

Title**Vessel Monitoring System****Technical Field**

- 5 The invention concerns a vessel monitoring system for monitoring characteristics of a vessel from a remote location.

Background of the Invention

- 10 Fleet management of naval vessels is logistically difficult. Vessel may be located in any ocean of the world and are thus geographically distant from a fleet manager.

- Vessels and their cargo are valuable assets. Not only is the vessel valuable itself, but in recent times, the high price of oil means that its fuel is also valuable. Theft of fuel by the crew or from leakages is an expensive cost. It is the responsibility of the fleet manager to minimise or eliminate this cost.
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- Bunker C Fuel Oil D also known as bunkering fuel is a fuel used in ships. It is usually a No. 6 grade of residual fuel oil with an API gravity of about 10.5 degrees. To calculate the amount of bunkering fuel in a vessel, vessel sounding must be performed manually. Also, vessel sounding is not accurate to determine the amount of bunkering fuel in a vessel.
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- In certain parts of the world, piracy exists. It is also the responsibility of the fleet manager to manage the risk of piracy to ensure control of the vessel is not lost to pirates and to recover a vessel quickly in the event of piracy.
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- Therefore, it is a desire to provide a system to enable convenient monitoring of vessels from a remote location and to alert the fleet manager if the operational status a vessel is unusual. In particular, it is desirable that the fleet manager is made aware of any pilferage or loss of fuel from a vessel at any moment in time.
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Summary of the Invention

- In a first preferred aspect, there is provided a vessel monitoring system for monitoring characteristics of a vessel from a remote location, the system comprising:
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a controller to collect data relating to the characteristics of the vessel from a plurality of field components, and to convert the collected data into a predetermined format for reporting to a client device at the remote location;

5 a satellite transceiver to transmit the converted data to a base station receiver via at least one satellite;

wherein the converted data is delivered by an electronic delivery system to the client device.

10 The controller may be a Programmable Logic Controller (PLC) unit to collect the data from the field components in real time.

15 A field component of the plurality of field components may be any one from the group consisting of: magnetic pickup unit (MPU), micro motion flow meter, rosemount radar tank level transmitter, and a float switch.

20 Fuel consumption of the vessel may be monitored using at least two micro motion flow meters, a first of the at least two micro motion flow meters is located at a bunker inlet manifold of the vessel and a second the at least two micro motion flow meters is located at an entry point of a daily tank of the vessel, and the amount of fuel consumed is estimated by subtracting the reading of the second micro motion flow meter from the reading of first micro motion flow meter.

25 The revolutions per minute (RPM) of an engine of the vessel may be monitored using a magnetic pickup unit (MPU) to detect the rotation of a flywheel of the engine passing through a magnetic field.

30 The amount of fuel in the vessel may be monitored by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch.

The controller may report pilferage of fuel to the client device by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter.

35 The system may further comprise at least one field component to determine fuel mass, fuel temperature, fuel volume, fuel density and flow rates from the bunker inlet manifold.

The system may further comprise an engine alarm monitor to monitor engine characteristics from any one from the group consisting of: temperature, pressure, rpm limit, engine hour and engine active status.

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In a second aspect, there is provided a method for monitoring characteristics of a vessel from a remote location, the method comprising:

collecting data relating to the characteristics of the vessel from a plurality of field components;

10 converting the collected data into a predetermined format for reporting to a client device at the remote location; and

transmitting the converted data to a base station receiver via at least one satellite;

15 wherein the converted data is delivered by an electronic delivery system to the client device.

The method may further comprise estimating the amount of fuel consumed by subtracting the reading of a second micro motion flow meter located at an entry point of a daily tank of the vessel from the reading of a first micro motion flow meter
20 located at a bunker inlet manifold of the vessel.

The method may further comprise monitoring the amount of fuel in the vessel by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch.

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The method may further comprise reporting pilferage of fuel to the client device by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter.

30 In a third aspect, there is provided a data signal transmitted from a satellite transceiver located on a vessel to a client device via a satellite and base station receiver, the signal comprising:

converted data in a predetermined format;

35 wherein the converted data is data that is converted from data that is collected from field components located in the vessel.

The data signal may be encrypted and may be decrypted by the client device on reception.

The data signal may further comprise data relating to pilferage of fuel of the vessel.

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In a fourth aspect, there is provided a software system for monitoring characteristics of a vessel from a remote location, the software system being executed by a Programmable Logic Controller (PLC) unit, the software system comprising:

10 a plurality of scripts;

wherein a first script estimates the amount of fuel consumed by subtracting the reading of a second micro motion flow meter located at an entry point of a daily tank of the vessel from the reading of a first micro motion flow meter located at a bunker inlet manifold of the vessel;

15 a second script monitors the amount of fuel in the vessel by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch; and

a third script determines pilferage of fuel by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter.

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In a fifth aspect, there is provided a device for mounting on a non-powered vessel, the device comprising:

a satellite transceiver to transmit data to a base station receiver via at least one satellite, the data including location data of the vessel;

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a plurality of solar powered panels mounted on at least one side surface of the device, the solar powered panels being inclined relative to the base of the device to receive sunlight;

wherein the satellite transceiver is powered solely by the solar powered panels.

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The device may also comprise a stabilised polyethylene casing that is resistant to marine corrosion.

35 **Brief Description of the Drawings**

An example of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of a vessel monitoring system in accordance with a preferred embodiment of the present invention;

Figure 2 is a graphical illustration of a barge tracking device in accordance with a preferred embodiment of the present invention; and

- 5 Figure 3 is a series of screenshots using data received from the barge tracking device of Figure 2.

Detailed Description of the Drawings

Referring to Figure 1, a vessel monitoring system 5 for monitoring characteristics of
 10 a vessel 10 from a remote location is provided. The system 5 comprises a controller 12 and a satellite transceiver 11. The controller 12 collects data from a plurality of field components 13 in the vessel 10, and converts the collected data into a predetermined format for reporting to a client device 50 located at the remote location. The satellite transceiver 11 transmits the converted data to a Land Earth
 15 Station (LES) 30 via at least one satellite 20. The converted data is delivered by an electronic delivery system 40 to the client device 50.

The controller 12 may be a Programmable Logic Controller (PLC) unit 12 that is located on the bridge of the vessel 10. The PLC unit 12 is operatively connected to
 20 the satellite transceiver 11, for example, by wire cabling, and is also operatively connected to the field components 13, for example, also by wire cabling.

The field components 13, Programmable Logic Controller (PLC) unit 12, satellite transceiver 11 and satellite 20 are part of a SCADA (Supervisory Control and Data
 25 Acquisition) system. The satellite transceiver 11 may be an Inmarsat-C or mini-C transceiver 11. Global coverage is provided by the Inmarsat-C satellite network 20. This allows reception and transmission of messages from the vessel 10 from any ocean, directly to an e-mail address, SMS, fax, Telex or another Inmarsat-C or mini-C transceiver 11.

30 The field components 13 on the vessel 10 generate and process the data for the SCADA system. The PLC unit 12 collects and converts data for the SCADA system from the field components 13. The satellite transceiver 11 then transmits the data to a satellite network 20 which propagates the data from the SCADA system to the
 35 LES 30. The LES 30 then transmits the data to an e-mail server 41 on a server 40 where the data is packaged in an e-mail for transmission to an e-mail client 42 installed on a computing device 50, for example, desktop computer, notebook

computer or handheld wireless device. Also, the data may be sent via a SMS text message or MMS message to a mobile phone 50. The data signal from the satellite transceiver 11 to the server 40 may be encrypted and the e-mail from the server 40 to the client 50 may also be encrypted to prevent unauthorized access or
 5 tampering with the data signal or e-mail. Symmetric or asymmetric encryption may be used. The encrypted e-mail may be automatically decrypted by the client 50 on reception using a secret key.

Depending on the model of the transceiver 11, an easyMail message object is
 10 prepared by an EasyMail communication software for Enhanced Group Call (EGC) reception for FleetNet and SafetyNet. EGC supports reception of free Inmarsat-C broadcasted weather reports and maritime safety warning. easyMail is popular onboard commercial ships, fishing vessels and ocean going yachts since it is one of the most simple and cost-efficient communications solution.

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Field Components

The field components 13 include magnetic pickup unit (MPU), micro motion flow meters, rosemount radar tank level transmitter, and a float switch. These components 13 send signals to the PLC unit 12 in the form of frequency, totalizer
 20 value, 4~20ma signal and digital signal, respectively. The field components 13 are positioned throughout the vessel 10 to monitor the RPM of the vessel's engine, tank level, fuel, and the vessel's engine.

PLC unit

25 The PLC unit 12 collects real time data measured by the field components 13 and converts the collected data into an engineering format. Some conversions, for example, are frequency to RPM, totalizer value to kg, 4~20ma analog signal to liters and the digital signal to binary format (0 or 1).

30 The PLC unit 12 is located on the vessel 10 where engine signals, fuel signals and miscellaneous data terminates at the PLC unit 12. The PLC unit 12 is operatively connected to the field components 13 located throughout the vessel 10 via wire cabling. The PLC unit 12 has a flash Read Only Memory (ROM). The ROM 12A stores preconfigured scripts 12B which allow the PLC unit 12 to independently
 35 send each data signal at a periodic interval to the LES 30. The scripts 12B for the PLC unit 12 primarily use the Ladder Logic 47 programming language. The PLC

unit 12 is instructed by the scripts 12B to transmit data at periodic intervals via the transceiver 11.

After converting the collected data, the PLC unit 12 transmits the converted data to
5 a satellite 20 via the Immarsat-C transceiver 11.

The PLC unit 12 is preferable to a general purpose computer. The PLC unit 12 is programmable and generally robust because there are no moving parts. Conventional tracking systems must utilize computers to aid tracking. However,
10 this may be disadvantageous at sea due to undulating waves which could create stress points on moving parts in the computer such as the hard disk drive which could corrupt data over time and fail after a short period of time. The PLC unit 12 uses the flash ROM 12B in which the scripts 12B are stored. The PLC unit 12 operates independently and reads and processes the scripts 12B without the use
15 of a hard disk drive and executes the scripts 12B. The PLC unit 12 is designed and highly optimized for marine use where the equipment is able to withstand shocks at the same time occupy minimal space in the vessel 10 so as to make it look conspicuous, in the event piracy of the vessel 10. The PLC unit 12 also has a fast programming development cycle, is easy to learn to program, and is powerful and
20 future proof.

Satellite transceiver

The SAILOR mini-C satellite transceiver 11 is designed to minimize payable airtime traffic. The system 5 allows event based position reporting. This means that the
25 satellite transceiver 11 only transmits when it is required by the system 5. The satellite transceiver 11 also provides the crew with a range of other useful applications for the technology including e-mail, free EGC reception and Immarsat-C maritime distress. The satellite transceiver 11 is placed on the monkey island of the vessel 10 to facilitate outgoing transmission.

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The system 5 is able to monitor and control the vessel equipment using the SCADA system. Monitoring and controlling may be performed locally or remotely. The SCADA system also comprises total ship alarm status, warning alert, vessel fuel bunkering management, tank level management and engine management.
35 This data from the SCADA system can be monitored when the vessel 10 is at any location by any client device 50 at periodic time of intervals or in real-time.

Vessel monitoring systems include: RPM monitoring, tank level monitoring, fuel monitoring, engine alarm monitor and control and vessel distress to mobile phones as well as via emails to a fixed location, for example, an office.

- 5 The satellite 20 forwards the converted data to the LES 30. The LES 30 sends the converted data to a recipient email server 40. The email server 40 then distributes the data to client workstations 50 via group email id.

RPM Monitoring

- 10 The RPM monitoring is an important feature of the SCADA system. The RPM monitoring provides 0.5 % accuracy of the engine speed of the vessel 10 in the form of real-time data. The RPM of the engine is calculated by the PLC system 12. The RPM of the engine depends on the flywheel and magnetic pick up of the vessel's engine. The wire cabling from the field components 13 to the PLC unit 12
15 are all marine standard armored cables and are heavy duty to withstand high temperature, mechanical and electrical sound.

Tank level monitoring

- Tank level monitoring provides useful information to fleet managers. Tank level
20 monitoring is used to measure the fuel of all fuel tanks of the vessel 10. This day may be monitored locally by the crew as well remotely by the fleet manager. The data may be, for example, the day tank alarm and fuel measurement of the vessel 10. Tank level monitoring may also be used to measure daily tank fuel in volume and give over flow alarm, high level, and low level alarm of the daily tank.

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Fuel monitoring

- Fuel monitoring reduces the workload of a fleet manager. It also enables fuel management for multiple vessels without human error. Fuel monitoring requires the use of micro motion flow meters, to measure fuel in mass/kg with 0.5% accuracy.
30 Preferably, two micro motion flow meters are used. One is placed near the bunkering manifold inlet (f1). The other is placed at the entry point of the daily tank (f2). The f1 value provides the total fuel input of the vessel 10. The f2 value is the measurement of fuel out to the engine, the generator fuel and the tank level transmitter measurement of the return flow of the engine and generators. The
35 approximate fuel consumption of the vessel 10 is calculated by (f1 - f2). The actual fuel consumption of the vessel 10 is calculated by (f1 - (f2 - daily tank transmitter)). An important feature for fuel monitoring is on-line bunkering. On-line bunkering is

very accurate and does not involve vessel sounding to manually calculate the bunkering fuel. In contrast, a fleet manager may read the value of the flow meter f1 on a display. This display also shows the fuel mass, temperature, volume, density and flow rates of the vessel bunkering. Fuel monitoring also has an additional
 5 function to monitor the bunkering information by a fleet manager in real time. The field components 13 for fuel monitoring are secured by high security locks and the wire cabling is standard marine armored cables which cannot be damaged or easily tampered.

10 Engine alarm monitoring and control

Engine alarm monitoring and control provides multiple engine alarms including temperature, pressure, RPM limit, engine duration, engine on/ engine off status. These systems variables can also be monitored locally as well remotely.

15 Vessel distress function:

The vessel distress function is a unique function of the SCADA system because the distress message is programmed to contact the owner of the vessel 10 or fleet manager in case of emergency. The owner or fleet manager will receive the distress message on their mobile phone and also to their designated email address
 20 within several minutes of transmitting the distress message. The distress message is received by the recipients once a panic button is activated by the crew on the vessel 10.

The SCADA function and features are not limited to those described and is flexible
 25 to cater to end user requirements and/or company policy.

Referring to Figure 2, in another embodiment, there is provided a barge tracking device 100. A barge is typically a long, large, usually flatbottom boat for transporting freight that is unpowered and towed or pushed by other craft. The
 30 barge tracking device 100 comprises a mounting plate 120 which is used to mount the device 100 on the surface of the barge. The device 100 comprises an Inmarsat D transceiver 130 positioned at the top of the device 100 to communicate with a satellite network 20 for communication with a LES 30. The device 100 also comprises a plurality of solar powered panels 110 mounted to the side surfaces of
 35 the device 100 to provide power to the device 100 for receiving and transmitting information from the device 100 to the satellite network 20. As barges do not typically have their own power source, the device 100 is self-sufficient on power by

relying on the solar powered panels 110. The side surfaces of the device 100 are inclined such that they receive an adequate amount of sunlight during the day. The device 100 is packaged in a stabilised polyethylene casing that is resistant to marine corrosion.

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Data that is transmitted from the device 100 include the GPS co-ordinates of the barge and other environmental conditions, such as wind, temperature, etc. The solar powered panels 110 may be a SLC400 4nm solar LED lantern.

10 Referring to Figure 3, screenshots of a client application using GPS data received from the device 100 are illustrated. The top left screenshot illustrates the vessel's location on a map. The top right screenshot is a zoomed in view of the vessel's location with information about the vessel. The bottom screenshot is a history of the vessel's journey.

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It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the scope or spirit of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects
20 illustrative and not restrictive.

WE CLAIM:

1. A vessel monitoring system for monitoring characteristics of a vessel from a remote location, the system comprising: a controller to collect data relating to the characteristics of the vessel from a plurality of field components, and to convert the collected data into a predetermined format for reporting to a client device at the remote location; a satellite transceiver to transmit the converted data to a base station receiver via at least one satellite; wherein the converted data is delivered by an electronic delivery system to the client device, wherein fuel of the vessel is monitored using at least two micro motion flow meters and the amount of fuel consumed is estimated by subtracting the reading of a second micro motion flow meter from the reading of a first micro motion flow meter in the at least two micro motion flow meters.
2. The system according to claim 1, wherein the controller is a Programmable Logic Controller (PLC) unit to collect the data from the field components in real time.
3. The system according to claim 1, wherein a field component of the plurality of field components is any one from the group consisting of: magnetic pickup unit (MPU), micro motion flow meter, rosemount radar tank level transmitter, and a float switch.
4. The system according to claim 1, wherein the first of the at least two micro motion flow meters is located at a bunker inlet manifold of the vessel.
5. The system according to claim 4, wherein the second of the at least two micro motion flow meters is located at an entry point of a daily tank of the vessel.
6. The system according to claim 1, wherein the revolutions per minute (RPM) of an engine of the vessel is monitored using a magnetic pickup unit (MPU) to detect the rotation of a flywheel of the engine passing through a magnetic field.
7. The system according to claim 1, wherein the amount of fuel in the vessel is monitored by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch.
8. The system according to claim 4, 5 or 7, wherein the controller reports pilferage of fuel to the client device by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter.
9. The system according to claim 4 or 5, further comprising at least one field component to determine fuel mass, fuel temperature, fuel volume, fuel density and flow rates from the bunker inlet manifold.

10. The system according to claim 1, further comprising an engine alarm monitor to monitor engine characteristics from any one from the group consisting of: temperature, pressure, rpm limit, engine hour and engine active status.

11. A method for monitoring characteristics of a vessel from a remote location, the method comprising: collecting data relating to the characteristics of the vessel from a plurality of field components; converting the collected data into a predetermined format for reporting to a client device at the remote location; and transmitting the converted data to a base station receiver via at least one satellite; wherein the converted data is delivered by an electronic delivery system to the client device, wherein fuel of the vessel is monitored using at least two micro motion flow meters and the amount of fuel consumed is estimated by subtracting the reading of a second micro motion flow meter from the reading of a first micro motion flow meter in the at least two micro motion flow meters.

12. The method according to claim 11, further comprising estimating the amount of fuel consumed by subtracting the reading of a second micro motion flow meter located at an entry point of a daily tank of the vessel from the reading of a first micro motion flow meter located at a bunker inlet manifold of the vessel.

13. The method according to claim 11, further comprising monitoring the amount of fuel in the vessel by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch.

14. The method according to claim 12 and 13, further comprising reporting pilferage of fuel to the client device by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter.

15. A data signal transmitted from a satellite transceiver located on a vessel to a client device via a satellite and base station receiver, the signal comprising: converted data in a predetermined format; wherein the converted data is data that is converted from data that is collected from field components located in the vessel, wherein fuel of the vessel is monitored using at least two micro motion flow meters and the amount of fuel consumed is estimated by subtracting the reading of a second micro motion flow meter from the reading of a first micro motion flow meter in the at least two micro motion flow meters.

16. The data signal according to claim 14, wherein the data signal is encrypted and is decrypted by the client device on reception.

17. The data signal according to claim 14, wherein the data signal further comprises data relating to pilferage of fuel of the vessel.
18. The system according to claim 14, wherein the first of the at least two micro motion flow meters is located at a bunker inlet manifold of the vessel.
19. The system according to claim 14 or 18, wherein the second of the at least two micro motion flow meters is located at an entry point of a daily tank of the vessel.
20. A software system for monitoring characteristics of a vessel from a remote location, the software system being executed by a Programmable Logic Controller (PLC) unit, the software system comprising: a plurality of scripts; wherein a first script estimates the amount of fuel consumed by subtracting the reading of a second micro motion flow meter located at an entry point of a daily tank of the vessel from the reading of a first micro motion flow meter located at a bunker inlet manifold of the vessel; a second script monitors the amount of fuel in the vessel by measuring the tank level of at least one fuel tank of the vessel using a rosemount radar tank level transmitter and a float switch; and a third script determines pilferage of fuel by subtracting the amount of fuel in the vessel and the amount of fuel consumed by the vessel from the reading of the first micro motion flow meter, wherein fuel of the vessel is monitored using at least two micro motion flow meters and the amount of fuel consumed is estimated by subtracting the reading of a second micro motion flow meter from the reading of a first micro motion flow meter in the at least two micro motion flow meters.
21. The system according to any one of claims 1-10 wherein the satellite transceiver to transmit data to a base station receiver via at least one satellite, the data including location data of the vessel; the system further comprising a plurality of solar powered panels mounted on at least one side surface of the device, the solar powered panels being inclined relative to the base of the device to receive sunlight; wherein the satellite transceiver is powered solely by the solar powered panels.
22. The device according to claim 21, wherein the device comprises a stabilised polyethylene casing resistant to marine corrosion.

Abstract**VESSEL MONITORING SYSTEM**

A vessel monitoring system (5) for monitoring characteristics of a vessel (10) from a remote location, the system (5) comprising: a controller (12) to collect data
5 relating to the characteristics of the vessel (10) from a plurality of field components (13), and to convert the collected data into a predetermined format for reporting to a client device (50) at the remote location; a satellite transceiver (11) to transmit the converted data to a base station receiver (30) via at least one satellite (20);
10 wherein the converted data is delivered by an electronic delivery system (40) to the client device (50).

Figure 1