



Engine Oil Condition Monitoring System with Auto Prevention System

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KEYWORDS

Embedded System, IoT Technology, Nodemcu, Blynk Cloud Server

ABSTRACT

The lubricating system is a mechanical apparatus that supplies lubrication to internal combustion engines by using a pump to provide oil to the engine's moving components. Engine lubrication is the procedure whereby frictional metal components are separated by the circulation of a lubricating material between them. Lubricants exist in liquid, solid, or gaseous states, with the liquid form being the predominant kind used in engines. This innovative project involves the design, modeling, and construction of a gadget for monitoring engine oil health. This project aims to develop a gadget that monitors the quality and longevity of engine oil in a vehicle's engine. The mechanics are sometimes unaware of the oil's quality, whether it is contaminated or laden with carbon deposits.

1. INTRODUCTION

Engine lubrication plays a crucial role in maintaining the efficiency, performance, and lifespan of engines used in automobiles, generators, industrial machinery, and agricultural equipment. Engine oil acts as a protective medium by reducing friction between moving parts, minimizing wear, carrying away heat, and preventing metal-to-metal contact. However, over time, engine oil gradually loses its viscosity, thermal stability, and lubrication quality due to high temperature,

contaminants, oxidation, and prolonged usage. If not monitored properly, degraded engine oil can lead to overheating, increased friction, power loss, engine knocking, and even complete mechanical failure.

In conventional systems, oil maintenance is carried out based on fixed service intervals or manual inspection, which is not always accurate because oil degradation depends on operating conditions, load variations, driving patterns, and environmental factors. Many users ignore oil health until visible symptoms appear, which

leads to reactive maintenance rather than preventive care. This gap highlights the need for an intelligent, sensor-based monitoring solution that can assess oil condition in real-time and help in predictive maintenance rather than waiting for a failure event.

With the rise of smart automotive systems, IoT technology, and digital maintenance tools, there is an increasing demand for intelligent engine monitoring solutions that not only provide data but also improve safety, reliability, and cost-effectiveness. A system that continuously monitors oil condition and alerts the user before any potential damage can significantly reduce repair costs, improve fuel efficiency, and extend engine life. Integrating such a solution with cloud platforms, GSM communication, and mobile-based interfaces aligns with the modern trend of digital service tracking and smart vehicle diagnostics. Therefore, developing a smart oil condition monitoring system is highly relevant to current industrial and automotive technology trends and contributes to the advancement of intelligent maintenance systems.

1.1 Problem Statement

Industrial environments are especially susceptible to hazardous conditions, such as gas leaks, equipment overheating, and unauthorized access to restricted areas. Conventional manual monitoring methods often demonstrate inefficiency, require considerable time, and are prone to human error, leading to delayed responses and increased risks of accidents, equipment damage, and fatalities. The absence of real-time monitoring, automated alert systems, and intelligent decision-making frameworks undermines the effectiveness of existing safety protocols. The lack of centralized data storage and predictive analysis impedes the ability to anticipate potential anomalies before they escalate into significant problems. There is an urgent necessity for an intelligent, IoT-enabled industrial safety system that can continuously monitor environmental conditions, detect anomalies in real time, issue prompt alerts, and enable predictive safety analysis to enhance the protection of personnel and equipment.

1.2 Objective

The main objectives of the Engine Oil Condition Monitoring System with Auto Prevention System are as follows:

- To continuously monitor engine oil level and temperature using multiple sensors for real-time safety assessment.
- To alert the user through SMS, buzzer, and visual indicators when oil condition crosses the predefined safety threshold.
- To automatically shut down the engine using a relay-based prevention mechanism if the user fails to respond within a safe time limit, thus preventing engine damage.
- To implement IoT-based remote monitoring using NodeMCU and Blynk Cloud for displaying oil health status, remaining kilometers before refill, and last oil change history

2. RELATED WORK

Omiya et al.[1] developed sophisticated machine learning models to forecast engine oil deterioration for various vehicle types using telemetry data and oil characteristics. The research shown enhanced forecast accuracy relative to conventional rule-based approaches, underscoring the significance of AI in contemporary predictive maintenance systems. This study emphasizes the future trajectory of engine oil monitoring, whereby onboard sensors are integrated with advanced analytics to provide proactive and efficient maintenance approaches

Liu et al.[2] Liu and collaborators suggested an integrated methodology using optical debris detection and viscosity assessment to ascertain oil deterioration and mechanical wear. The approach demonstrated significant sensitivity to pollutants and early wear particles, providing critical insights on engine condition. Nonetheless, the optical systems in question are very intricate and costly, potentially restricting their use for economical or extensive vehicle retrofitting.

Jeon et al.[3] Assessed tuning-fork sensors for the surveillance of hydraulic oil quality, emphasizing viscosity and contaminant identification in industrial settings. The research confirmed the efficacy and resilience of tuning-fork sensors under actual operating settings, showing dependable oil condition evaluation. The research focused on hydraulic systems, although the sensing concepts and approaches are applicable to vehicle oil monitoring applications.

Raposo et.al [4] Raposo and associates used laboratory oil analysis data to formulate condition-based

maintenance models for diesel bus fleets, enabling enhanced forecast of maintenance requirements and optimal intervention time. The research revealed significant advantages of data-driven decision-making in minimizing superfluous maintenance and averting breakdowns. Nonetheless, the methodology depends on intermittent laboratory testing instead of continuous onboard sensing, hence limiting real-time monitoring capabilities.

Agoston-et.al [5] Agoston examined several viscosity sensing methodologies, including acoustic approaches, capacitive micromachined ultrasonic transducers (CMUTs), and micro-viscometer designs, intended for in-situ assessment of engine oil quality. The research established a robust theoretical and empirical basis for measuring oil viscosity, underscoring its significance as a critical indication of lubricant deterioration. Nonetheless, the study indicated that more research is necessary to guarantee sensor reliability and precision under the high-temperature and adverse working circumstances characteristic of car engines.

3. EXISTING SYSTEM

In existing automobiles and industrial engines, oil condition monitoring is mostly conducted manually or via rudimentary signs like low oil pressure warning lights. These indications notify the user just after a major failure situation has transpired, indicating that the engine has already begun sustaining damage. Conventional systems lack comprehensive data on oil levels, temperature, or service history, and thus do not provide remote monitoring or automated safety measures. Users or drivers must depend on regular manual inspections, and often, engines are run with compromised oil conditions owing to unawareness, resulting in overheating, heightened friction, wear, and unforeseen engine failures. Present embedded systems in mid-range automobiles are restricted to basic dashboard warning indicators, without preemptive shutdown mechanisms or IoT/GSM connection functionalities.

4. PROPOSED APPROACH

The proposed Engine Oil Condition Monitoring System with Auto Prevention System presents an intelligent and automated solution using ultrasonic sensors for oil level detection, temperature sensors for heat monitoring, a GSM module for SMS notifications,

and NodeMCU for IoT-based real-time oversight via Blynk Cloud. This system, unlike standard indicator systems, informs the user via a buzzer, LCD display, online dashboard, and SMS notification, and also automatically shuts down the engine via relay control if oil conditions become severe and the user does not react. The system also preserves digital service logs, monitors remaining kilometers till the next oil refill, and documents the previous oil change date, making it a contemporary predictive maintenance system appropriate for automobiles, generators, agricultural equipment, and fleet management applications.

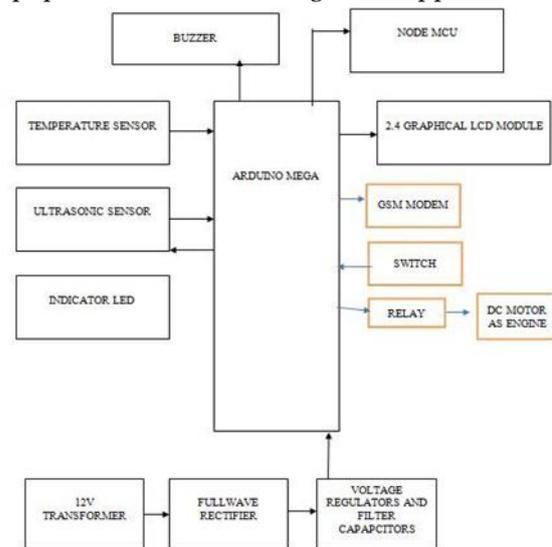


Figure 1. System Architecture

The proposed Engine Oil Condition Monitoring System with Auto-Prevention System integrates multiple sensors, control units, and communication modules to ensure continuous monitoring and safe engine operation. Each component plays a crucial role in detecting abnormal conditions and initiating preventive actions.

Temperature Sensor

The temperature sensor is employed to continuously monitor the engine oil temperature. Since oil viscosity and lubrication efficiency degrade at elevated temperatures, real-time temperature sensing is critical for early fault detection. When the measured temperature exceeds predefined safety thresholds, the system generates alerts and initiates preventive mechanisms to avoid engine damage.



Fig2: Temperature Sensor

Ultrasonic Sensor

The ultrasonic sensor is utilized to measure the oil level by estimating the distance between the sensor and the oil surface. This non-contact measurement technique ensures accurate detection of low oil level conditions. Insufficient oil levels can result in increased friction and wear; therefore, the sensor enables timely detection and preventive action.



Fig3: Ultrasonic Sensor

Indicator LED

Indicator LEDs provide visual feedback regarding the system's operational state. Different illumination patterns indicate normal operation, warning conditions, or critical faults, allowing quick visual assessment by the operator.



Fig4: Indicator LED

Buzzer

The buzzer serves as an audible alert mechanism. It is activated when abnormal oil temperature or oil level conditions are detected, ensuring immediate user attention even in noisy environments.



Fig5: Buzzer

Arduino Mega Controller

The Arduino Mega functions as the central processing unit of the system. It acquires data from the temperature and ultrasonic sensors, processes the information, and executes decision-making algorithms. Based on sensor inputs, it controls the relay, display unit, and communication modules.



Fig6: Arduino Mega Controller

NodeMCU (Wi-Fi Module)

The NodeMCU module provides wireless connectivity for Internet of Things (IoT) integration. It transmits real-time oil condition data to a cloud server or remote monitoring platform, enabling continuous supervision and data logging.



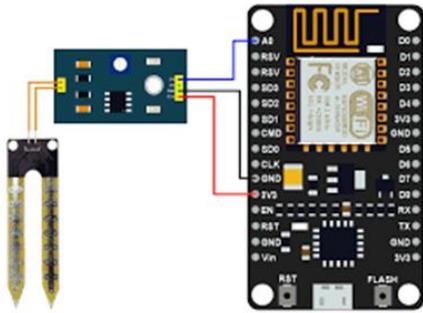


Fig7: NodeMCU (Wi-Fi Module)

Graphical LCD Module

A 2.4-inch graphical LCD module is used to display real-time engine oil parameters such as temperature, oil level, and system status. This facilitates local monitoring and enhances user interaction with the system.



Fig8: Graphical LCD Module

GSM Modem

The GSM modem enables long-distance communication by sending SMS alerts to registered users during critical fault conditions. This ensures prompt notification even in the absence of internet connectivity.



Fig9: GSM Modem

Relay Module

The relay module acts as an electrically controlled switch that enables automatic intervention. When unsafe oil conditions are detected, the relay disconnects the engine or activates protective mechanisms to prevent further damage.

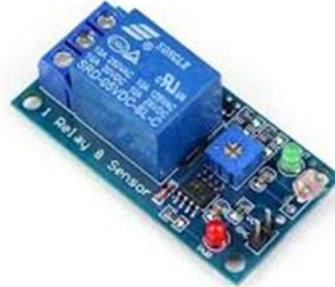


Fig10: Relay Module

DC Motor (Engine Representation)

A DC motor is used to simulate engine operation in the prototype implementation. It allows validation of the auto-prevention mechanism by enabling controlled shutdown during fault conditions.

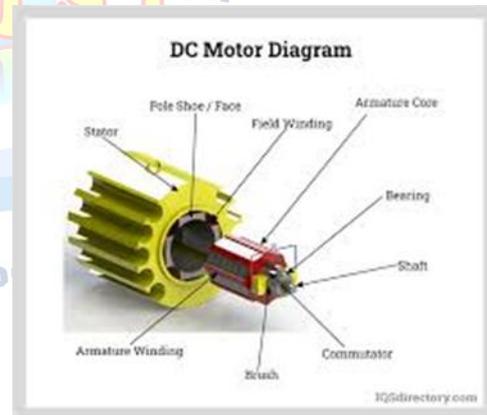


Fig11: DC Motor (Engine Representation)

Power Supply Unit

The power supply unit consists of a transformer, full-wave rectifier, voltage regulators, and filter capacitors. It provides a stable and regulated DC supply required for reliable operation of all sensors and control modules.



Fig12: Power Supply Unit

4.1 Methodology

We have developed an innovative system using embedded and IoT technology. In this process, we typically monitor the oil quantity and oil temperature by using many sensors and an Arduino controller board. The LCD module is used for the continuous presentation of sensor data. If the oil temperature rises, an SMS will be sent to the user and a buzzer alarm will be activated. The user must activate the switch within a certain timeframe; failure to do so will result in the controllers deactivating the relay, which then turns off the DC motor. The GSM modem is connected to this system to transmit SMS to pre-registered mobile numbers.

The Ultrasonic Sensor measures the engine oil level and prevents engine start if it falls below the threshold, while also generating a buzzer alarm and indicator display. The purpose of this project is to develop and build a user-friendly and cost-effective engine lubricant health monitoring system. A transformer-based power source is used in this system. Voltage regulators and filter capacitors are used to provide a stable 12V and 5V DC supply to the whole system.

The Embedded C Programming Language is used to develop logical code, while the Arduino IDE compiler is employed to compile and upload the code onto the Arduino Uno. Digital Pins serve as output interfaces, whereas Analog Pins function as inputs for sensors.

An IoT-based web application is integrated with this system to show the remaining kilometers till engine oil refill, along with the date of the last oil change. The Blynk-based cloud application is used for data

monitoring. Nodemcu is used for WiFi and IoT connectivity.

5. RESULTS AND DISCUSSIONS

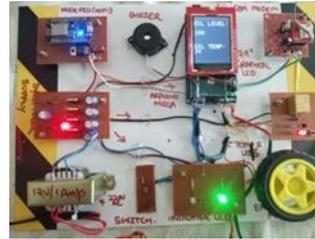


Figure2: Proposed kit Engine oil sensor heating for testing

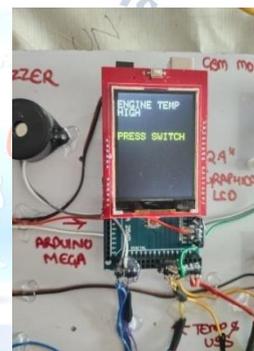


Figure3: LCD showing engine oil temperature alert GSM alert message sent to mobile



Figure4: Alert message received on mobile

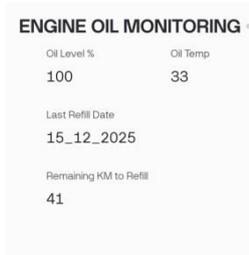


Figure5: LCD shows NO Action-Engine StoppedEngine oil monitoring data received from Blynk cloud

6. CONCLUSION

The suggested Engine Oil Condition Monitoring System with Auto Prevention effectively combines several sensor technologies with GSM and IoT connection to provide real-time protection against engine damage. By autonomously identifying anomalous oil conditions, such as insufficient oil levels and overheating, the system warns the user and initiates an automated engine shutdown to avert significant mechanical failure. This intelligent monitoring strategy diminishes maintenance expenses, augments engine efficiency, and improves safety, making it a formidable option for both personal and industrial vehicle engine protection.

Future Scope

Future advancements may include AI-driven predictive maintenance algorithms that evaluate driving behaviors and autonomously project the subsequent oil change interval using intelligent analytics. A mobile application with GPS tracking for fleet cars may be implemented for real-time health monitoring. Future enhancements may include connectivity with the vehicle CAN bus for OEM-grade engine diagnostic input and the implementation of automated refill valve systems to sustain minimal oil levels without operator intervention. This concept has significant potential for commercial implementation in intelligent automobile maintenance systems, enhanced by integrated cloud intelligence.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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