

Unmanned vehicle for rope transfer

Field of the invention

The present invention concerns a method for establishing a mechanical connection to or from a vessel by use of an unmanned vehicle. The present invention also concerns an unmanned vehicle for rope transfer.

Background of the invention

Today vessels require crew on both the quay and the vessel to moor or unmoor a vessel in port. This is a labour intensive operation where crews throw lines to each other and then make them fast by hand or using deck machinery. When tugs are required for harbour approach/manoeuvring, manned operations have a crew on the assisted vessel who throws a light heaving line to the crew on the tug. The crew on the tug then ties the heaving line to a heavy tug line. The crew on the assisted vessel then winches up the heaving/tug line and makes the tug line fasten to a bollard. This is a very labour intensive operation.

Remote/autonomous vessels inherently have a problem of making rope connections as some or all of the crew has been removed.

Devices for providing connection between vessels are known by using for example manned aircraft and towline. Patent document US5797343 A discloses a system for establishing a towing connection between a marine casualty and a salvage vessel. This is achieved by means of a loop-forming arrangement, e.g. in the form of a chain, which is held distended in the horizontal plane and which is connected to a towline, the loop-forming arrangement being adapted to be brought in over and around a strong structural member on the casualty by means of a helicopter.

Publication WO0068077 A1 discloses an aircraft for transporting a load through the air between source and destination locations.

The above aircrafts are labour intensive and do not include equipment for mooring a vessel. Remote/autonomous vessels will have a problem of making rope connections and to fasten a mooring line. The problem to be solved by the present invention is to establish mechanical connection to or from a vessel by unmanned operations. It is also an object to fasten a mooring line and also release it by unmanned operations. The purpose of the present invention is to provide a device and a method that addresses at least one of the above problems while retaining the benefits of prior art.

Summary of the invention

This is achieved according to the invention by providing a method for establishing a mechanical connection to or from a vessel, the method comprising:

- attaching a first end of a connection line to an unmanned vehicle,
- 5 - attaching a second end of said connection line to a first connector,
- transferring said first end of said connection line using said unmanned vehicle to a second connector,
- attaching said first end of said connection line to said second connector,

10 wherein one of said first connector and said second connector is aboard a vessel and the remaining second or first connector respectively is located aboard the same or another vessel, a fixed location or onshore, and

wherein the method is **characterized in that** the unmanned vehicle is an unmanned aerial vehicle.

15 In another aspect, the present invention relates to a method for establishing a mechanical connection to or from a vessel, the method comprising:

- attaching a first end of a connection line to an unmanned vehicle,
- attaching a second end of said connection line to a first connector,
- transferring said first end of said connection line using said unmanned vehicle to a second connector,
- 20 - attaching said first end of said connection line to said second connector,

wherein one of said first connector and said second connector is aboard a vessel and the remaining second or first connector respectively is located aboard the same or another vessel, a fixed location or onshore, and

25 wherein the method is **characterized in that** the unmanned vehicle and said first end of the connection line are launched from a mother vessel, wherein the unmanned vehicle communicates and cooperates with a navigation system of the mother vessel.

30 In another aspect, the present invention relates to a system for establishing a mechanical connection to or from a vessel, the system comprising a mother vessel, a connection line and an unmanned vehicle, wherein said unmanned vehicle comprises equipment to grasp and release the line, and wherein the system is **characterized in**

that the unmanned vehicle is an unmanned aerial vehicle. The equipment to grasp may be any suitable equipment known to a person skilled in the art.

In another aspect, the present invention relates to a system for establishing a mechanical connection to or from a vessel, the system comprising a mother vessel, a connection line and an unmanned vehicle, wherein the unmanned vehicle is launched from a mother vessel with a first end of the connection line attached to the unmanned vehicle, and wherein the system is **characterized in that** the unmanned vehicle communicates and cooperates with a navigation system of the mother vessel.

Brief description of the drawings

10 The present invention will be described in greater detail in the following with reference to the exemplary embodiment shown in the drawing, in which:

Figures 1a-c shows an unmanned vehicle transferring a connection line between two vessels.

15 Figure 2a shows an unmanned vehicle transferring a connection line from a vessel to a mooring buoy.

Figure 2b shows an unmanned vehicle transferring a connection line from a winch on a mooring buoy to a vessel.

Figure 3a shows an unmanned vehicle transferring a connection line from a winch located onshore to a vessel.

Figure 3b shows an unmanned vehicle transferring a connection line from a vessel to a bollard located onshore.

Figures 4a-e shows a drone equipped with a gripping device, detection sensors and communication device.

5 Figure 5a shows an amphibious drone swimming.

Figure 5b shows an amphibious drone which has transferred a connection line between two vessels to the ship hull of a vessel.

10 **Detailed description**

Figures 1a-c illustrate a system for establishing a mechanical connection between two vessels. A first end of a connection line 4 is attached to an unmanned vehicle 1. The unmanned vehicle is in this embodiment an unmanned aerial vehicle
15 commonly known as a drone. A second end of said connection line 4 is attached to a first connector 3, where the first connector 3 is located for example aboard a vessel.

The unmanned aerial vehicle 1 transfers the first end of the connection line 4 to a second connector 2. The unmanned vehicle could be an aerial vehicle 1 as shown in Figure 1a or an amphibious unmanned vehicle as the swimming amphibious drone
20 shown in Figure 1b and Figure 5a. The unmanned vehicle 1 comprises equipment to grasp 5 and release the connection line, and the line 4 is thereupon attached to the second connector 2 by the unmanned aerial vehicle 1. An example of a possible gripping device 5 on a drone is illustrated in Figure 4a. The gripping device can be many different types. Figures 4b-4e illustrates how the gripping device operates to
25 fasten and release the line 4. This operation could be useful if a line needs to be delivered from a vessel to another vessel, such as tug boat to a vessel requiring assistance as illustrated in Figure 1.

The first connector 3 and/ or the second connector 2 could be located aboard a vessel or at a fixed location as an oil or gas platform. The fixed location could be for
30 example mooring buoys as illustrated in Figures 2a and 2b. One of the connectors could also be located onshore for mooring of a vessel to shore for example to a quay as illustrated in Figures 3a and 3b. In Figure 3a the winch is located onshore and in Figure 3b the winch is located on the vessel.

In one embodiment the line needs to be transferred from a vessel around a
35 bollard and back to the vessel.

The connection line 4 could be made of any suitable material and could be any suitable mooring line or towing line. The line 4 could also be a heaving line, messenger line or provision hoses for fueling, water, etc. A floating bouy could be attached to the

connection line 4. The connectors are for example bitts or bollards or any device suitable for mooring of a vessel.

The unmanned vehicle 1 is stored on shore or onboard said vessel. It could also be stored at a floating location that is located near to where these operations typically occur, for example just outside a port where tugs meet larger vessels. It could also be stationed on a mooring buoy and facilitates the connection between ship and buoy.

The unmanned vehicle could be aerial or amphibious, and has a docking station that will allow it to be serviced and provisioned. The unmanned vehicle 1 is powered by electricity or fuel fluid or a combination between the two. The power source could be for example batteries, fuel cells, or a small internal combustion engine.

As illustrated in Figures 4a-e the unmanned vehicle 1 is equipped with sensors 6 and cameras 6 that will allow it to identify lines, winches, spools, bollards and humans. It is capable to collect and deliver the line 4 from or to a winch, a spool, a bollard, a flat surface, a surface of water, a rope handling crane, and also a human for example from a hand of a crew member and any other suitable devices known to a person skilled in the art. The unmanned vehicle is also capable to fasten and unfasten the line 4.

The unmanned vehicle 1 is equipped with sensors 6 to measure the dynamic weight of the line as the line pays out from start location to final location. At least one sensor allows for controlling pick-ups, drop offs, payload weight. Also a sensor to measure environmental effects is included in the unmanned vehicle 1. In event of aerial drone the sensor will measure wind and weather conditions. In event of amphibious drone current and waves etc. are measured.

A control system that can either operate autonomously, semi autonomously or remotely by an operator is associated with the unmanned vehicle 1.

A navigation system will allow the unmanned vehicle 1 to control its movements and compensate for environmental factors. The outputs from the sensor(s) are utilized for environmental effects for operational control.

In the event of amphibious drone, the drone will be able to move on land, water, and along a ship's hull. The drone will have special equipment that will allow it to scale negative or positive slopes such as a ship's hull and quays. This equipment can include wheels/tracks and a device that allows it to attach itself to the surface that it is climbing such as suction or magnetic device.

The unmanned vehicle can include wheels, tracks and climbing equipment (suction or magnetic device) to move on land, water, and along a ship's hull. Devices that allow it to attach itself to the surface that it is climbing such as suction or magnetic device could also be included.

Equipment to scale negative or positive slopes (such as a ship's hull and quays) and sensors for at least current and waves could also be included on the unmanned vehicle 1.

5 The unmanned vehicle 1 is shaped to have a location feature that mates with a receiving location feature on the deck of the vessel contributing to make it easier to fasten the rope.

According to the invention there is provided a system wherein an unmanned vehicle 1, for example a drone, and a connection line 4 is launched from a mother vessel. The drone cooperates/communicates/coordinates with the navigation systems
10 of the mother vessel such as dynamic positioning system to ensure the smooth delivery of the line. The drone and mother ship know where they are relative to each other at all times and can perform maneuvers with the rope smoothly without unanticipated changes in the tension or length line being transferred. The mother ship can move relative to the drone to aid with the delivery of the line such as when it needs to
15 compensate for environmental factors such as wind waves etc.

While the invention has been described with reference to specific examples and embodiments, the scope of the invention is determined by the accompanying claims.

Claims

1. Method for establishing a mechanical connection to or from a vessel, the method comprising:

- 5 - attaching a first end of a connection line (4) to an unmanned vehicle (1),
 - attaching a second end of said connection line (4) to a first connector (3),
 - transferring said first end of said connection line (4), using said unmanned
 vehicle (1), to a second connector (2),
 - attaching said first end of said connection line (4) to said second connector (2),
10 wherein one of said first connector (3) and said second connector (2) is aboard a
 vessel and the remaining second (2) or first connector (3) respectively is located aboard
 the same or another vessel, a fixed location or onshore, and
 wherein the method is **characterized in that** the unmanned vehicle (1) is an
 unmanned aerial vehicle.

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2. Method for establishing a mechanical connection to or from a vessel, the method comprising:

- attaching a first end of a connection line (4) to an unmanned vehicle (1),
 - attaching a second end of said connection line (4) to a first connector (3),
20 - transferring said first end of said connection line (4), using said unmanned
 vehicle (1), to a second connector (2),
 - attaching said first end of said connection line (4) to said second connector (2),
 wherein one of said first connector (3) and said second connector (2) is aboard a
 vessel and the remaining second (2) or first connector (3) respectively is located aboard
25 the same or another vessel, a fixed location or onshore, and

 wherein the method is **characterized in that** the unmanned vehicle (1) and said
 first end of the connection line (4) are launched from a mother vessel, wherein the
 unmanned vehicle (1) communicates and cooperates with a navigation system of the
 mother vessel.

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3. Method according to claim 1 or 2,

wherein said connection line (4) is selected from a group comprising a mooring line and a towing line, a heaving line, messenger line, or provision hoses.

4. Method according to any of claims 1-3,

5 wherein a floating buoy is attached to the connection line (4).

5. Method according to any of claims 1-4,

wherein the fixed location is a mooring buoy (2, 3).

10 6. Method according to any of claim 1-5,

wherein said unmanned vehicle (1) collects and/or delivers said line (4) to any of the group: bitts, bollard, winch, spool, flat surface, a surface of water, a human, rope handling crane.

15 7. A system for establishing a mechanical connection to or from a vessel, the system comprising a mother vessel, a connection line (4) and an unmanned vehicle (1), wherein the unmanned vehicle (1) is launched from a mother vessel with a first end of the connection line (4) attached to the unmanned vehicle (1), and wherein the system is **characterized in that** the unmanned vehicle (1) communicates and cooperates with a
20 navigation system of the mother vessel.

8. The system according to claim 7, wherein said unmanned vehicle (1) is an unmanned aerial vehicle.

25 9. A system for establishing a mechanical connection to or from a vessel, the system comprising a mother vessel, a connection line (4) and an unmanned vehicle (1), wherein said unmanned vehicle (1) comprises equipment to grasp (5) and release the connection line (4), and wherein the system is **characterized in that** the unmanned vehicle (1) is an unmanned aerial vehicle.

10. The system according to claim 8, wherein the unmanned vehicle (1) communicates and cooperates with a navigation system of the mother vessel.

11. The system according to claim 10,
5 wherein the navigation systems of the mother vessel is a dynamic positioning system, providing the position of the unmanned vehicle and mother ship relative to each other at all times and perform maneuvers with the connection line (4) smoothly without unanticipated changes in the tension or length connection of the line (4) being transferred, whereby the mother ship can move relative to the unmanned vehicle to aid
10 with the delivery of the connection line (4), and compensate for environmental factors such as wind waves and ensure smooth delivery of the connection line (4).

12. The system according to any of claim 7-11, wherein said unmanned vehicle (1) is stored on shore or onboard said vessel.

13. The system according to any of claim 7-12, wherein said unmanned vehicle (1)
15 has a docking station that will allow it to be serviced and provisioned.

14. The system according to any of claim 7-13, wherein said unmanned vehicle (1)
20 is powered by electricity or fuel fluid or a combination between the two.

15. The system according to any of claim 7-14, wherein said unmanned vehicle (1) comprises at least one sensor (6) to identify lines, winches, spools, bollards and humans.

16. The system according to any of claim 7-15, wherein said unmanned vehicle (1)
25 comprises at least one sensor (6) to measure line weight changes during operation.

17. The system according to any of claim 7-16, comprising at least one sensor (6) to measure environmental effects.

18. The system according to any of claim 7-17, utilizing output of said at least one sensor (6) for environmental effects for operational control.

19. The system according to any of claim 7-18, wherein output of said at least one
5 sensor (6) allows for controlling pick-ups, drop offs, payload weight.

20. The system according to any of claim 7-19, wherein said unmanned vehicle (1) includes equipment to collect and deliver the first end of the connection line (4) from one of a winch, a spool, a bollard, a flat surface, and a human.
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21. The system according to any of claim 7-20, operating autonomously, semi autonomously or remotely controlled.

22. The system according to any of claim 7-21, wherein said unmanned vehicle (1)
15 is an unmanned amphibious vehicle including at least one of wheels, tracks and climbing equipment (suction or magnetic device) to move on land, water, and along a ship's hull and having equipment to scale negative or positive slopes (such as a ship's hull and quays) and sensors (6) for at least current and waves.

20 23. The system according to any of claim 7-22, shaped to have a location feature that mates with a receiving location feature on the deck of the vessel being assisted to make it easier to fasten the first end of the connection line (4).

24. The system according to any of claim 7-23 wherein said unmanned vehicle (1)
25 can be remotely controlled or perform operations, fully or partially, according to prescribed algorithms analyzing the information it gets from its sensors (6) and camera (6).