



IoT Based Maritime Safety, Navigation Assistance and Predictive Maintenance System

R.AAKASH¹, R.GOPAL², S.JAYASEELAN³, S.KARANKUMAR⁴

Department of ECE, Arunai Engineering College (Autonomous), Tiruvannamalai.

MR.S.GOPAL

Assistant Professor, Department of ECE, Arunai Engineering College (Autonomous), Tiruvannamalai.

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Abstract

Maritime safety and equipment reliability are important factors in marine transportation systems. Conventional monitoring methods often fail to provide real-time information about engine conditions and obstacle detection, which may lead to accidents and equipment failure. This paper presents an IoT-based maritime safety navigation assistance and predictive maintenance system using an Arduino UNO microcontroller. The proposed system monitors engine temperature, oil level, and nearby obstacles using multiple sensors. Sensor data is processed by the controller and displayed on an LCD module for real-time monitoring. In abnormal conditions, the system generates alerts through a buzzer and GSM module. The proposed system improves maritime safety, supports predictive maintenance, and reduces operational risks with a low-cost and efficient design.



I. INTRODUCTION

Maritime transportation is important for trade, fishing and things that happen on the coast. Maritime transportation is important for trade, fishing and coastal activities. We need to make sure the vessels are safe and the equipment works well to avoid problems at sea. We have to check the vessels and do maintenance work on them. This might not be enough to find problems with the engines or navigation systems when they happen. The Internet of Things technology is really helpful because it lets us make systems that collect and process data from sensors. These systems make things safer by watching things and sending warnings when something is not right. They help stop accidents and equipment failures from happening. This paper is about a safety system that uses Arduino UNO to help with navigation and maintenance. Maritime transportation safety system uses sensors to watch the engine temperature, oil level and things around the vessel. It shows the information, on a screen. Sends warnings through a loud noise and a GSM module when there is a problem. This system is meant to make things safer help with maintenance and stop equipment failures from happening. The system watches the engine temperature so it does not get too hot. It also checks the oil level so the engine has oil. It finds things that're in the way so the vessel does not hit them. By watching these things the system helps stop accidents and makes sure the vessel is safe. The system shows the information it collects on a screen so people can watch it. It also makes noises and sends warnings through a GSM module when something is wrong. This makes sure the crew knows what is happening and can do something to stop accidents. Overall the system that uses the Internet of Things technology makes things safer helps with maintenance and stops equipment failures from happening. It does this by watching things and making loud noises when something is not right. The system is a tool to make sure the vessel is safe and to stop accidents from happening at sea. Maritime transportation safety is important. This system helps with that.

II. LITERATURE REVIEW

Maritime monitoring systems used to rely on people checking things by hand and simple alarms. These methods were not good enough for keeping an eye on things all the time because problems could only be found after they happened. This often meant that maintenance was done late and the risk of the system failing increased. As technology got better sensors were used to monitor things like temperature and vibration. These systems were better at finding problems. They still had limitations because they only looked at one thing at a time instead of looking at the whole system.

These days the Internet of Things makes it possible to monitor things in time and send data from afar. Some systems can send alerts to users. Many of them do not have important safety features like alerts on the spot and automatic controls. Also systems that use vibration sensors to find problems and check oil levels have been made. They are separate and not part of one platform. The big problem with the systems we have now is that they do not combine sensors and real-time alert systems. To fix this problem the new system combines vibration sensors temperature sensors like the LM35, oil level sensors and rain sensors with a microcontroller. It also has alerts that sound a buzzer controls that use relays and communication that uses GSM. This design puts everything together. Provides a good and affordable solution, for maritime safety and maintenance that can predict problems without needing systems that rely on pressure or GPS.



III.SYSTEM ARCHITECTURE



Figure 1: BLOCK DIAGRAM

The system they are talking about is really good for safety. It makes sure the equipment on the ship works properly. The system uses an Arduino UNO computer to do this. The Arduino UNO computer has sensors and parts that help it talk to things on the ship. The system checks on some ship details like: Engine temperature, Oil level, Obstacles.

This makes being at sea safer for people on the ship. The equipment on the ship works better when the system is working. The temperature sensor on the system checks the engine to see if it is getting too hot. The oil level sensor on the system makes sure there is oil in the engine. The obstacle sensor on the system looks for things that could cause a crash. All the information from the sensors on the system goes to the Arduino UNO computer so people on the ship can look at it. The information from the sensors shows up on an LCD screen so people on the ship can watch it. If something bad happens like the temperature gets too high or the oil gets too low the Arduino UNO computer turns on a buzzer and a relay to warn people on the ship. At the time a GSM module on the system sends a message to the operator so they can do something about it right away. The system on the ship helps people watch what is going on with the equipment. It sends emergency alerts to people when something is wrong. The system on the ship helps with maintenance of the equipment.

IV.HARDWARE DESCRIPTION

A. Arduino UNO

The Arduino UNO is the brain of our safety and predictive maintenance system. It is in charge of everything. The Arduino UNO uses a microcontroller to look at the data from the sensors do the control algorithms and talk to the devices. It gets signals from the temperature sensor and the oil level sensor and the obstacle sensor. Then it does things based on what the threshold value set to. We picked the Arduino UNO because it does not use a lot of power and it is easy to program. It is small and it works with a lot of other devices.

B. Temperature Sensor

The temperature sensor keeps an eye on the engine temperature of the vessel all the time. If the engine gets too hot that can mean there are problems like it is not getting cooling or there are mechanical problems. The sensor turns the heat into signals. Sends them to the Arduino UNO to look at. When the temperature gets too high the Arduino UNO turns on warnings like the buzzer and the GSM alert system to stop the engine from getting damaged.

C. Oil Level Sensor

The oil level sensor checks how much oil is in the engine system. Oil is very important for the engine because it helps reduce friction and it helps minimize wear. It keeps the engine working well. If the oil level gets too low that can cause problems and make the engine not last as long. The sensor measures the oil level. Sends that information to the Arduino UNO. If the oil level falls below the threshold we set the system sends warnings. Tells the operator to do some maintenance.

D. Obstacle Sensor

The obstacle sensor helps keep the vessel safe by finding objects when the vessel is moving. It finds obstacles that are close and sends a signal to the Arduino UNO.



In some environments finding obstacles is very important to stop the vessel from hitting things like rocks or other vessels. When an obstacle is found the Arduino UNO turns on the warning buzzer. Shows a message on the LCD screen.

E. LCD Display

The LCD module shows us what is going on with the system and any warnings in time. It shows us the readings from the sensors like the engine temperature and the oil level. If there are any obstacles, the LCD helps the people using the system keep an eye on what's going on with the vessel. When something bad happens, it shows emergency warnings so the operator can respond quickly.

F. GSM Module

The GSM module lets the talk to people who are not on the vessel through the mobile network. It sends messages when something abnormal is found, like the engine is too hot or the oil level is too low or there is an obstacle. The module sends text messages with warnings about what's going on. This helps people keep an eye on the vessel and do something away if there is an emergency.

G. Relay Module

The relay module is a device that can turn things on and off in our system. It controls things like the alarm system or the engine protection based on what the Arduino UNO tells it to do. When something critical happens, the relay can turn things on and off to stop the vessel from getting damaged.

H. Buzzer

The buzzer is a device that warns the people on the vessel when something is wrong. It makes noise when something abnormal happens, like the engine is too hot or the oil level is too low. There is an obstacle.

The buzzer helps the operators hear the warnings even when it is noisy, on the vessel.

I. Power Supply Unit

The power supply section gives power to all the parts of the system. It takes the voltage from the power company and turns it into the voltage we need. A stable power supply is very important for the Arduino UNO and the sensors and the GSM module and the display to work properly. The power supply unit is very important for our system to work.

V. SOFTWARE IMPLEMENTATION

The software is made using Arduino IDE and the Embedded C language. It always checks the sensor values. Looks at the conditions to see if they are okay based on some rules we set. If it finds something, it turns on the alarm and sends a warning message using the GSM module. The LCD screen shows what is happening with the vessel now so people can always see what is going on. The software we made works well and does its job when things are not normal so the system is stable and works well.

VI. RESULTS AND DISCUSSION

. The proposed system for helping ships navigate safely and predicting when maintenance is needed was successfully. Tested in different situations.

This system kept an eye on things like engine temperature, oil level. If there were any obstacles nearby, all in real time using sensors that were connected.

Experimental results showed the temperature sensor worked well in detecting when the engine was getting too hot.

The oil level sensor was also good at finding out when the lubricant level was low. The sensor for detecting obstacles successfully found objects that were close by, which helped make navigation safer.

All the information from the sensors was shown on an LCD screen so people could keep an eye on things. When anything abnormal happened, a buzzer and a relay went off away to warn people.



At the time a GSM module sent messages to the operator to alert them. The system worked reliably and responded quickly. Was good at monitoring things.

The prototype that was made helped make ships safer by reducing the chance of the engine failing and of collisions happening.

The feature for predicting maintenance helped find issues with equipment on, which meant that maintenance costs and downtime were kept to a minimum. Overall the system that was proposed was a cost, efficient and reliable solution that was suitable for use, in ships.

VII. ADVANTAGES

1. It watches vessel conditions as they happen
2. This makes navigation safer by finding obstacles.
3. The system reduces engine failure by predicting maintenance needs.
4. It sends alerts if something goes wrong.
5. You can monitor things using GSM communication.
6. This system cuts maintenance costs and downtime.
7. It's a cost easy-to-set-up system.
8. The equipment gets more reliable. The vessel gets safer.
9. The system is compact. Doesn't use much energy.
10. It's suitable for, to medium-sized marine vessels.

VIII. APPLICATIONS

1. The fishing boats and the small marine vessels use these things.
2. We have harbor navigation systems that people use.
3. There are also marine safety monitoring applications that're very useful.
4. Some ships use ship maintenance systems to keep them running well.
5. The commercial maritime transportation industry is an user of these systems.
6. Naval and defense marine operations also use these systems for their work.

7. Monitoring and surveillance systems are used to keep an eye on things.
8. Accident prevention and emergency alert systems are very important for safety.
9. Real-time vessel condition monitoring helps us know what is going on with the vessels.
10. IoT-based marine automation systems are used to make things easier and more efficient, for the vessels and the marine industry.

IX. FUTURE SCOPE

Machine learning techniques can really help with maintenance. This means the system can find faults easily by looking at what happened in the past with the sensor data. The communication module can be made better by changing it from GSM to Wi-Fi or using advanced IoT modules.

This will make the data transmission faster and more reliable. We can also add sensors like humidity sensors, gas sensors and water level sensors. This will help the system to monitor things. A mobile application or a web interface can be made so that users get notifications in time can see the system status and have control options. We can also make some improvements like keeping a record of the data making reports automatically and having a battery backup system.

This will make sure the system keeps working all the time. All these improvements will make the system smarter more reliable and better for maritime applications. The machine learning techniques and other improvements will make the system more intelligent.

The system will be more reliable with the communication module upgrade and additional sensors, like humidity sensors and gas sensors.



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