A SYSTEM FOR MONITORING MARINE VESSELS

Background

1. Technical Field

This invention relates generally to monitoring systems. Particularly, but not exclusively, it relates to a system for monitoring marine vessels.

2. Description of Related Art

Globalization of world-markets has fueled greater volumes of commodities and goods being transported and traded between different countries via shipping, resulting in exponential growth of cross-country trading. This immensely underlines the importance of the shipping trade as such. During the transportation of cargos to their destinations, marine vessels (hereinafter "vessels") could be located in any ocean around the world. Thus, a fleet manager faces severe logistic problems when attempting to perform fleet management of his vessels.

Most modern vessels are equipped with a variety of operation systems required for operation thereof such as propulsion and navigation systems. Thus, management and monitor of the systems are crucial for safe and efficient operation of the vessels. Separately, the vessels and their cargos are also valuable assets, typically worth several millions or billions in value. Thus, it is desirable to secure the vessels against unwanted intruders and be protected from system failures when they are being docked and left unattended for substantial periods. Accordingly, it is also necessary to monitor system conditions of the vessels during operation or while the vessels are being docked.

Currently, there are no convenient means for the fleet manager to readily obtain information about the system conditions of a vessel whether it is sailing in the ocean or docked at some locations. The easiest method available is for vessel crews to periodically update the fleet manager via satellite-based communications. However, such a method is cost-ineffective as well as laborious in nature. In addition, monitoring of the vessels is conventionally performed using independent monitoring and control systems onboard the vessels which may impose difficulties when attempting to consolidate the associated data output therefrom. Furthermore, these monitoring and

control systems require a substantial amount of wires and interconnection points in order to connect the sensors, transducers, and operative devices to their respective components. Hence, the integration of these systems is considered a relatively complex task in view of the large number of related components to be installed and the lengthy wires required. Yet further, management and maintenance of such monitoring and control systems is also equally complex.

Summary

Embodiments of the invention disclosed herein provide systems and methods thereof for monitoring marine vessels.

According to an embodiment of the invention, there is provided a system for monitoring a marine vessel. The system comprises a plurality of sensors, a telemetry unit and a transceiver. Each of the plurality of sensors monitors one of a component and a system onboard the marine vessel. The telemetry unit receives and converts data outputs from the plurality of sensors into telemetry signals in which each of the data outputs is representative of a state of the one of the component and the system monitored by the each of the plurality of sensors. The transceiver is adapted for transmitting the telemetry signals using one of a plurality of communication modes to a computing device at a remote location. The computing device then processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

According to another embodiment of the invention, there is provided a method for monitoring a marine vessel. The method comprises providing a plurality of sensors in which each of the plurality of sensors monitors one of a component and a system onboard the marine vessel. The method also comprises receiving and converting data outputs from the plurality of sensors into telemetry signals by a telemetry unit. Each of the data outputs is representative of a state of the one of the component and the system monitored by the each of the plurality of sensors. Further, the method comprises transmitting the telemetry signals by a transceiver using one of a plurality of communication modes to a computing device at a remote location. The computing device then processes the telemetry signals to obtain the data contained therein, the

obtained data being displayable by the computing device. The plurality of sensors, the telemetry unit and the transceiver form a marine vessel monitoring system.

According to a further embodiment of the invention, there is provided a method for monitoring a marine vessel. The method comprises transmitting an update request from a computing device at a remote location to the marine vessel. The method also comprises providing a plurality of sensors in which each of the plurality of sensors monitors one of a component and a system onboard the marine vessel. Additionally, the method comprises retrieving data outputs from the plurality of sensors by a telemetry unit in response to the update request and thereafter converting the data outputs into telemetry signals. Each of the data outputs is representative of a state of the one of the component and the system monitored by the each of the plurality of sensors. Further, the method comprises transmitting the telemetry signals by a transceiver using one of a plurality of communication modes to the computing device. The computing device processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device. The plurality of sensors, the telemetry unit and the transceiver form a marine vessel monitoring system.

According to yet another embodiment of the invention, there is provided a computer-program product, comprising a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising instructions, which when executed by a marine vessel monitoring system, cause the system to receive and convert data outputs from a plurality of sensors into telemetry signals by a telemetry unit. Each of the plurality of sensors monitors one of a component and a system onboard a marine vessel. Each of the data outputs is representative of a state of the one of the component and the system monitored by the each of the plurality of sensors. Further, the instructions which when executed also cause the system to transmit the telemetry signals by a transceiver to a computing device at a remote location using one of a plurality of communication modes. The computing device then processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

According to yet a further embodiment of the invention, there is provided a computer-program product, comprising a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising instructions, which when executed by a computing device at a remote location, cause the device to transmit an update request to a marine vessel monitoring system. The marine vessel monitoring system comprises a plurality of sensors, a telemetry unit and a transceiver. Each of the plurality of sensors monitors one of a component and a system onboard a marine vessel. The telemetry unit retrieves data outputs from the plurality of sensors in response to the update request and thereafter converts the data outputs into telemetry signals. Each of the data outputs is representative of a state of the one of the component and the system monitored by the each of the plurality of sensors. The transceiver is adapted for transmitting the telemetry signals using one of a plurality of communication modes to the computing device. Additionally, the instructions which when executed also cause the computing device to process the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

Brief Description of the Drawings

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

Figure 1 illustrates a schematic diagram of a system for monitoring marine vessels in accordance with an embodiment of the invention;

Figure 2 is a block diagram showing the inputs and outputs for an onboard-vessel module containing a local processor as well as transmission of data between the local processor and a central processor of a central monitoring station, the onboard vessel module being part of the system of Figure 1;

Figure 3 is a block diagram of the system architecture of the onboard-vessel module;

Figure 4 is a block diagram illustrating the functional relationships between system components of the onboard-vessel module;

Figure 5 is a flow diagram illustrating an exemplary method for monitoring marine vessels in accordance with some embodiments, the method being performed in a "data-pushing" configuration; and

Figure 6 is a flow diagram illustrating an exemplary method for monitoring marine vessels in accordance with some embodiments, the method being performed in a "data-pulling" configuration.

Detailed Description

Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one of ordinary skill in the art that the invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments. In the drawings, like reference numerals refer to like elements or functionalities throughout the various presented views.

It will also be understood that, although the terms first, second and etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another, without departing from the scope of the present invention.

The terminology used in the description of the invention herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used in the description of the invention and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items. It will be further understood that the terms comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not

preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Exemplary embodiments of a system 100 for monitoring marine vessels 102 (hereinafter "vessels") as illustrated in the schematic diagram of Figure 1 and associated processes therewith are described. When the vessels 102 are transporting cargos to their destinations, a fleet manager who wishes to know the system conditions of the vessels 102 at any time may then make use of the system 100 for such purposes. In order to utilize the system 100, an onboard-vessel module (not shown) is preinstalled on each vessel 102. In an embodiment, the onboard-vessel module is configured to automatically transmit data output retrieved from sensors installed onboard the vessels 102. This is termed the "data-pushing" configuration. The sensors provide automated real-time monitoring of the various systems (e.g. electrical power systems and engines) and components (e.g. rudders) of the vessels 102 thereby providing vessel captains with important real-time parameters regarding the current system conditions of the vessels 102.

In the "data-pushing" configuration, the system 100 may periodically receive data from the sensors installed onboard the vessels 102. The data are then digitized, collated and compressed into data packets. The data packets are then transmitted as telemetry signals to a central monitoring station. Optionally, the data packets may be encrypted before being transmitted. Encryption may be performed using any encryption algorithms well known in the art such as Advanced Encryption Standard (AES) or Triple Data Encryption Standard (T-DES). An encryption encoder or equivalent software may be provided together with the onboard-vessel module to facilitate secure transmission of the telemetry signals. Separately, the central monitoring station comprises an administration and processing server 104 (hereinafter "server") for administering, receiving and processing the telemetry signals received from the vessels 102. The server 104 is installed with an operating system (e.g. Darwin, RTXC, LINUX, UNIX, OS-X, WINDOWS or an embedded operating system such as VxWorks) which includes various software components and/or drivers for controlling and managing general system tasks (e.g. memory management, storage device control, power management and etc) and facilitating intercommunications between various hardware and software components of

the server 104. Additionally, the server 104 may be connected to the Internet via any connection means known in the art.

The central monitoring station is typically land-based although sea-based equivalents may be possible as well. A sea-based central monitoring station may be established on a vessel 102 and is deployable to any part of the world for managing fleets of vessels 102 located therein. For the purpose of the embodiments contained herein, the central monitoring station is a land-based type. This however does not preclude and limit the workings of the system 100 described herein in any way from being deployed and used by a sea-based central monitoring station. All onboard-vessel modules of the vessels 102 using the system 100 are preconfigured to provide system conditions updates of the vessels 102 to the central monitoring station at specific predefined intervals. However, the fleet manager may change the predefined intervals to desired new intervals through the server 104. The new intervals are then transmitted as instructions data packets to all the vessels 102 in the system 100 via any one of the plurality of communication modes to be described herein. Upon receiving the instructions data packets and thereafter updating to the new intervals, the vessels 102 then provide periodic updates to the central monitoring station in accordance to the new intervals.

The onboard-vessel module uses a plurality of communication modes for transmitting the telemetry signals to the server 104. The plurality of communication modes comprises General Packet Radio Service (GPRS), Worldwide-Interoperability for Microwave Access (WiMAX) and satellite-based communication. The satellite-based communication may be established through any commercial satellite services such as those using Iridium Satellites 106 or Inmarsat Satellites 108. Through use of special satellite phones/transceivers, the Iridium Satellites 106 provide essential services for maritime operations such as sending of Short Message Service (SMS) messages, making voice and data calls via a constellation of sixty-six active communication satellites. On the other hand, the Inmarsat Satellites 108 provide global coverage for the Global Maritime Distress Safety System (GMDSS) to the vessels 102 via the Inmarsat-C/D+ Satellite networks. Capabilities of the Inmarsat-C/D+ Satellite networks include providing ship-to-shore, shore-to-ship and ship-to-ship store-and-forward data and email

messaging, sending preformatted distress messages to a rescue coordination center and the Inmarsat-C SafetyNET service.

The fleet manager may predefine a list containing the sequence of communication modes which the system 100 should adhere to and use for data transmission. According to system design, the onboard-vessel module initially uses a communication mode (i.e. first communication mode) as defined at the start of the list for data transmission. However, the onboard-vessel module switches and attempts to use a subsequent communication mode (i.e. second communication mode) defined in the list if using the first communication mode results in repeated unsuccessful data transmission. A criterion for switching to the second communication mode is that the onboard-vessel module needs to perform data transmission via the first communication mode for a predetermined duration (i.e. a timeout period) and results in failure to transmit the data at the end of the predetermined duration. Notably, as defined in the list, it is to be appreciated that a specific predetermined duration is associated with a corresponding communication mode.

An exemplary list may define a sequence of the plurality of communication modes to be the following: WiMAX, GPRS, Inmarsat Satellites 108 and Iridium Satellites 106. The onboard-vessel module first attempts to transmit the telemetry signals using WiMAX at every predefined interval in which the telemetry signals are relayed from the vessels 102 to a nearest WiMAX base station 110 on land. The predefined interval corresponds to the first predetermined duration which may be defined to be approximately three hundred seconds. The telemetry signals are then transmitted from the WiMAX base station 110 to the server 104 which may be equipped with a matching WiMAX receiver (not shown). However, if the onboard-vessel module is unable to transmit the telemetry signals via WiMAX at the end of a second predetermined duration, the onboard-vessel module then switches to using GPRS in which the telemetry signals are relayed then to a nearest GPRS base station 112 instead. The second predetermined duration may be predefined to be approximately thirty minutes. Similarly, the telemetry signals are transmitted from the GPRS base station 112 to the server 104 which may be equipped with a matching GPRS receiver (not shown). Yet again, if the telemetry signals cannot be transmitted using GPRS at the end of a third predetermined duration, the onboard-vessel module

then switches to using the Iridium Satellites 106. The third predetermined duration may be predefined to be approximately four hours. The telemetry signals are then transmitted from the vessels 102 to the Iridium Satellites 106 orbiting in Space, which then relay the telemetry signals back to a Land Earth Station 114 (LES) located on Earth. The Land Earth Station 114 then preferably transmits the telemetry signals via the Internet to the server 104. Alternatively, the server 104 may be equipped with a matching Iridium satellite receiver (not shown) to receive the telemetry signals directly from the Iridium satellites 106. However, if using the Iridium Satellites 106 yet again results in failure to transmit the telemetry signals at the end of a fourth predetermined duration, the onboard-vessel module then switches to using the Inmarsat Satellites 108. The fourth predetermined duration may be predefined to be approximately six hours. Similarly, the telemetry signals are transmitted to the Inmarsat Satellites 108 orbiting in Space, which then relay the telemetry signals back to the Land Earth Station 114. The telemetry signals are then transmitted from the Land Earth Station 114 to the server 104 via the Internet. Alternatively, the server 104 may be equipped with a matching Inmarsat satellite receiver (not shown) to directly receive the telemetry signals from the Inmarsat satellites 106. If transmission is still unsuccessful by the end of a fifth predetermined duration, the onboard-vessel module will abandon transmission of the telemetry signals using any of the communication modes. The fifth duration may be defined to be approximately six hours. Thereafter, the onboard-vessel module may immediately reinitiate transmission of the telemetry signals by attempting to re-transmit via WiMAX and subsequently, if necessary, cycles through the defined sequence of communication modes in the list in accordance with the foregoing descriptions. Alternatively, the onboard-vessel module may reinitiate transmission of the telemetry signals after a predefined pause period.

In an alternative embodiment, instead of relying on the list to decide the particular communication mode to use for transmission of the telemetry signals, the onboard-vessel module may assess and select a communication mode that possesses the strongest signal strength in the locality which the vessel 102 is in. For example, after assessing the signal strengths of both WiMAX and GPRS signals in a vicinity of the vessel 102, the onboard-vessel module may preferably select WiMAX over GPRS as the communication mode to use if the WiMAX signals are significantly stronger than the detected GPRS signals.

On receipt of the telemetry signals from the vessels 102, the server 104 will decrypt and uncompress the data packets before processing them to obtain the data therein which correspond to the sensor readings of systems and components being monitored onboard the vessels 102. The server 104 may be provided with a decryption decoder or equivalent software in order to decrypt the data packets. The data are then formatted and displayed as visual information outputs (e.g. web-pages viewable using web-browsers) to the fleet manager operating the server 104. The visual information outputs may also be forwarded to extended users operating computing devices 116 that are communicably coupled to the server 104. Similar to the fleet manager, the extended users may also be authorized to use the system 100 for monitoring the vessels 102. Examples of the computing devices 116 include a cellular phone 118, a Tablet PC 120, a Personal-Digital-Assistant 122 (PDA), a smartphone 124, a laptop 126 and a mobile Internet device 128 (MID). Alternatively, the visual information outputs may instead be forwarded by an Internet web server (not shown) to the extended users in which the Internet web server is communicably coupled to the server 104. Further, the visual information outputs may be forwarded to the computing devices 116 using Short Message Service (SMS), multimedia messaging service (MMS), emails, Hypertext Transfer Protocol (HTTP) over Internet Protocol (IP) or any like data exchanging schemes known in the art.

Furthermore, the data may also be stored in an archival database located on the server 104. Alternatively, the archival database may be located on a specialized database server (not shown) provided for such purposes. In addition, the archival database may also store event logs, status reports and inspection reports related to the vessels 102. Database management systems (e.g. MySQL, Microsoft SQL Server or PostgreSQL) are also preferably installed on the server 104 or the specialized database server for managing and maintaining the archival database.

In yet another embodiment, the onboard-vessel module is also configurable for on-demand data retrieval from the sensors based on incoming update requests. This is termed the "data-pulling" configuration. In the "data-pulling" configuration, the onboard-vessel module responds to an update request sent by the server 104. The update request may be transmitted to a vessel 102 using any one of the plurality of

communication modes as described afore. On receipt of the update request by the vessel 102, the system 100 then polls and retrieves data from the sensors onboard the vessel 102. Accordingly, the retrieved data is then processed in a similar manner as for the case when the onboard-vessel module is operating in the "data-pushing" configuration before being transmitted as telemetry signals to the server 104 for updating the fleet manager or the extended users about the system conditions of the vessel 102. The "data-pulling" configuration allows the fleet manager or the extended users to obtain the latest system conditions updates from the vessels 102 when desired (i.e. on-demand updating). In contrast, the vessels 102 passively update the fleet manager or the extended users at periodic predefined intervals when the onboard-vessel module is operating in the "data-pushing" configuration.

With reference to Figure 2, a block diagram 200 showing the inputs and outputs for the onboard-vessel module of the system 100 is as illustrated. The onboard-vessel module comprises a local processor 202 which receives a plurality of direct real-time inputs 204. The direct real-time inputs 204 include sensor inputs providing real time indications of, for example, the sea state, the ocean currents encountered, weather, torque, fuel flow, fuel density, fuel temperature, vessel speed, current time, engine speed in terms of revolutions-per-minute (rpm), the pressures and temperatures internal to the engine, rudder angle, vessel trim, vessel heading and position, electrical power load of the vessel 102, fuel tank level and engine start/stop status. It is to be appreciated that other additional inputs may also be provided as necessary. Further, sensors which provide the real-time inputs 204 to the local processor 202 are fully automated equipments which do not require any human interventions during normal operations. Moreover, the sensors may either be of wired or wireless type. In additional, the significance of each of the direct real-time inputs 204 to the present invention will become apparent only when combined and interpreted in conjunction with the other real-time inputs 204.

The sea state is determinable through use of the vessel's 102 autogyro-driven trim indicator which is able to sense the sea state through interaction of pitch, roll and yaw characteristics of the vessel 102 at varying speeds. The ocean currents and tides are detectable by comparing navigation check points with pre-stored data in navigation systems. Weather conditions throughout the voyage are sensed and added to a matrix of

events for determining the best shipping route. The torque generated by the engine is dynamically measurable at the output shaft thereof using a computerized instrument for such purposes as known in the art. It is to be noted that torque is typically measured in foot pounds or in kilograms per square meter. Separately, fuel flow rate to the main power plant and auxiliary engines is measured using fuel volumetric flow meters. Further, fuel density is measured on line in real-time and the density value, when combined with the flow rate and adjusted for temperature, may then provide accurate mass flow readout. In addition, the temperature of the fuel flowing to the engine is constantly being measured to provide a compensation factor when computing mass flow to ensure that fuel heaters are functioning properly. Fuel consumption rate may be determined by measuring a difference between the supply and return flow of the fuel to the vessel engines. The level of fuel in the fuel tank may also be monitored to provide an indication of rate of usage of the fuel.

Vessel speed (in knots per hour) is measurable using a Doppler speed device. For redundancy, this measured vessel speed may be counterchecked against measured speed readings from a satellite navigation device. As such, any possible errors resulting from the Doppler speed device can be minimized. Separately, the ship's time and date are inputted into data files by the system's internal chronograph. The engine speed (in revolutions-per-minute (rpm)) is determinable from the shaft speed of the main power system by using a shaft speed sensor. Similarly, the shaft speed of any auxiliary engines in the power system is also measurable in this manner.

The rudder angle can be known from readings provided by the vessel's 102 auto piloting system. Further, the heading and positioning of the vessel 102 are continuously monitored using the satellite navigation device. The trim of the vessel 102 is then sensed in real-time through use of autogyroscope devices. The auxiliary power loads are monitored by power metering and monitoring devices that remove power from the main engine to determine the true energy use of the power system. The auxiliary power loads include electrical power as well as pump pressures and any outflows. In addition, the pressures and volumetric output of pumps used for steering, cargo handling and other ship operations can also be monitored in real-time as well. The start/stop status of the vessel engine may be provided for determining whether the engine is in an on/off state.

The local processor 202 is preferably installed with an embedded real-time operating system (e.g. RT-LINUX, MicroC/OS-II, QNX or VxWorks) which includes various software components and/or drivers for controlling and managing real-time system tasks (e.g. memory management, storage device control, power management and etc) and facilitating intercommunications between various hardware and software components of the local processor 202. The Central Processing Unit (CPU) of the local processor 202 may use embedded processors implemented using microprocessor architectures such as MIPS, Freescale Coldfire, Intel x86, ARM or Blackfin. Additionally, the local processor 202 is connected to a first storage device 206, a first transceiver 208 and a satellite navigation device 209. Optionally, a first display unit 210 may also be connected to the local processor 202 if desired.

The direct real-time inputs 204 received by the local processor 202 are storable on the first storage device 206. The storing of the direct real-time inputs 204 on the vessel 102 enables the vessel captain to easily access historical and current data that are indicative of the system conditions of the vessel 102. The first storage device 206 may be a solid-state drive (SSD) which may use either static-RAM (SRAM) or dynamic-RAM (DRAM) as storage memory modules. Optionally, the first storage device 206 may also be a regular hard-drive, a magnetic tape storage device or the like. However, it is to be appreciated to those skilled in the art that the first storage device 206 preferably uses a SSD due to the harsh and rugged marine environments which the vessels 102 typically operate in. In one exemplary embodiment, the onboard-vessel module of the system 100 is designed such that the operations thereof are transparent to the vessel crews. Thus, no interventions are required from the vessel crews and the direct real-time inputs 204 received by the local processor 202 are also not accessible by the vessel crews. However, optionally, the direct real-time inputs 204 may be presented to the vessel captain through the first display unit 210 by converting the direct real-time inputs 204 into visual information outputs displayable thereby. The first display unit 210 is a conventional display terminal that may use LCD (liquid crystal display) technology, or LPD (light emitting polymer display) technology, although other display technologies are usable in other embodiments.

The satellite navigation device 209 provides the local processor 202 with positional information regarding the current location of the vessel 102. Thus, the satellite navigation device 209 may use any modern Global Navigation Satellite Systems (GNSS) to provide location data corresponding to a current position of the vessel 102. Examples of GNSS include the Global Positioning System (GPS), Galileo, GLONASS and Beidou Navigation System (BNS).

Data from the direct real-time inputs 204 are then converted by the local processor 202 into telemetry signals and subsequently transmitted by the first transceiver 208 to a second transceiver 212 of the central monitoring station through an established communications link 214. Optionally, the location data from the satellite navigation device 209 may also be bundled and transmitted together with the data from the direct real-time inputs 204 to provide the fleet manager with useful location-based system conditions of the vessel 102. The first transceiver 208 establishes the communications link 214 to the second transceiver 212 using one of the following communication modes: WiMAX, GPRS, Inmarsat Satellites 108 or Iridium Satellites 106. Consequently, the first transceiver 208 and the second transceiver 212 are preferably matching equivalents of each other and capable of communicating to any one of the following: the WiMAX base station 110, the GPRS base station 112, the Iridium Satellites 106 and the Inmarsat Satellites 108. Moreover, the first transceiver 208 and the second transceiver 212 may employ separate radios, each being capable of transmitting using a pre-specific communication mode and thus the respective radios are to be used whenever transmission via different communication modes is required. Alternatively, both the first transceiver 208 and the second transceiver 212 may be application-specific integrated circuits (ASICs) which are designed as customized circuit chips and implement all required radios for the various communication modes thereon. Yet alternatively, the first transceiver 208 and the second transceiver 212 may otherwise implement cognitive radio or software-defined radio technologies.

A central processor 216 installed at the central monitoring station then receives the telemetry signals through the second transceiver 212. The central processor 216 is further connected to a second storage device 218 and a second display unit 220. The second storage device 218 provides archival storage for data obtained from the received

telemetry signals and may be, for example, a disk storage device, a magnetic tape storage device, a SSD or the like. In addition, the second storage device 218 may also store event logs, status reports and inspection reports related to the vessels 102. The second display unit 220 is a conventional display terminal that may use LCD technology, LPD technology or the like display technologies.

The central processor 216 handles administering, receiving and processing of the telemetry signals. In particular, the central processor 216 decrypts and un-compresses the telemetry signals before processing them to obtain the data from the direct real-time inputs 204. The central processor 216 may be provided with a decryption decoder or equivalent software in order to decrypt the telemetry signals. The data are then formatted and displayed as visual information outputs (e.g. web-pages viewable using web-browsers) on the second display unit 220 to the fleet manager. Optionally, the visual information outputs may also be transmitted to the extended users of the system 100 by the Internet web server communicable with the server 104. Independently, the central processor 216 may be equipped with a state-of-the-art CPU (e.g. INTEL Core™ 2 Dual or AMD Athlon™) and provided with an operating system (e.g. LINUX, UNIX, OS-X or WINDOWS) which comprises various software components and/or drivers for controlling and managing general system tasks (e.g. memory management, storage device control, power management and etc) and facilitating intercommunications between various miscellaneous hardware and software components of the central processor 216.

Figure 3 shows a block diagram 300 of the system architecture of the onboard-vessel module of the system 100. The onboard-vessel module comprises various sub modules being co-operatively used to monitor the system conditions of the vessels 102. As exemplified in Figure 3, the onboard-vessel module comprises a control module 302, sensors modules 304, a processing module 306, an interface module 308, a transceiver module 310, an optional display module 312, a storage module 314 and a power supply module 316.

The control module 302 may comprise control functions required for controlling and managing the onboard-vessel module. The control functions may include status

checking of the sensors installed on the vessel 102, adjusting the updating intervals, setting access control, software updating, statistics gathering and other associated functions. Furthermore, the control module 302 may also optionally provide a user-interface, such as a web-based interface, through the display module 312 to the vessel captain.

The sensors modules 304 may comprise a plurality of sensors onboard the vessel 102 for providing real-time automated monitoring and status updates of the systems (e.g. electrical power systems and engines) and components (e.g. rudders) of the vessel 102. The plurality of sensors may include an autogyro-driven trim indicator, fuel volumetric flow meters, a Doppler speed device, an anemometer, a satellite navigation device, a shaft speed sensor, autogyroscope devices, power metering and loads sensors or the like. The plurality of sensors is connected to the control module 302 through the interface module 308 which will be discussed below. Additionally, the plurality of sensors may either be of wired or wireless type.

The processing module 306 may comprise processing functions for receiving, processing, compressing and encrypting the data inputs from the sensors modules 304. Processing of the data inputs comprises collating them before compressing the collated data inputs into data packets. The compressed data packets may then be encrypted prior to being transmitted by the transceiver module 310 as telemetry signals to the server 104 of the central monitoring station. Examples of data compression algorithms that may be used for compressing the collated data inputs include the Lempel-Ziv (LZ), DEFLATE, LZ-Renau (LZR), bzip2 and the like algorithms. Examples of encryption algorithms that may be used for encrypting the compressed data packets include the RSA, DES/3DES, BLOWFISH, IDEA, SEAL, RC4 and the like algorithms. Moreover, the collated data inputs may optionally be organized and presented to the vessel captain via the display module 312 as visual information outputs (e.g. web-pages viewable using web-browsers) if the display module 312 is provided as part of the onboard-vessel module. The display module 312 is typically a conventional display terminal that may use LCD technology, LPD technology or the like display technologies. A verbatim copy of the collated data inputs may also be stored locally on the storage module 314 to facilitate retrieval of any historical data pertaining to the system conditions of the vessel 102 when required. The

storage module 314 may be one of a SRAM/DRAM solid-state drive (SSD), a regular hard-drive, a magnetic tape storage device or the like storage devices. Furthermore, the storage module 314 may also store event logs, status reports and inspection reports related to the vessels 102.

The interface module 308 may comprise interfacing components for facilitating connection between the transceiver module 310, processing module 306 and sensors modules 304. Examples of interface standards that may be used by the interfacing components for connecting to the sensors modules 304 include RS-232/422/485, Digital Input/Output, MODBUS, Universal Serial Bus (USB), Serial Peripheral Interface (SPI), General Purpose Input/Output (GPIO), Registered-Jack-45 (RJ-45) and the like. Separately, examples of interface standards that may be used by the interfacing components for connecting to the transceiver module 310 include USB, D-subminiature-9 (DB9), RS-232 and the like.

The transceiver module 310 may comprise a WiMAX transceiver, a GPRS transceiver, an Iridium satellite transceiver and an Inmarsat satellite transceiver for transmitting the telemetry signals using any one of the communication modes in accordance with the foregoing descriptions. Alternatively, the transceiver module 310 may be implemented as an application-specific integrated circuit (ASIC) chip which incorporates all the communication modes thereon. Yet alternatively, the transceiver module 310 may also implement cognitive radio or software-defined radio technologies. The power supply module 316 may include power electronics such as voltage/current converters and regulators to supply regulated power required for operating the onboard-vessel module.

Figure 4 illustrates functional relationships 400 between system components of the onboard-vessel module and a control panel 402. The system components comprise a controller box 404 and a plurality of sensors 406. The control panel 402 is a typical electrical panel interface provided on the vessel 102 which enables the vessel captain to manage different systems connected thereto in which the onboard-vessel module may be one such system. Consequently, the control panel 402 may provide general control buttons such as on/off switches for operating the onboard-vessel module. Further, the

control panel 402 is also communicably coupled to the controller box 404 using different types of connections (e.g. a RS-232 or a LAN connection) as known in the art.

The controller box 404 comprises the necessary interfacing components required to enable bi-directional communications with the plurality of sensors 406 for obtaining data readings therefrom. The plurality of sensors 406 may either be of wired or wireless type. The interfacing components that may be employed are similar to those as described for the interface module 308 of Figure 3. In one embodiment, the controller box 404 may be the ASCENZ™ Controller Box. Upon obtaining the data readings from the plurality of sensors 406 and thereafter collating them, the controller box 404 then transmits the collated data as an output 408. The output 408 may then be subjected to further processing or be transmitted by the transceiver module 310 to the server 104 of the central monitoring station.

Figure 5 shows a flow diagram illustrating a first exemplary method 500 used by the onboard-vessel module operating in the "data-pushing" configuration. In block 502, data are periodically retrieved from the plurality of sensors 406 onboard the vessel 102. The retrieved data are then collated into data packets. The data packets are further compressed and converted into telemetry signals suitable for transmission thereof in block 504. Optionally, the compressed data packets may also be encrypted for secure transmission thereof. Next, in block 506, a communications mode is selected for transmitting the telemetry signals to a destination such as the central monitoring station.

Accordingly, the communication mode is selected from a list which predefines the sequence of communication modes which the onboard-vessel module should adhere to for data transmission. A subsequent communication mode in the list will be selected if use of the preceding communication mode results in transmission failure after a predetermined timeout period associated therewith. In block 508, the telemetry signals are then transmitted to the central monitoring station. Received telemetry signals are then processed by the server 104 of the central monitoring station and the data obtained are thereafter displayed as visual information outputs via a user-interface to the fleet manager in block 510. Optionally, the visual information outputs may also be forwarded to the computing devices 116 communicably coupled to the server 104. Alternatively,

the visual information outputs may instead be forwarded to the computing devices 116 through the Internet web server communicably coupled to the server 104.

Figure 6 shows a flow diagram illustrating a second exemplary method 600 used by the onboard-vessel module operating in the "data-pulling" configuration. In block 602, a fleet manager who desires to know the system conditions of a vessel 102, initiates an update request through the server 104 of the central monitoring station. In particular, the update request may be sent from the server 104 of the central monitoring station. The update request is subsequently transmitted to the vessel 102 in block 604. In response to the update request, data are then retrieved from the plurality of sensors 406 onboard the vessel 102 in block 606. The retrieved data are then collated into data packets. The data packets are further compressed and converted into telemetry signals for transmission thereof in block 608. Optionally, the compressed data packets may also be encrypted for secure transmission thereof. Next, in block 610, a communications mode is selected for transmitting the telemetry signals to the central monitoring station.

Accordingly, the communication mode is selected from a list which predefines the sequence of communication modes which the onboard-vessel module should adhere to for data transmission. A subsequent communication mode in the list will be selected if use of the preceding communication mode results in transmission failure after a predetermined timeout period associated therewith. In block 612, the telemetry signals are transmitted to the central monitoring station. Received telemetry signals are then processed by the server 104 of the central monitoring station and the data obtained are thereafter displayed as visual information outputs via a user-interface to the fleet manager in block 614. Optionally, the visual information outputs may also be forwarded to the computing devices 116 communicably coupled to the server 104. Alternatively, the visual information outputs may instead be forwarded to the computing devices 116 through the Internet web server communicably coupled to the server 104.

Additionally, a further embodiment of the invention may be realized as computer readable code (i.e. programming instructions) on a computer readable storage medium. The computer readable storage medium is any data storage device that can store data which can thereafter be read by a computer system, including both transfer and non-

transfer devices. Examples of the computer readable storage medium include read-only memory, random-access memory, CD-ROMs, Flash memory cards, DVDs, magnetic tape, optical data storage devices, and carrier waves. The computer readable storage medium can also be distributed over network-coupled computer systems so that the computer readable code is stored and executed in a distributed fashion.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

Claims

1. A system for monitoring a marine vessel comprising:

a plurality of sensors, each of the plurality of sensors for monitoring one of a component and a system onboard the marine vessel;

a telemetry unit for receiving and converting data outputs from the plurality of sensors into telemetry signals, each of the data outputs being representative of a state of the one of the component and the system monitored by the each of the plurality of sensors; and

a transceiver adapted for transmitting the telemetry signals using one of a plurality of communication modes to a computing device at a remote location,

wherein the computing device processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

2. The system according to claim 1, wherein the computing device at the remote location is one of land-based and sea-based.

3. The system according to claim 1, wherein the data outputs are real-time parameters related to the system conditions of the marine vessel.

4. The system according to claim 1, wherein the plurality of communication modes comprises Worldwide-Interoperability for Microwave Access (WiMAX), General Packet Radio Service (GPRS) and satellite-based communication.

5. The system according to claim 4, wherein the satellite-based communication is established via one of Iridium Satellites and Inmarsat Satellites.

6. The system according to claim 4, wherein the one of the plurality of communication modes for transmitting the telemetry signals is selected from the plurality of communication modes according to a predetermined sequence, the predetermined sequence being of an order: WiMAX, GPRS and satellite-based communication.

7. The system according to claim 6, wherein a subsequent communication mode is selected from the plurality of communication modes according to the predetermined sequence upon failure to transmit the telemetry signals at the end of a predetermined duration using the one of the plurality of communication modes, the predetermined duration being associated to the one of the plurality of communication modes.

8. The system according to claim 1, wherein the plurality of sensors is one of wired and wireless.

9. The system according to claim 1, wherein the plurality of sensors comprises an autogyroscope device for sensing the trim of the marine vessel.

10. The system according to claim 1, wherein the plurality of sensors comprises a fuel-monitoring device for determining fuel-related information of the marine vessel.

11. The system according to claim 1, wherein the plurality of sensors comprises a satellite navigation device for sensing a heading and positioning of the marine vessel.

12. The system according to claim 1, wherein the plurality of sensors comprises a shaft speed sensor for determining an engine speed of the marine vessel.

13. The system according to claim 1, wherein the plurality of sensors comprises a Doppler speed device for determining a speed of the marine vessel.

14. The system according to claim 1, wherein the plurality of sensors comprises a power-metering device for determining the power loading of electrical power systems of the marine vessel.

15. The system according to claim 1, wherein the computing device comprises an archival database for storing at least one of event logs, status reports and inspection reports related to the marine vessel.

16. The system according to claim 15, further comprising:

an Internet web server for transmitting a webpage via the Internet to an extended user of the system, the webpage including data stored in the archival database relating to the past and current system conditions of the marine vessel, the Internet web server being communicable with the computing device.

17. A method for monitoring a marine vessel comprising:

providing a plurality of sensors, each of the plurality of sensors for monitoring one of a component and a system onboard the marine vessel;

receiving and converting data outputs from the plurality of sensors into telemetry signals by a telemetry unit, each of the data outputs being representative of a state of the one of the component and the system monitored by the each of the plurality of sensors; and

transmitting the telemetry signals by a transceiver using one of a plurality of communication modes to a computing device at a remote location,

wherein the computing device processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device,

wherein the plurality of sensors, the telemetry unit and the transceiver form a marine vessel monitoring system.

18. The method according to claim 17, wherein the computing device at the remote location is one of land-based and sea-based.

19. The method according to claim 17, wherein the data outputs are real-time parameters related to the system conditions of the marine vessel.

20. The method according to claim 17, wherein the plurality of communication modes comprises Worldwide-Interoperability for Microwave Access (WiMAX), General Packet Radio Service (GPRS) and satellite-based communication.

21. The method according to claim 20, wherein the satellite-based communication is established via one of Iridium Satellites and Inmarsat Satellites.

22. The method according to claim 20, wherein the one of the plurality of communication modes for transmitting the telemetry signals is selected from the plurality of communication modes according to a predetermined sequence, the predetermined sequence being of an order: WiMAX, GPRS and satellite-based communication.

23. The method according to claim 22, wherein a subsequent communication mode is selected from the plurality of communication modes according to the predetermined sequence upon failure to transmit the telemetry signals at the end of a predetermined duration using the one of the plurality of communication modes, the predetermined duration being associated to the one of the plurality of communication modes.

24. The method according to claim 17, wherein the plurality of sensors is one of wired and wireless.

25. The method according to claim 17, wherein the plurality of sensors comprises an autogyroscope device for sensing the trim of the marine vessel.

26. The method according to claim 17, wherein the plurality of sensors comprises a fuel-monitoring device for determining fuel-related information of the marine vessel.

27. The method according to claim 17, wherein the plurality of sensors comprises a satellite navigation device for sensing a heading and positioning of the marine vessel.

28. The method according to claim 17, wherein the plurality of sensors comprises a shaft speed sensor for determining an engine speed of the marine vessel.

29. The method according to claim 17, wherein the plurality of sensors comprises a Doppler speed device for determining a speed of the marine vessel.

30. The method according to claim 17, wherein the plurality of sensors comprises a power-metering device for determining the power loading of electrical power systems of the marine vessel.

31. The method according to claim 17, wherein the computing device comprises an archival database for storing at least one of event logs, status reports and inspection reports related to the marine vessel.

32 The method according to claim 31, further comprising:

transmitting a webpage by an Internet web server via the Internet to an extended user of the marine vessel monitoring system, the webpage including data stored in the archival database relating to the past and current system conditions of the marine vessel, the Internet web server being communicable with the computing device.

33. A method for monitoring a marine vessel comprising:

transmitting an update request from a computing device at a remote location to the marine vessel;

providing a plurality of sensors, each of the plurality of sensors for monitoring one of a component and a system onboard the marine vessel;

retrieving data outputs from the plurality of sensors by a telemetry unit in response to the update request and thereafter converting the data outputs into telemetry signals, each of the data outputs being representative of a state of the one of the component and the system monitored by the each of the plurality of sensors; and

transmitting the telemetry signals by a transceiver using one of a plurality of communication modes to the computing device,

wherein the computing device processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device,

wherein the plurality of sensors, the telemetry unit and the transceiver form a marine vessel monitoring system.

34. The method according to claim 33, wherein the computing device at the remote location is one of land-based and sea-based.

35. The method according to claim 33, wherein the data outputs are real-time parameters related to the system conditions of the marine vessel.

36. The method according to claim 33, wherein the plurality of communication modes comprises Worldwide-Interoperability for Microwave Access (WiMAX), General Packet Radio Service (GPRS) and satellite-based communication.

37. The method according to claim 36, wherein the satellite-based communication is established via one of Iridium Satellites and Inmarsat Satellites.

38. The method according to claim 36, wherein the one of the plurality of communication modes for transmitting the telemetry signals is selected from the plurality of communication modes according to a predetermined sequence, the predetermined sequence being of an order: WiMAX, GPRS and satellite-based communication.

39. The method according to claim 38, wherein a subsequent communication mode is selected from the plurality of communication modes according to the predetermined sequence upon failure to transmit the telemetry signals at the end of a predetermined duration using the one of the plurality of communication modes, the predetermined duration being associated to the one of the plurality of communication modes.

40. The method according to claim 33, wherein the plurality of sensors is one of wired and wireless.

41. The method according to claim 33, wherein the plurality of sensors comprises an autogyroscope device for sensing the trim of the marine vessel.

42. The method according to claim 33, wherein the plurality of sensors comprises a fuel-monitoring device for determining fuel-related information of the marine vessel.

43. The method according to claim 33, wherein the plurality of sensors comprises a satellite navigation device for sensing a heading and positioning of the marine vessel.

44. The method according to claim 33, wherein the plurality of sensors comprises a shaft speed sensor for determining an engine speed of the marine vessel.

45. The method according to claim 33, wherein the plurality of sensors comprises a Doppler speed device for determining a speed of the marine vessel.

46. The method according to claim 33, wherein the plurality of sensors comprises a power-metering device for determining the power loading of electrical power systems of the marine vessel.

47. The method according to claim 33, wherein the computing device comprises an archival database for storing at least one of event logs, status reports and inspection reports related to the marine vessel.

48. The method according to claim 47, further comprising:

transmitting a webpage by an Internet web server via the Internet to an extended user of the marine vessel monitoring system, the webpage including data stored in the archival database relating to the past and current system

conditions of the marine vessel, the Internet web server being communicable with the computing device.

49. A computer-program product, comprising: a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising instructions, which when executed by a marine vessel monitoring system, cause the system to:

receive and convert data outputs from a plurality of sensors into telemetry signals by a telemetry unit, each of the plurality of sensors for monitoring one of a component and a system onboard a marine vessel, each of the data outputs being representative of a state of the one of the component and the system monitored by the each of the plurality of sensors; and

transmit the telemetry signals by a transceiver to a computing device at a remote location using one of a plurality of communication modes,

wherein the computing device processes the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

50. The computer-program product according to claim 49, wherein the computing device at the remote location is one of land-based and sea-based.

51. The computer-program product according to claim 49, wherein the data outputs are real-time parameters related to the system conditions of the marine vessel.

52. The computer-program product according to claim 49, wherein the plurality of communication modes comprises Worldwide-Interoperability for Microwave Access (WiMAX), General Packet Radio Service (GPRS) and satellite-based communication.

53. The computer-program product according to claim 52, wherein the satellite-based communication is established via one of Iridium Satellites and Inmarsat Satellites.

54. The computer-program product according to claim 52, wherein the one of the plurality of communication modes for transmitting the telemetry signals is selected from the plurality of communication modes according to a predetermined sequence, the predetermined sequence being of an order: WiMAX, GPRS and satellite-based communication.

55. The computer-program product according to claim 54, wherein a subsequent communication mode is selected from the plurality of communication modes according to the predetermined sequence upon failure to transmit the telemetry signals at the end of a predetermined duration using the one of the plurality of communication modes, the predetermined duration being associated to the one of the plurality of communication modes.

56. The computer-program product according to claim 49, wherein the plurality of sensors is one of wired and wireless.

57. The computer-program product according to claim 49, wherein the plurality of sensors comprises an autogyroscope device for sensing the trim of the marine vessel.

58. The computer-program product according to claim 49, wherein the plurality of sensors comprises a fuel-monitoring device for determining fuel-related information of the marine vessel.

59. The computer-program product according to claim 49, wherein the plurality of sensors comprises a satellite navigation device for sensing a heading and positioning of the marine vessel.

60. The computer-program product according to claim 49, wherein the plurality of sensors comprises a shaft speed sensor for determining an engine speed of the marine vessel.

61. The computer-program product according to claim 49, wherein the plurality of sensors comprises a Doppler speed device for determining a speed of the marine vessel.

62. The computer-program product according to claim 49, wherein the plurality of sensors comprises a power-metering device for determining the power loading of electrical power systems of the marine vessel.

63. The computer-program product according to claim 49, wherein the computing device comprises an archival database for storing at least one of event logs, status reports and inspection reports related to the marine vessel.

64. The computer-program product according to claim 63, further comprising:

transmitting a webpage by an Internet web server via the Internet to an extended user of the marine vessel monitoring system, the webpage including data stored in the archival database relating to the past and current system conditions of the marine vessel, the Internet web server being communicable with the computing device.

65. A computer-program product, comprising: a computer readable storage medium and a computer program mechanism embedded therein, the computer program mechanism comprising instructions, which when executed by a computing device at a remote location, cause the device to:

transmit an update request to a marine vessel monitoring system comprising:

a plurality of sensors, each of the plurality of sensors for monitoring one of a component and a system onboard a marine vessel;

a telemetry unit for retrieving data outputs from the plurality of sensors in response to the update request and thereafter converting the data outputs into telemetry signals, each of the data outputs being representative of a state of the one of the component and the system monitored by the each of the plurality of sensors; and

a transceiver adapted for transmitting the telemetry signals using one of a plurality of communication modes to the computing device; and

process the telemetry signals to obtain the data contained therein, the obtained data being displayable by the computing device.

66. The computer-program product according to claim 65, wherein the computing device at the remote location is one of land-based and sea-based.

67. The computer-program product according to claim 65, wherein the data outputs are real-time parameters related to the system conditions of the marine vessel.

68. The computer-program product according to claim 65, wherein the plurality of communication modes comprises Worldwide-Interoperability for Microwave Access (WiMAX), General Packet Radio Service (GPRS) and satellite-based communication.

69. The computer-program product according to claim 68, wherein the satellite-based communication is established via one of Iridium Satellites and Inmarsat Satellites.

70. The computer-program product according to claim 68, wherein the one of the plurality of communication modes for transmitting the telemetry signals is selected from the plurality of communication modes according to a predetermined sequence, the predetermined sequence being of an order: WiMAX, GPRS and satellite-based communication.

71. The computer-program product according to claim 70, wherein a subsequent communication mode is selected from the plurality of communication modes according to the predetermined sequence upon failure to transmit the telemetry signals at the end of a predetermined duration using the one of the plurality of communication modes, the predetermined duration being associated to the one of the plurality of communication modes.

72. The computer-program product according to claim 65, wherein the plurality of sensors is one of wired and wireless.

73. The computer-program product according to claim 65, wherein the plurality of sensors comprises an autogyroscope device for sensing the trim of the marine vessel.

74. The computer-program product according to claim 61, wherein the plurality of sensors comprises a fuel-monitoring device for determining fuel-related information of the marine vessel.

75. The computer-program product according to claim 65, wherein the plurality of sensors comprises a satellite navigation device for sensing a heading and positioning of the marine vessel.

76. The computer-program product according to claim 65, wherein the plurality of sensors comprises a shaft speed sensor for determining an engine speed of the marine vessel.

77. The computer-program product according to claim 65, wherein the plurality of sensors comprises a Doppler speed device for determining a speed of the marine vessel.

78. The computer-program product according to claim 65, wherein the plurality of sensors comprises a power-metering device for determining the power loading of electrical power systems of the marine vessel.

79. The computer-program product according to claim 65, wherein the computing device comprises an archival database for storing at least one of event logs, status reports and inspection reports related to the marine vessel.

80. The computer-program product according to claim 79, further comprising:

transmitting a webpage by an Internet web server via the Internet to an extended user of the marine vessel monitoring system, the webpage including data stored in the archival database relating to the past and current system conditions of the marine vessel, the Internet web server being communicable with the computing device.