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System for operating a boat equipped with an electric drive

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Abstract

The present invention relates to a system for operating a boat equipped with an electric drive, comprising a component controller which comprises a component interface for connecting a system component of the electric drive and a communication interface for connecting the component controller to a system bus of the drive control.

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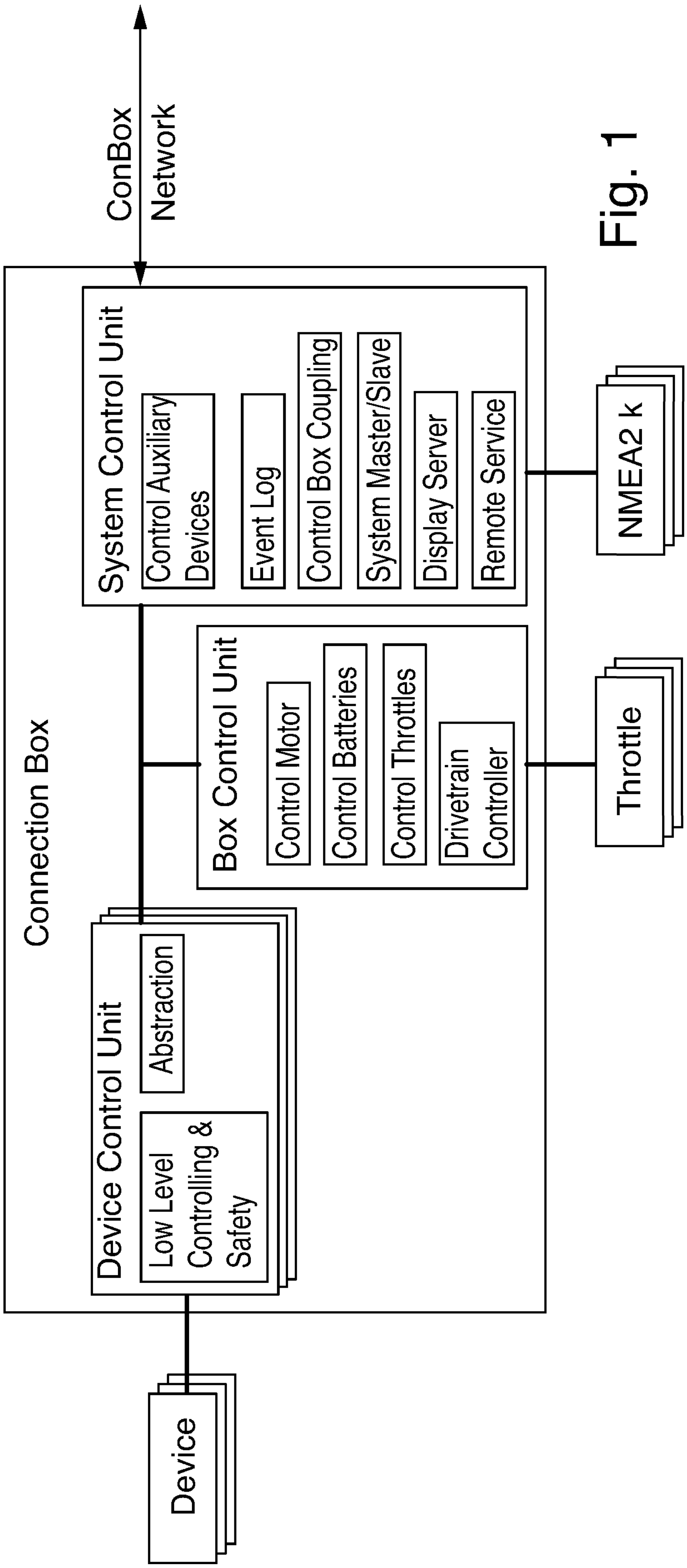

Fig. 1

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System for operating a boat equipped with an electric drive

Technical Field

The present invention relates to a system for operating a boat equipped with an electric drive, preferably a boat equipped with one or more electric motors and/or a boat equipped with a hybrid drive comprising at least one internal combustion engine and at least one electric motor.

Technical Background

It is known to power boats with an electric drive and, in this regard, fundamentally different installation types for the electric motor are known. Furthermore, in addition to the installation types of an electric motor which are known in the domain of internal combustion engines, directly on the shaft system of the propeller shaft in the interior of the boat or the installation of the electric motor in the interior of the boat on a Z-drive or a sail drive, installation types are also known in which the electric motor is arranged outside the hull of the boat, for example, in the form of outboard engines or under the hull in a drive gondola or pod drives provided on the rudder system.

In order to supply the electric motor of a boat drive with electrical energy, it is known to provide corresponding battery banks in the boat. The batteries of the battery banks can be charged, for example, by means of a charging device which is connected to a shore connection, provided the boat is in the region of a shore connection - that is, typically in a port. For this purpose, a charging device is normally provided in the boat, by means of which a controlled charging of the batteries of the battery banks can be achieved. Herein, the charging device can either be provided on the boat itself - this is then referred to as AC charging, or the charging device can be on land and the boat is supplied directly with a direct current - this is then referred to as DC charging.

In a hybrid system which, aside from the drive by means of the electric motor, also has an internal combustion engine, in principle two different variants are known.

In a first variant, the electric motor and the internal combustion engine act together on the shaft system of the boat, so that optionally an individual or a simultaneous driving of the propeller is possible via the internal combustion engine and/or the electric motor. The two drives are coupleable

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into the shaft system by means of corresponding transmissions. Both the electric motor and the internal combustion engine can accordingly act simultaneously or one after the other, via the transmissions, on the shaft system and thereby on the propeller.

In a second variant, only the electric motor has an effect on the propeller and the internal combustion engine is coupled to a generator which undertakes the supply of the electric motor and the charging of the batteries of the battery banks. Thus the batteries of the battery banks can also be charged when the boat is not in the region of a shore power connection. In this variant, an energy supply to the electric motor which is used for travelling can be carried out either by means of the battery banks or by means of an operation of the generator simultaneously with the electric motor.

It is further known also to charge the batteries of the battery bank by means of regenerative energy converters provided on the boat, for example, by means of solar cells which are arranged, for example, on a roof of the boat, or by means of a wind generator which is provided on the boat.

The system provided for operating the electric drive can be used, apart from the supply of the actual electric drive, also for supplying other consumers on board, for example, for supplying communications devices, lights and other consumers on the boat which are not directly linked to the electric drive.

A corresponding system is known, for example, from EP 2 330 030 A2.

In the known systems, it is required that a central system control, such as is known for example from the cited prior art, is individually adapted to the respective components of the system. Accordingly, a simple exchange of system components cannot be carried out, but a renewed programming must always be carried out in order in this way to provide anew a function of the system after a component exchange or a defect.

Summary of the Invention

It is an object of the present invention to provide a system for operating a boat equipped with an electric drive which provides a simplified design and increased reliability or to at least provide the public with a useful alternative to existing systems.

A system with a simplified design and increased reliability may be provided by the system of the invention.

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In one aspect, the invention provides a boat operating system to operate a boat equipped with an electric drive, the system comprising a first component controller which comprises a component interface configured to connect the first component controller to at least one specific system component of the electric drive to enable data exchange between the first component controller and the at least one specific system component, a communication interface configured to connect the first component controller to a system bus of a drive control. The at least one specific system component exchanges the data with the system bus of the drive control only via the first component controller, and the data exchange comprises sending commands to the at least one specific system component and receiving state parameter(s) from the at least one specific system component. The first component controller further comprises an abstraction module configured to exchange the data with the at least one specific system component via the component interface. The abstraction module abstracts the data, such that the at least one specific system component is represented as an abstracted system component at the communication interface to enable a higher-order control system, which communicates with the first component controller via the system bus, to address the at least one specific system component directly and generally without having to take account of technical peculiarities or particular specifications of the specific system components. The first component controller decouples the at least one system component from the system bus such that defects in at least one system component do not disrupt the system bus. Upon failure of the first component controller, the at least one specific system component can be disconnected from the first component controller and connected to a second component controller, identical to the first component controller, which is configured to be connected to a second specific system component, different from the at least one specific system component.

In some forms, the component controller comprises a component interface for connecting a system component of the electric drive and a communication interface is provided for connecting the component controller to a system bus. The component controller effectively functions as an intermediate member between the specific physical system components which can be, for example, a battery, an electric motor, a generator, a converter or an internal combustion engine drive, and the system bus.

Thus, the specific system components are in communication with the system bus of the drive control only via the component controller, whereas a direct communication of the system components with the system bus does not take place. Thus, the system bus of the drive control can be configured clearly defined, robust and reliable. An adaptation of the system bus on an exchange of system components is correspondingly not necessary. The respective component controller connected to the system components is connected therebetween and, in each case, assumes the translation and preparation of the signals, states and data communication of the specific system

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components for the system bus. Furthermore, a decoupling of the system components from the system bus takes place so that defects in individual system components cannot disrupt the system bus.

The system for operating a boat equipped with an electric motor should be understood, in particular, as one which comprises and puts into relation with one another system components necessary at least for the driving of the boat. For the driving of a boat equipped with an electric motor, apart from the actual drive comprising the electric motor with a propeller or a jet drive, an energy supply for the electric motor is also provided which can be provided in the form of a battery, but also in the form of a generator. Such a system further comprises an input unit for defining a desired drive level by the operator of the system.

Apart from the aforementioned system components that are necessary for the actual driving, a system for operating a boat equipped with an electric motor can also comprise further auxiliary system components, such as charging devices for charging a battery, DC/DC converters, DC/AC converters, generators and a plurality of auxiliary consumers such as communication devices, navigation lights, navigation devices, entertainment devices, illumination, kitchen appliances, cooling devices, etc.

By means of the abstraction module, the component controller enables the respective specific system components to be abstracted to a generic level, so that the system component can easily be detected, addressed and controlled by a higher-level drive control or system control.

A generic system component should be understood as such which comprises the control and state parameters necessary for operating the system as well as data communication and/or control commands in a general form without having to take account of the specific technical parameters of the connected system component.

For example, in the case of a battery or battery bank, a switch-on signal for the system start may be necessary as a control parameter. On the generic components, only the command “Switch On” is present - the component-specific implementation is then undertaken by the component controller on the basis of the specific properties of the battery or battery bank connected via the component interface. If the command is received accordingly at the communication interface via the system bus to switch on the battery bank on a system start, then the component controller converts this

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command, dependent upon the battery connected to the component interface in that with a first battery type, for example, a 12 V ignition signal is transferred, with a second battery type, a 24 V ignition signal is transferred and with a third battery type, a pulse is transferred to switch a load relay.

As a state parameter, for example, a charging state can be transferred from the battery to the component controller which then provides at the communication interface, for example abstracted, a percentage charging state or an actual residual capacity.

Thus, all the system components of one system component type connected to the component controller behave equally. In other words, at the communication interface, a generic battery is

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always displayed and addressed the same, regardless of the actual technical manifestation of the battery.

As a further example, an electric motor can be provided with which as a generic electric motor, for example, only one drive level can be transferred as a drive command. Accordingly, the drive command, e.g. “Half ahead”, “Full ahead”, “Full reverse” or a percentage drive command, e.g. “80% ahead”, “20% reverse”, is transferred from a higher-order drive control via the system bus, said command then being converted in the component controller into a corresponding rotary speed stipulation, torque stipulation or power stipulation for the specific electric motor connected to the component interface and being converted into a control command according to the respective power electronics connected to the component interface.

In the case of an electric motor, for example, state parameters such as the temperature, preferably a percentage temperature relative to a maximum temperature permissible for the specific electric motor connected via the component interface are also transferred at the communication interface. A higher-order drive control can correspondingly read out the current percentage temperature loading, regardless of the absolute thermal loading capacity of the specific electric motor.

In other words, a higher-order control system which communicates with the component controller via the system bus can address a system component connected to the component controller via the component interface directly and generally without having to take account of technical peculiarities or particular specifications of the specific system components. Equally, the higher-order control system only receives state parameters and data communication in a generic format.

Accordingly, even on an exchange of system components - for example, the installation of a more powerful motor or the exchange of the battery bank for a battery bank with greater capacity - no change need be made to the higher-order control system and the overall system can be constructed as easy to maintain and scalable.

Preferably, at least two different system components can be alternatively connectable to a single component interface and the component controller can be configurable, dependent upon the system component connected, such that the respective specific system component connected is represented as a generic system component.

Thus, system components, for example, a battery or an electric motor can be connected alternatively to one component controller. In other words, if a battery is connected to the component

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interface of the component controller, a generic battery can be represented at the communication interface and if, in place of the battery, an electric motor is connected to the component interface of the same component controller, a generic electric motor can be represented at the communication interface. Thus, by means of a single of type of component controller, depending on the system component connected to the communication interface, in each case a corresponding generic system component can be represented and it is not necessary to provide a specific component controller for each type of system component. Only the component controller is adapted to the specific system component connected thereto in that the corresponding parameters are updated. In other words, an initialization of the component controller takes place in that the component controller is adapted to the respective system component connected to the component interface - by means of a corresponding parameterization and/or by means of the use of corresponding conversion tables for the data communication and/or by means of a corresponding internal wiring.

Thus, the possibility exists in the overall system of the boat to provide identical component controllers for connection to a plurality of different or even all types of system components. Thus, the number of possible identical parts within the system is greater, which also has an advantageous effect on the serviceability and the costs.

In this way, it is also possible to exchange system components and/or component controllers against one another, for example, on occurrence of a defect without having to intervene in the higher-level control system. The system controller further controls the generic components represented by means of the component controller.

In the event of a defect in a component controller on the component interface of which the electric motor is arranged, the electric motor can be disconnected, for example, from the defective component controller and connected to a functioning component controller which is not essential for pure vehicle operation - for example, to a component controller to the component interface of which the charging device of the shore connection is connected. Thus, in an emergency situation at sea, the vehicle operation can accordingly be maintained even with a defective component interface.

In that the component controller can, in principle, be connected to any desired system components, for example, to a battery or to the power electronics of an electric motor of the electric drive or a charging device for charging the battery or a generator for charging the battery and the component controller provided therefore are always identically designed, apart from the simplified configuration of the programming of a higher-order control system, an efficient design of the device can also be

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provided. Furthermore, in this way, redundancies in the system can be built up such that on failure of a component controller, another component controller can take its place.

In this way, it is possible to maintain the driving function of the boat and thus the maneuvering capability and, in this way, to construct a redundant and secure system.

Preferably, a connection unit controller is provided which communicates with the component controller via the system bus and by means of which the component controller receives drive commands. Particularly preferably, the connection unit controller communicates with an input device, for example, a remote throttle lever to specify a drive level by means of an operator and the connection unit controller controls the predetermined drive level according to one or more component controllers via the system bus in order to achieve the pre-determined drive level.

Preferably, the connection unit controller combines at least two component controllers into an organizational connection unit, in particular as a core system and controls the underlying drive functions.

Preferably, the connection unit controller communicates with a device for specifying a desired drive level, for example, with a remote throttle lever, by means of which, accordingly, the respective drive level of the electric drive is specified. Thus, by means of a direct communication between the remote throttle lever and the connection unit controller, the connection unit controller can control the respective components represented as generic system components by the component controller with regard to the underlying drive functions.

For example, by means of a drive command pre-determined by the user by means of the remote throttle lever and transferred to the connection controller, the connection unit controller can transfer the drive command via the system bus and the communication interface directly to the addressed component controller.

The connection unit controller can accordingly be used, firstly, for the organization of the connection unit and, secondly, for processing the respective drive commands, so that here short reaction times and, in particular, also short system start times can be achieved. Rapid booting up of the system and conversion of a drive command is significant particularly when, during maneuvering of the boat, a rapid reaction is needed, for example, in a suddenly occurring emergency stop situation in which an emergency stop maneuver must be carried out or if other maneuver functions are significant.

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It is accordingly possible, without involvement of a system controller or even a whole-boat network, to transfer the drive commands immediately and directly by means of the transfer of the respective drive commands or drive level wishes from the remote throttle lever to the connection unit controller and from this via the internal communication bus within the connection unit to the respective component controllers. Thus, the maneuverability of the boat can be provided rapidly and robustly sustained.

In a preferred development, the system controller is configured by means of a corresponding initialization also to serve as a connection unit controller. Thus, a separate connection unit controller can be dispensed with and the number of identical parts in the system can be further increased.

Preferably, the component controllers and the connection unit controller are structurally integrated into one housing which is designated a connection unit. In the connection unit which accordingly consists of a connection unit controller and a plurality of component controllers, a communication takes place between the communication interface of the component controller and the communication interface of the connection unit controller via a system bus which is provided within the connection unit. A system bus can be, for example, a bus which communicates via a known protocol, for example a CANopen bus or another standardized protocol. However, a proprietary protocol can also be used.

Both each component controller as well as each connection unit controller and also each system controller comprises its own microprocessor by means of which the corresponding applications can be processed and by means of which the communication via the corresponding buses can be handled.

In the system, also, at least two connection units, can each be provided with at least one component controller, a connection unit controller and a system controller and the system controllers of the connection units then communicate with one another wherein one system controller then functions as a master system controller and all the other system controllers are operated as slave system controllers.

In this way, a distributed system can be provided in the boat, wherein, for example, on provision of an electric drive with more than one electric motor, a connection unit is associated with each electric motor and the battery banks associated with each electric motor. A further connection unit can be provided, for example, for a generator spaced apart from the electric motors. The battery banks, when they are arranged spaced from the electric motors associated with them in the boat can also

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be provided with their own connection unit. By means of the communication of the system controllers of the individual connection units among one another, such a distributed system can also be designed as easily scalable and easily serviceable.

In a particularly preferred embodiment, the component controller is configured to detect, on the basis of the system components connected via the component interface, which system component is actually connected and accordingly to carry out an initialization according to the respective specific system component.

Brief Description of the Drawings

Preferred further embodiments of the invention are described in detail with the following description of the drawings. In the drawings:

Fig. 1 is a schematic illustration of the system architecture described;

Fig. 2 is a schematic illustration of the layered structure of the implementation;

Fig. 3 is a schematic representation of a service access.

Detailed Description of Preferred Exemplary Embodiments

Preferred exemplary embodiments will now be described with reference to the drawings. Herein, identical, similar or similarly acting elements are provided with the same reference signs in the different drawings, and repeated description of these elements is in part dispensed with for the avoidance of redundancy.

The system is shown schematically in Fig. 1 wherein, in a connection unit (Connection Box) at least one component controller (Device Control Unit - DCU) is provided which is connectable to individual system components (Device) via the component interface.

Furthermore, a connection unit controller (Box Control Unit - BCU) is provided by means of which the component controllers are organized in the connection unit and can be controlled via the system bus.

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In the component controller, aside from the hardware control system, an abstraction module (Abstraction) is also provided which enables a representation of the specific system components connected via the component interface as a generic system component at the communication interface to the system bus.

In the component controller, aside from the abstraction of the abstraction module by means of which the system component actually connected to the component controller is abstracted to a generic system component, corresponding control signals are also output at the component interface to the system component.

For example, at the component interface of the component controller, on connection of a battery, a corresponding ignition voltage can be output in order to bring the battery into the operating mode. For this purpose, for example, an ignition voltage of 12 V can be transferred to the battery when the connection unit controller transfers a request for switching on the battery via the system bus within the connection unit to the component controller to which the battery is connected. With another battery type, however, the component controller can be configured at its component interface such that another ignition voltage which is suitable for the respective specific battery type is transferred or a different ignition signal or switch-on signal is transferred to the battery.

Furthermore, the component controller can assume fundamental control functions and safety functions for the respective system component (Low Level Controlling and Safety).

By means of the component interface, a bus communication can also be carried out with the system components in order, by means of the component interface, also to enable data communication with the system components. This can be achieved, for example, through the provision of a CAN bus or by means of a serial bus such as UART or LIN or RS485 or RS232 or another bus which can be in communication with the respective system component.

The bus communication with the system component is independent of the communication of the component controller with the system bus by means of its communication interface. In other words, the system bus is not in direct communication with the system components, but rather a data exchange takes place with the system components only via the interposition of the component controller. A direct communication of the system components with the system bus is therefore not possible. Rather, the communication with the system components from the standpoint of the system bus takes place exclusively via the respective component controller.

The exemplary battery transfers via the component interface, for example, its temperature, its charge level, the current discharging, the residual capacity or other parameters which can be of significance for the boat operation.

If, for example, an electric motor is connected to the component controller via the component interface, then the component interface is connected to the power electronics of the motor and can accordingly provide the sensor signals which are provided by the power electronics to the communication interface in a general form without the specific knowledge having to be passed on for the respective electric motor on the system bus. In other words, for example, a rotary speed, a torque generated, the power, a temperature and other parameters can be transferred from the electric motor via the component interface to the component controller, which then abstracts the specific data and provides them generically by means of the communication interface.

Furthermore, in this case, it is possible by means of the component controller to convert a corresponding drive command which is obtained from the connection unit controller via the system bus into a specific drive signal or operating signal for the specific power electronics of the respective electric motor and to provide it via the component interface of the respective power electronics. Accordingly, the component controller can then instruct the power electronics to operate the specific electric motor with the drive level pre-determined by the operator of the electric drive by means of the remote throttle lever.

Furthermore, in the component controller, dependent upon the system component connected via the component interface, apart from the underlying control functions which are dependent on the connected system components, at the same time, fundamental safety functions are implemented for these specific system components. For example, on the basis of the knowledge of the respectively connected system component, for example an electric motor, then a current limitation, a torque limitation or a temperature limitation already in the component controller can be implemented specifically for the system component connected. Accordingly, if a drive command is communicated by the connection unit controller, the component controller will take account of the pre-determined safety parameters and if necessary put the implemented safety functions into play and in this way avoid damage or overloading of the system components connected.

In the component controller, in order to switch from system components connected via the component interface, inter alia, current management components such as switches, fuses and current or voltage meters can be provided in order, in this way, to enable switching of the respective

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connected system components to the required switching voltages or switching currents and on the other hand also to prevent, by means of a fuse, that system components become damaged.

The connection unit controller can serve as a master of the respective connection unit, and numbers and oversees the logical and, via the component controller, abstracted system components. If at least one abstracted battery, one abstracted motor and one abstracted throttle handle are to be found, the connection unit controller also provides the underlying functions for driving. In this way, the pure driving of the boat with an electric drive is possible in a simple, robust and error-reduced manner and the function can further be readily monitored. In this way, the targets regarding a rapid system start and rapid operability following the system start can also be achieved.

Furthermore, in a connection unit, a system controller (System Control Unit) can also be provided which, firstly, accepts the statuses and signals communicated via the system bus and, secondly, also processes the information provided from the wider environment of the system or the boat. The system controller can also, for example, undertake communication with a further connection unit in order to be able to determine the corresponding overall system state, given the presence of more than one connection unit.

Accordingly, the system controller can, for example, also transfer the entire system state to a central display unit, equalize the loading of different battery banks against one another, on use of charging devices, distribute the charging currents to the different battery banks efficiently and also balance the other loads that are present in the overall system, for example, auxiliary consumers and additional consumers which have nothing to do with the actual electric drive such that an efficient use of the system is achieved. Furthermore, by means of the system controller, the charging of batteries in a hybrid system by means of a generator or the states which occur through the switching of a drive with an internal combustion engine in the electric drive system can be taken into account in the overall distribution and load balancing.

The system controller is, firstly, connected to the system bus which is provided in the connection unit for communication of the component controllers with the connection unit controller and is connected via a network to the further system controllers which are provided in the respective system and, in particular, in other connection units. The system controller can further also be connected to a whole-boat communication network, in particular a boat bus, for example, an NMEA2k bus in order to be able simultaneously to receive information regarding further consumers or the environmental conditions into the representation of the system state or the prediction of ranges and other system states.

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The system controller which is provided in each connection unit forms, via the network with other system controllers of other connection units, a network wherein only a single system controller functions as master, whereas the other system controllers function as slaves. In this way, a freely selectable scalability of the system is possible with a plurality of connection units.

The system controller, apart from the connection to the NMEA2k bus, correspondingly gathers the overall abstracted system component data and, in this way, can implement a system-wide energy management and bring together the individual connection units into an overall system.

The system controller can accordingly develop a tree of system components so that all the connection units are coupled to one another into a complete system.

From a configuration file, the master of the system controllers detects how the respective connection units are connected to one another and in the event of a system error, can make a decision such that particular contacts are made or broken.

Furthermore, the master system controller can also implement and define an energy management strategy which is applied on the respective energy-generating devices and the energy-consuming components on board.

The master system controller can also gather information and detect warnings and errors in order to react and to communicate them to the respective user or to incorporate them into the system event log.

Furthermore, a display server can be provided in the master system controller which combines different displays that are provided in the system with one another and operate these as notification clients or display clients wherein different displays can also supply different representations on the basis of the same data. The master system controller can also communicate with mobile hand-held devices, for example, a smartphone or a tablet in order also thereby to display system data.

The master system controller can further serve as a service access point wherein a service technician can log into the system by means of the master system controller, for example, via an encrypted channel, and find an error or upload software updates. A possible implementation is illustrated in Fig. 3.

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With the construction of the connection unit on the basis of a plurality of component controllers and a connection unit controller in combination with a system controller, as compared with conventionally constructed systems in which each system component must be controlled individually, the number and length of the necessary cable connections can be significantly reduced. By means of the reduction of the cable connections, the reliability of the overall system can be further improved.

Preferably, the high voltage distribution is also provided in the connection unit or in a housing structure accommodating the connection unit, wherein for example in a first layer of the connection unit controller, the component controller and the system controller can be provided and in a second layer, for example, the high voltage distribution can be arranged underneath the circuit boards forming the component controller, the connection unit controller and the system controller.

With regard to the communication between the connection unit controller and the component controllers, a system bus is preferably provided, by means of which the abstracted system components can exchange information or the abstracted component information packets can be exchanged between the component interfaces and the connection unit controllers. For this purpose, for example, a CANopen protocol or another standardized or proprietary protocol can be used.

In this way, also, the main structure for an emergency drive function can be provided, wherein for this a combination of component controllers and connection unit controllers are sufficiently provided in order to provide the emergency drive function. A communication for the emergency drive function takes place between the connection unit controller to which, for example, a remote throttle handle is connected, and at least one of the component controllers. The communication between the connection unit controller and the component controller takes place via the system bus which is self-contained in relation to other communication partners of third parties.

The connection unit with the component controllers, the connection unit controller and also the system controller can be provided self-contained in the connection unit and can communicate via this system bus. Further components are not permitted herein, so that the bus for communication between the component controllers, the connection unit controller and the system controller is occupied within the connection unit exclusively by these components and no other components acting from outside, for example, from third party providers can communicate via this bus.

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The communication between individual connection units and, in particular, between the system controllers of the individual connection units can be created, for example, via an Ethernet connection.

The connections to the indicator displays and, for example, to multifunction displays (MFD), boat networks etc. are preferably also achieved via an Ethernet connection within the boat.

Both each component controller and also each connection unit controller and also each system controller comprises its own microprocessor by means of which the corresponding applications can be processed and by means of which the communication via the corresponding buses can be handled.

Regarding the structure of the implementation, as shown in Fig. 2, a layered structure is provided in which the code (Driver) of the component controller is provided, in relation to the component interface (Hardware) to which a component of the electric drive can be connected, in a separate layer. The abstraction module (Hardware Abstraction Layer) by means of which an abstraction of the specific control parameters and state parameters of the respective system components is abstracted at the level of a generic system component, is also provided in a separate layer.

A delimitation of the individual layers between one another can be achieved in that the software is written as self-contained encapsulated classes without any direct coupling to a specific system component.

In order to be as flexible as possible, the software code is provided in a layered architecture. In the hardware abstraction layer, a simple Round Robin Scheduler is provided which makes it simple to carry out differently prioritized tasks.

The communication protocol (Communication Protocol) and the actual application code (Application Code) are furthermore fully decoupled from the specific hardware and also from the other layers.

Accordingly, a developer developing a specific system component can focus, when constructing the system, on a reliable and safe implementation of this specific system component and must not take account of the remainder of the system. Accordingly, highly complex systems with a large number of different system components and a large number of auxiliary components can be safely constructed in a simple manner. Each detected system component results in an instance of the

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specific component class and is accordingly represented by the abstraction module as a logical system component or a generic system component on the internal CANopen bus.

The code is particularly preferably generated automatically on the basis of a corresponding design pattern and on the basis of a corresponding database in which all the component-specific data are included. Furthermore, the data for the component abstraction, the data types, the transfer objects and the component errors are defined in this database. Through the use of this database, all the changes and updates of component-specific data can be automatically incorporated and implemented in all hardware platforms and, in particular, in the component controllers and also the connection unit controllers as well as the system controllers. In this way, the complexity that results from the distributed control structure can be reduced or eliminated since a central data definition is provided. Thus normally, an interface must be defined on both sides thereof. On the basis of the provision of the component controller which provides via the abstraction module an abstracted or generic system component, the system errors which typically occur due to the programming by different developers, can be reduced or prevented.

In other words, on the basis of a clear definition of the interfaces between the individual layers and a central storage of the definitions and generation of the code, a consistent and error-reduced or error-free system can be achieved.

Furthermore, on the basis of the distributed structure with the component controllers, the connection unit controller, the system controller and the connection of different connection units via the communication of the system controllers to one another, by means of a central update function, new software or updated data can be transferred to all the controllers in the whole system, so that a consistent version is always present on the master system controller and the slave system controllers.

The master system controller and the slave system controllers force the component controller and the connection unit controllers to implement the new software with the respective boat loaders and also, via the CAN-bus, to be supplied with the respective components or system components.

The system configuration per se can also be achieved by means of a central software distribution and, in particular, by means of a central file which is edited, for example, by the service technician and is then transferred to the master system controller which then further distributes the data accordingly.

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The GUIs and other user interfaces can be written, for example, using QT/QML, so that accordingly, they are portable across different platforms on the basis of the same code base.

The component controllers are preferably provided in the form of separate hardware components, for example in the form of plug-in cards. For each of the specific physical system components which can be, for example, a battery, an electric motor, a generator, a converter or an internal combustion engine drive, a separate component controller can be available.

As far as practicable, all the individual features which are described in the exemplary embodiments can be combined with one another and/or exchanged without departing from the scope of the invention.

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Claims

1. A boat operating system to operate a boat equipped with an electric drive, the system comprising a first component controller which comprises a component interface configured to connect the first component controller to at least one specific system component of the electric drive to enable data exchange between the first component controller and the at least one specific system component, the communication interface configured to connect the first component controller to a system bus of a drive control;

wherein the at least one specific system component exchanges the data with the system bus of the drive control only via the first component controller, and wherein the data exchange comprises sending commands to the at least one specific system component and receiving state parameter(s) from the at least one specific system component;

the first component controller further comprising an abstraction module configured to exchange the data with the at least one specific system component via the component interface;

wherein the abstraction module abstracts the data, such that the at least one specific system component is represented as an abstracted system component at the communication interface to enable a higher-order control system, which communicates with the first component controller via the system bus, to address the at least one specific system component directly and generally without having to take account of technical peculiarities or particular specifications of the specific system components;

wherein the first component controller decouples the at least one system component from the system bus such that defects in at least one system component do not disrupt the system bus; and

wherein upon failure of the first component controller, the at least one specific system component can be disconnected from the first component controller and connected to a second component controller, identical to the first component controller, which is configured to be connected to a second specific system component, different from the at least one specific system component.

2. The system according to claim 1, wherein at least two different system components are alternatively connectable via a single component interface and the first component controller is configurable, dependent upon the system component connected, such that the respective specific system component connected is represented as a generic system component.

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3. The system according to any one of the preceding claims, wherein the component interface of the first component controller comprises signal outputs and sensor inputs and bus interfaces for communication with a bus of the system component.

4. The system according to claim 3, wherein the bus comprises a CAN bus, a serial bus, UART, LIN, RS485 or RS232.

5. The system according to any one of the preceding claims, comprising a connection unit controller to communicate with the first component controller via the system bus and by means of which the first component controller receives drive commands.

6. The system according to claim 5, wherein the connection unit controller is configured to communicate with an input device, which is configured to receive an operator input to specify a drive level, and the connection unit controller is configured to control at least the first component controller via the system bus to achieve the specified drive level.

7. The system according to claim 5 or 6, wherein the connection unit controller is configured to combine the first component controller and at least one further component controller into an organizational connection unit.

8. The system according to claim 7, wherein the connection unit controller combines the first component controller and at least one further component controller into an organizational connection unit to control the underlying drive functions of the electric drive.

9. The system according to any one of the claims 5 to 8, wherein at least two component controllers and one connection unit controller are accommodated together in a housing forming a connection unit.

10. The system according to any one of the preceding claims, wherein a system controller is provided which communicates with at least one component controller and one connection unit controller via the system bus, wherein the system controller is configured to receive and process state data from the component controller(s) and the connection unit controller.

11. The system according to any one of the preceding claims, comprising at least two connection units, each provided with at least one component controller, a connection unit controller and a system controller and the system controllers of the connection units

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communicate with one another, wherein a system controller functions as a master system controller and all the other system controllers are operated as slave system controllers.

12. The system according to any one of the preceding claims, wherein the first component controller is configured to detect the system component connected to the component interface and to carry out an initialization according to the respective specific system component.

13. The system according to any one of the preceding claims, wherein a system component, a battery, an electric motor, a charging device, a DC/DC converter, a DC/AC converter, a generator, or an auxiliary aggregate is connected to the first component controller.

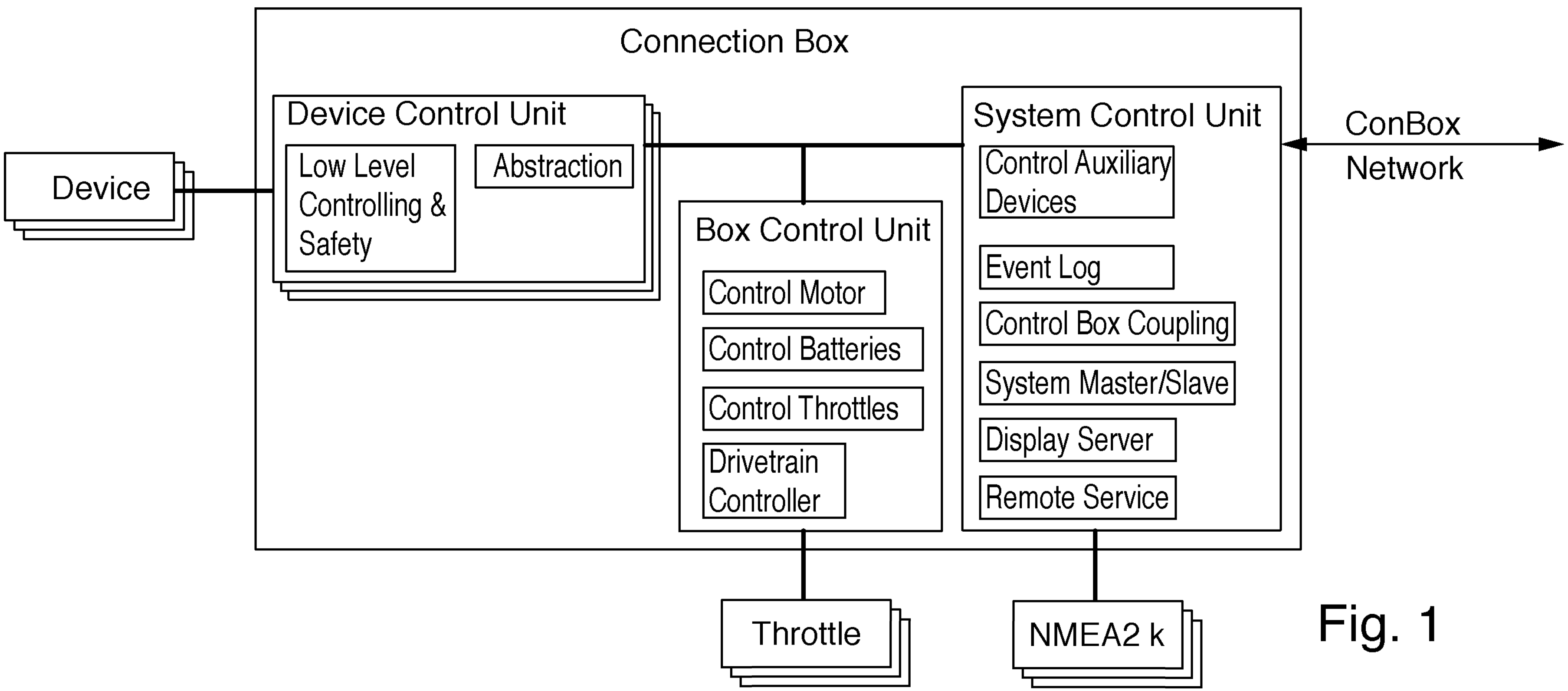
Connection Box
Device Control Unit
Low Level Controlling & Safety
Abstraction
Device
Box Control Unit
Control Motor
Control Batteries
Control Throttles
Drivetrain Controller
System Control Unit
Control Auxiliary Devices
Event Log
Control Box Coupling
System Master/Slave
Display Server
Remote Service
ConBox Network
Throttle
NMEA2 k

Fig. 1

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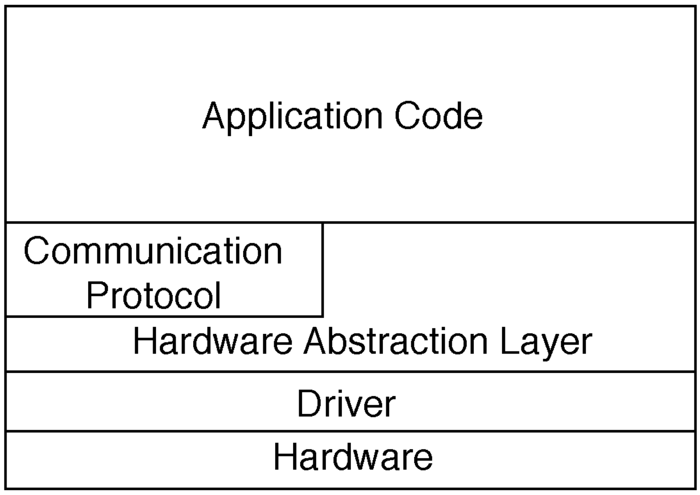

Fig. 2

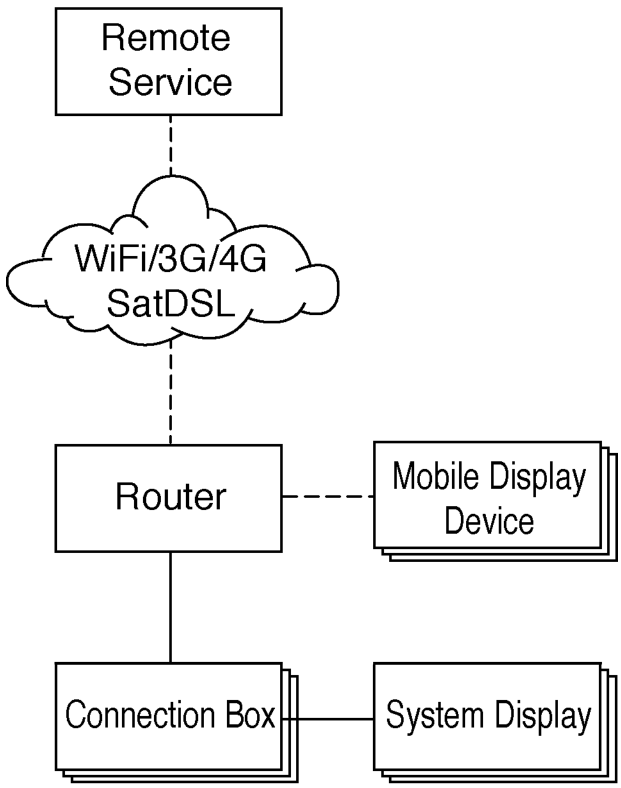

Fig. 3