ~~4-10~~1-9, further comprising a camera disposed at the front end of the capture device and another camera disposed at the rear end, with the cameras being equipped with lights for illumination.

11~~12~~. The LARS according to any one of claims ~~4-11~~1-10, further comprising a pair of hydrophones disposed at the front end of the upper jaw to provide stereoscopic locating of the AUV.

12~~13~~. The LARS according to claim ~~12~~11, further comprising a pair of hydrophones disposed at the front end of the lower jaw.

13~~14~~. The LARS according to any one of the preceding claims, further comprising a depth sensor so that launch and recovery of the AUV is operable at a predetermined depth.

14~~15~~. Method for launching/recovering an autonomous underwater vehicle (AUV) from the water employing a launch and recovery system (LARS) having a cage-like capture device that is dimensioned to substantially accommodate the AUV, with the cage-like capture device having an upper jaw and a lower jaw pivotedly joined to the upper jaw, the method comprising:

~~increasing a mouth area at a front end by pivoting the lower jaw away from the upper jaw;~~

~~translating the capture device so that the AUV is substantially inside the capture device; and~~

~~closing the lower jaw against the upper jaw to locate and secure the AUV inside the capture device during recovery of the AUV;~~

~~or during launch of the AUV, comprising: increasing the mouth area at the front end by pivoting the lower jaw away from the upper jaw; translating the capture device a clear distance from the AUV; closing the capture device and retrieving the capture device from the water~~

operating a suspension and retrieval (SAR) apparatus between an inboard position and an outboard position on a surface vessel; and

suspending and launching/recovering the LARS when the SAR apparatus is at the outboard position;

wherein a motion of operating the SAR apparatus is independent of a motion of suspending and launching/recovering the LARS.

15~~16~~. The method according to claim ~~15~~14, wherein the independent motions of operating the SAR apparatus and launching or recovering of the ~~AUV is conducted at a predetermined depth below water~~LARS is implemented by locating a hoist winch on a pivoted frame of the SAR.