SUMMARY

Aspects of the present disclosure are set out in the accompanying independent and dependent claims. Combinations of features from the dependent claims may be combined with features of the independent claims as appropriate and not merely as explicitly set out in the claims.

According to a first aspect of the present invention, there is provided an underwater camera unit comprising:

a pressure housing containing:

a modem;

a command processor coupled to the modem to receive control and/or monitoring signals from the modem;

an image processor coupled to the modem to provide image data to the modem; and

a camera sensor coupled to the image processor; and

a connector for connecting the underwater camera unit to an underwater cable comprising two wires to receive control and/or monitoring signals and a DC supply voltage via the underwater cable comprising two wires and to transmit multiplexed image data and control and/or monitoring signals via the underwater cable comprising two wires,

wherein the modem is coupled to the connector,

wherein the modem is operable to:

multiplex image data from the image processor with control and/or monitoring signals from the command processor and transmit the multiplexed image data and control and/or monitoring signals from the underwater camera unit via the connector; and

receive control and/or monitoring signals via the connector and pass them to the command processor, and

wherein the pressure housing also contains a power supply circuit coupled to the connector for receiving the DC supply voltage from the underwater cable comprising two wires via said connector.

By multiplexing the image data with the control and/or monitoring signals, image data may be transmitted from the underwater camera unit and control and/or monitoring signals may be transmitted and received by the underwater camera unit using a single underwater

cable. This may reduce the complexity and cost of the connection between the underwater camera unit and a surface controller.

The pressure housing may also contain a power supply circuit coupled to the connector for receiving a DC supply voltage from the underwater cable via the connector. The DC supply voltage may thus also be supplied to the underwater camera unit using the

surface of water in which the underwater camera unit is submerged. This can allow depth information to be used to provide monitoring of the local depth of the underwater camera unit for operational uses such as managing diver depth exposures or operational positioning. Again, because this information is multiplexed with the image data, no separate cable is required to connect to a depth sensor.

The underwater camera unit may comprise a further connector, for connecting the underwater camera unit to a further device located externally with respect to the pressure housing, wherein the modem is coupled to the further connector, and wherein the control and/or monitoring signals are for controlling and/or monitoring the operation of the further device. The further device may for instance comprise a pressure sensor for determining a remaining air supply in a diver's air tank.

The modem may be an orthogonal frequency-division multiplexing (OFDM) modem. OFDM multiplexed data may tolerate the presence of a DC supply voltage on the underwater cable without substantial distortion.

An underwater cable may be connected to the connector of the underwater camera unit. The underwater cable may comprise two wires. In some embodiments, the underwater cable may comprise exactly two wires.

According to a second aspect of the present invention, there is provided a surface controller for controlling an underwater camera unit via an underwater cable comprising two wires, the surface controller comprising:

a connector for connecting the surface controller to the underwater cable comprising two wires to couple the surface controller to the underwater camera unit to transmit control and/or monitoring signals and supply a DC supply voltage via the underwater cable comprising two wires and to receive image data multiplexed with control and/or monitoring signals via the underwater cable comprising two wires;

a modem coupled to the connector;

a processor operable to generate and process control and/or monitoring signals, wherein the processor is coupled to the modem; and

an interface for passing image data to image display/recording equipment, wherein the interface is coupled to the modem;

wherein the modem is operable to:

receive the image data multiplexed with control and/or monitoring signals via the connector,

de-multiplex the image data and the control and/or monitoring signals;

pass the de-multiplexed image data to the interface;

pass the de-multiplexed control and/or monitoring signals to the processor; and

receive the control and/or monitoring signals generated by the processor and pass them to the connector for transmission to the underwater camera unit via the underwater cable comprising two wires, and

wherein the surface controller further comprises a power supply circuit coupled to the connector, for supplying the DC supply voltage to the underwater cable comprising two wires via said connector.

By multiplexing the image data with the control and/or monitoring signals, image data may be received from an underwater camera unit and control and/or monitoring signals may be transmitted and received by the surface unit using a single underwater cable. This may reduce the complexity and cost of the connection between the surface controller and one or more underwater camera units.

The surface controller may comprise a power supply circuit couple to the connector, for supplying a DC supply voltage to the underwater cable via the connector. The DC supply voltage may thus also be supplied by the surface unit using the same underwater cable that is used to send/receive the multiplexed image data and control and/or monitoring signals.

The control and/or monitoring signals generated by the processor may be for controlling and/or monitoring the operation of a light source in the underwater camera unit. Accordingly, the first light source may be operated remotely by the surface unit.

The surface controller may comprise a user interface including a display and one or more user input devices.

The modem may be an orthogonal frequency-division multiplexing (OFDM) modem. OFDM multiplexed data may tolerate the presence of a DC supply voltage on the underwater cable without substantial distortion.

An underwater cable may be connected to the connector of the surface controller. The underwater cable may comprise two wires. In some embodiments, the underwater cable may comprise exactly two wires.

According to a third aspect of the present invention, there is provided a system comprising an underwater camera unit defined in the first aspect and a surface controller defined in the second aspect, wherein the underwater camera unit is coupled to the surface controller via the underwater cable comprising two wires.

The underwater camera unit may be coupled to the surface controller via the underwater cable.

The system may comprise at least one further said underwater camera unit coupled to the surface controller via the underwater cable. The multiplexed approach to sending and receiving the image data and control and/or monitoring signals lends itself to the connection of multiple underwater camera units to a single surface unit, because the data and signals for each underwater camera unit may be multiplexed together.

According to a fourth aspect of the present invention, there is provided a method of operating an underwater camera unit, the underwater camera unit comprising:

a pressure housing containing:

a modem;

a command processor coupled to the modem to receive control signals from the modem;

an image processor coupled to the modem to provide image data to the modem; and

a camera sensor coupled to the image processor; and

a connector for connecting the underwater camera unit to an underwater cable comprising two wires to receive control and/or monitoring signals and a DC supply voltage via the underwater cable and to transmit multiplexed image data and control and/or monitoring signals via the underwater cable comprising two wires,

wherein the modem is coupled to the connector,

wherein the method comprises the modem:

multiplexing image data from the image processor with control and/or monitoring signals from the command processor and transmitting the multiplexed image data and control and/or monitoring signals from the underwater camera unit via the connector; and

receiving control and/or monitoring signals via the connector and passing them to the command processor, and

wherein the pressure housing also contains a power supply circuit coupled to the connector, and wherein the method further comprises the power supply circuit receiving the DC supply voltage from the underwater cable comprising two wires via said connector.

By multiplexing the image data with the control and/or monitoring signals, image data may be transmitted from the underwater camera unit and control and/or monitoring signals

may be transmitted and received by the underwater camera unit using a single underwater cable.

According to a fifth aspect of the present invention, there is provided a method of operating a surface controller for controlling an underwater camera unit via an underwater cable comprising two wires, the surface controller comprising:

a connector for connecting the surface controller to the underwater cable comprising two wires to couple the surface controller to the underwater camera unit to transmit control and/or monitoring signals and supply a DC supply voltage via the underwater cable comprising two wires and to receive image data multiplexed with control and/or monitoring signals via the underwater cable comprising two wires;

a modem coupled to the connector;

a processor operable to generate and process control and/or monitoring signals, wherein the processor is coupled to the modem;

an interface for passing image data to image display/recording equipment, wherein the interface is coupled to the modem; and

a power supply circuit coupled to the connector;

the method comprising the modem:

receiving the image data multiplexed with control and/or monitoring signals via the connector;

de-multiplexing the image data and the control and/or monitoring signals;

passing the de-multiplexed image data to the interface;

passing the de-multiplexed control and/or monitoring signals to the processor;

receiving control and/or monitoring signals generated by the processor and passing them to the modem for transmission to the underwater camera unit via the underwater cable comprising two wires; and

the power supply circuit supplying a DC supply voltage to the underwater cable comprising two wires via said connector.

By multiplexing the image data with the control and/or monitoring signals, image data may be received from an underwater camera unit and control and/or monitoring signals may be transmitted and received by the surface unit using a single underwater cable.

CLAIMS

1. An underwater camera unit comprising:

a pressure housing containing:

a modem;

a command processor coupled to the modem to receive control and/or monitoring signals from the modem;

an image processor coupled to the modem to provide image data to the modem; and

a camera sensor coupled to the image processor; and

a connector for connecting the underwater camera unit to an underwater cable comprising two wires to receive control and/or monitoring signals and a DC supply voltage via the underwater cable comprising two wires and to transmit multiplexed image data and control and/or monitoring signals via the underwater cable comprising two wires,

wherein the modem is coupled to the connector,

wherein the modem is operable to:

multiplex image data from the image processor with control and/or monitoring signals from the command processor and transmit the multiplexed image data and control and/or monitoring signals from the underwater camera unit via the connector; and

receive control and/or monitoring signals via the connector and pass them to the command processor, and

wherein the pressure housing also contains a power supply circuit coupled to the connector for receiving the DC supply voltage from the underwater cable comprising two wires via said connector.

2. The underwater camera unit of claim 1, wherein the pressure housing also contains a first light source, wherein the control and/or monitoring signals are for controlling and/or monitoring the operation of the light source.

3. The underwater camera unit of claim 2, wherein the pressure housing contains a further light source for use when there is a malfunction in the operation of the first light source.

4. The underwater camera unit of claim 3, comprising a driver circuit for driving the further light source, wherein the driver circuit is operable to switch on the further light source in response to a loss of said DC supply voltage to the power supply circuit.

5. The underwater camera unit of claim 4, further comprising a magnet attachable to the underwater camera unit, wherein the driver circuit for driving the further light source is operable to detect the presence of magnetic flux associated with said magnet and to not switch on the further light source when said magnetic flux is detected, irrespective of whether said DC supply voltage to the power supply circuit is present.

6. The underwater camera unit of any preceding claim, wherein the underwater camera unit further includes at least one sensor, and wherein the control and/or monitoring signals are for controlling and/or monitoring the operation of the at least one sensor.

7. The underwater camera unit of claim 6, wherein the at least one sensor is a pressure sensor for determining a depth of the underwater camera unit beneath the surface of water in which the underwater camera unit is submerged.

8. The underwater camera unit of any preceding claim, wherein the underwater camera unit comprises a further connector, for connecting the underwater camera unit to a further device located externally with respect to the pressure housing, wherein the modem is coupled to the further connector, and wherein the control and/or monitoring signals are for controlling and/or monitoring the operation of the further device.

9. The underwater camera unit of claim 8, wherein the further device comprises a pressure sensor for determining a remaining air supply in a diver's air tank.

10. The underwater camera unit of any preceding claim, wherein the modem is an orthogonal frequency-division multiplexing (OFDM) modem.

11. The underwater camera unit of any preceding claim and said underwater cable comprising two wires, wherein the underwater cable comprising two wires is connected to the connector of the underwater camera unit.

12. A surface controller for controlling an underwater camera unit via an underwater cable comprising two wires, the surface controller comprising:

a connector for connecting the surface controller to the underwater cable comprising two wires to couple the surface controller to the underwater camera unit to transmit control and/or monitoring signals and supply a DC supply voltage via the underwater cable comprising two wires and to receive image data multiplexed with control and/or monitoring signals via the underwater cable comprising two wires;

a modem coupled to the connector;

a processor operable to generate and process control and/or monitoring signals, wherein the processor is coupled to the modem; and

an interface for passing image data to image display/recording equipment, wherein the interface is coupled to the modem;

wherein the modem is operable to:

receive the image data multiplexed with control and/or monitoring signals via the connector,

de-multiplex the image data and the control and/or monitoring signals;

pass the de-multiplexed image data to the interface;

pass the de-multiplexed control and/or monitoring signals to the processor; and

receive the control and/or monitoring signals generated by the processor and pass them to the connector for transmission to the underwater camera unit via the underwater cable comprising two wires, and

wherein the surface controller further comprises a power supply circuit coupled to the connector, for supplying the DC supply voltage to the underwater cable comprising two wires via said connector.

13. The surface controller of claim 12, wherein the control and/or monitoring signals generated by the processor are for controlling and/or monitoring the operation of a light source in the underwater camera unit.

14. The surface controller of claim 12 or 13, comprising a user interface including a display and one or more user input devices.

15. The surface controller of any of claims 12 to 14, wherein the modem is an orthogonal frequency-division multiplexing (OFDM) modem.

16. The surface controller of claim 12 or claim 13 and said underwater cable comprising two wires, wherein the underwater cable comprising two wires is connected to the connector of the surface controller.

17. A system comprising an underwater camera unit according to any of claims 1 to 11 and a surface controller according to any of claims 12 to 16, wherein the underwater camera unit is coupled to the surface controller via the underwater cable comprising two wires.

18. The system of claim 17, comprising at least one further said underwater camera unit coupled to the surface controller via the underwater cable comprising two wires.

19. A method of operating an underwater camera unit, the underwater camera unit comprising:

a pressure housing containing:

a modem;

a command processor coupled to the modem to receive control signals from the modem;

an image processor coupled to the modem to provide image data to the modem; and

a camera sensor coupled to the image processor; and

a connector for connecting the underwater camera unit to an underwater cable comprising two wires to receive control and/or monitoring signals and a DC supply voltage via the underwater cable and to transmit multiplexed image data and control and/or monitoring signals via the underwater cable comprising two wires,

wherein the modem is coupled to the connector,

wherein the method comprises the modem:

multiplexing image data from the image processor with control and/or monitoring signals from the command processor and transmitting the multiplexed image data and control and/or monitoring signals from the underwater camera unit via the connector; and

receiving control and/or monitoring signals via the connector and passing them to the command processor, and

wherein the pressure housing also contains a power supply circuit coupled to the connector, and wherein the method further comprises the power supply circuit receiving the DC supply voltage from the underwater cable comprising two wires via said connector.

20. A method of operating a surface controller for controlling an underwater camera unit via an underwater cable comprising two wires, the surface controller comprising:

a connector for connecting the surface controller to the underwater cable comprising two wires to couple the surface controller to the underwater camera unit to transmit control and/or monitoring signals and supply a DC supply voltage via the underwater cable comprising two wires and to receive image data multiplexed with control and/or monitoring signals via the underwater cable comprising two wires;

a modem coupled to the connector;

a processor operable to generate and process control and/or monitoring signals, wherein the processor is coupled to the modem;

an interface for passing image data to image display/recording equipment, wherein the interface is coupled to the modem; and

a power supply circuit coupled to the connector;

the method comprising the modem:

receiving the image data multiplexed with control and/or monitoring signals via the connector;

de-multiplexing the image data and the control and/or monitoring signals;

passing the de-multiplexed image data to the interface;

passing the de-multiplexed control and/or monitoring signals to the processor;

receiving control and/or monitoring signals generated by the processor and passing them to the modem for transmission to the underwater camera unit via the underwater cable comprising two wires; and

the power supply circuit supplying a DC supply voltage to the underwater cable comprising two wires via said connector.