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A PROTOTYPE TWO-WHEELER OIL HEALTH MONITOR

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Abstract—**In today's world, the Internet of Things (IoT) represents a smart and dynamic approach, leaving a profound impact on the future of the automobile industry. The integration of IoT innovations across various sectors is catalyzed by emerging trends, driving the demand for an enhanced human lifestyle. The applications of IoT are diverse and extensive, with one compelling example being its implementation in the automobile industry to monitor engine lubricants in real-time. An IoT-based Engine Oil Monitoring (EOM) System has been developed to address this need, aiming to streamline processes and offer intelligent sensing solutions for maintaining optimal engine oil conditions. This system utilizes an Arduino Nano microcontroller along with sensor devices such as the Light Dependent Resistor (LDR) sensor for assessing oil quality, the LM35 Temperature sensor for monitoring temperature, and an Ultrasonic Sensor for measuring oil levels within the engine. The testing results are displayed on a connected unit, providing immediate feedback on the engine oil's status. Experimental findings from the proposed EOM system, utilizing IoT networks, demonstrate its efficacy in diagnosing engine lubricant conditions efficiently. Through rigorous experimental analysis, the functionality of the EOM system has been validated under various scenarios, such as testing with different engine oils like the 10W-50 4T Scooter Engine Oil used in Honda Activa 125. Overall, the successful operation of the EOM system signifies a significant advancement in the automotive industry, promising improved maintenance practices and contributing to the overall efficiency and longevity of vehicles**

Index Terms—**EOM System, Sensors, LED Display, Ultrasonic Sensor, LDR, Engine Oil, IoT Network.**

I. INTRODUCTION

The Internet of Things (IoT) stands as a pivotal innovation and economic force within the global information landscape, rivaled only by the Internet itself. IoT technology represents an intelligent networking paradigm, seamlessly connecting every computational device to the Internet for data exchange and communication via specialized sensing devices and agreed upon data transmission protocols. In contemporary times, IoT technology has evolved to encompass a spectrum of functionalities, including intelligent monitoring, identification, localization, tracking, and management of various entities. It serves as an extension and amplification of the internet-based network, fostering communication pathways between humans, humans and objects, and objects amongst themselves. Within the automobile industry, real-time measurement of engine oil quality emerges as a significant challenge, particularly prevalent in developing nations. This challenge arises primarily due to the absence of automatic monitoring systems, compounded by the continuous operation of engines. To address this issue, the concept of an IoT-based real-time Engine Oil Monitoring (EOM) system has been proposed, along with its architectural framework.

Current work proposes a prototype EOM system for real time diagnosis of lubricant using an IoT network, with the following contributions:

- A preliminary model for the EOM system has been developed employing IoT network principles alongside sensors to monitor lubricant visibility, depth, and other parameters.
- To verify the effectiveness of the designed EOM model, Oil Quality (PPM) is calculated relative to the distance covered by the two-wheeler.

II. LITERATURE SURVEY

Authors [1] have made a survey of existing work on engine oil monitoring systems which explores various approaches used by researchers. It describes a model utilizing oil health monitoring, diagnostics, and prognostics, known as wear particle condition monitoring. A comprehensive review of available lubrication oil conditioning techniques is conducted, categorized into four parts: electrical, physical, chemical, and optical. Each sensing technique and its characteristics are evaluated, with a comparison of their properties. Various oil condition monitoring sensing techniques for performance parameters such as TAN/TBN, water content, wear particle count, flash point, and viscosity are studied.

Jakobe et al [2] proposed the technique to find out the viscosity of lubricating oil using micro acoustic viscosity

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sensor and measuring the viscosity of various engine oil of cars and fresh oil samples. Viscosity dependence on temperature and other material in the lubricating oil samples is being measured. Paul et al [3] introduced the condition monitoring method for lubricating oil. The technique is based on capacitance and ultrasonic based method for finding or detecting the wear debris and analyzing the physical properties of lubricating oil. It was found that the techniques could detect particle size of 44.5m in diameter.

Measuring viscosity, both with and without additives in oil, involves subjecting it to an artificial aging process. Agoston et al. [4] utilized micro acoustic sensors to examine the viscosity of lubricating oil. These sensor probes take into account different rheological domains in their measurement results. Kenna et al. [5] conducted research on the flash point of engine oil. They utilized the Pensky Martens flash point test (closed cup test) at various temperatures to collect data. The flash point is used to differentiate between flammable liquids, such as petrol, and combustible fluids, like diesel. According to the data, a liquid with a flash point below 37.8°C (100.0°F) or 60.5°C (140.9°F) is classified as flammable, while a flash point above these temperatures classifies the liquid as combustible.

Perez et al. [6] introduced a real-time oil monitoring technique based on lubricant permittivity. As oil degrades during operation, the necessity for condition-based maintenance arises to determine the optimal time for oil replacement.

Kumaresan et al. [7] conducted research aimed at developing a model to assess the quality of engine oil. In their experimental analysis, they took three samples of 4T 10W30 engine oil every 1000 km. They employed LEDs to indicate the oil condition using different colors. A microcontroller was utilized to manage the LEDs, and signals from turbidity were sent to a PIC microcontroller to determine whether the engine oil quality had changed.

Mandekar et al [8] have developed an IoT-based model to monitor the distribution of transformer oil, which was previously done manually. Various parameters, such as oil level, temperature, current, voltage, and the viscosity of transformer oil, are monitored in real time using sensors. The system utilizes an AVR microcontroller for temperature and viscosity monitoring. By interfacing the necessary components, the developers created an application program in embedded C, enabling the controller to continuously read and display these parameters on an LCD. Raja kumar et al [9] have designed an IoT-based system to detect milk adulteration using various sensors, including gas, salinity, and milk level sensors. The apparatus was developed for real-time monitoring of milk spoilage to ensure it remains a healthy product. The system leverages IoT to notify users about milk quality via email or message and provides customers with a card to access milk diaries. Goyal et al [10] have developed an IoT-based wireless control system to monitor and control various parameters of an induction motor in real time. The system employs a module of sensors to monitor parameters such as current, voltage, temperature, and speed, using a microcontroller for analysis and display. If any parameter exceeds the set threshold, the Arduino Uno microcontroller analyzes and visualizes the data, then sends a signal to the relay at the transmitting end to cut off the motor supply.

III. PROJECT DESIGN

The architecture of the EOM system comprises three distinct phases:

- Data Sensing
- IoT-based Transmission
- Monitoring

Each phase plays a crucial role in facilitating the seamless operation of the EOM system, as detailed in the subsequent sections.

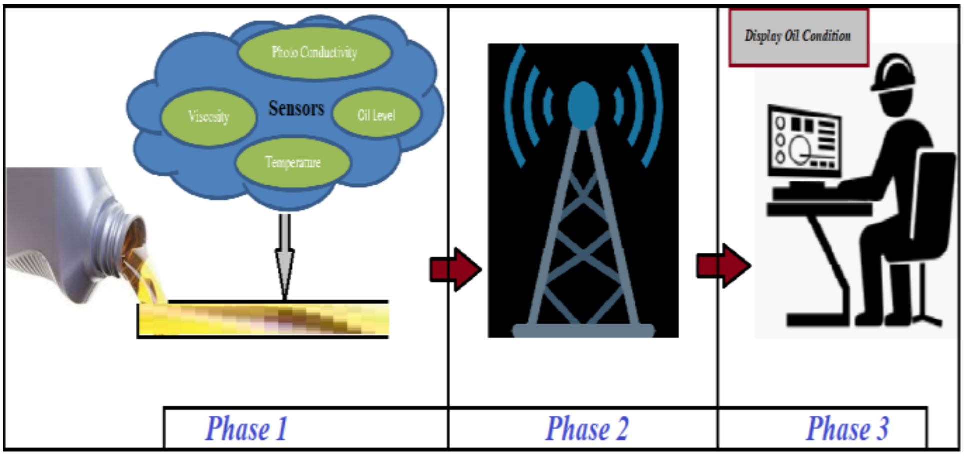

Fig. 1. Architecture of IoT based EOM System

Fig 8 depicts the architecture of an IoT-based EOM system tailored for the automobile industry. In the first phase, a series of electronic sensor devices, indicated by green circles, are deployed to detect the oil condition and capture raw data. In the second phase, this raw data is transmitted via wireless or wired mediums. Finally, in the third phase, specialized software is integrated with computational devices to monitor and display the exact condition of the lubricant, allowing for intelligent interaction.

• **Data Sensing:** Data sensing within the IoT-based Engine Oil Monitoring (EOM) system involves the utilization of specialized electronic sensors to assess the condition of the engine oil. The system incorporates various sensors tailored for specific functions:

– The Light Dependent Resistor (LDR) sensor to gauge the visibility of the lubricant, ensuring that adequate lubrication is maintained within the engine.

– An ultrasonic sensor to accurately measure the depth of the lubricant within the vehicle's oil tank, providing precise data on oil levels.

These electronic sensors exhibit superior sensing capabilities, enhancing the system's interaction with the physical environment. By continuously monitoring these parameters, the EOM system can effectively detect deviations from optimal oil conditions, facilitating proactive maintenance measures.

Furthermore, the data collected by these sensors can serve as crucial inputs for the intelligent processing and analysis stages of the EOM system. Through intelligent data storage and processing, the system can derive meaningful insights and actionable recommendations regarding engine oil maintenance, contributing to improved vehicle performance and longevity.

• **IoT based Transmission:** In this phase, an IoT network is established to facilitate communication and transmission of oil condition data from the EOM system to monitoring devices such as mobile phones, computers, and laptops. Various communication protocols including Bluetooth, RFID, Wi-Fi, and ZigBee are employed as medium for transmitting data from the transmitter to the receiver.

This IoT-based transmission phase is crucial for ensuring seamless and reliable data transfer, enabling real-time monitoring of engine oil conditions across different computational devices. Each communication protocol offers distinct advantages in terms of range, data transfer speed, and energy efficiency, catering to diverse operational requirements.

By leveraging these communication technologies, the EOM system establishes a robust network infrastructure, capable of transmitting oil condition data efficiently to monitoring devices located within the vicinity. This enables users to access critical information regarding engine oil status remotely, empowering them to make informed decisions regarding maintenance and operational efficiency.

Furthermore, the integration of IoT-based transmission mechanisms enhances the scalability and adaptability of the system, accommodating future advancements and expanding its capabilities to meet evolving industry needs.

• **Monitoring:** Monitoring involves the continuous observation and assessment of lubricant condition throughout its usage to ensure its quality is maintained over time. This process involves vigilant scrutiny and periodic checks to track any changes or deviations in the lubricant's properties, such as viscosity, contamination levels, and overall performance.

By actively monitoring the lubricant's condition during operation, potential issues or deterioration can be detected early, allowing for timely intervention and maintenance. This proactive approach helps to prevent potential equipment failures, minimize downtime, and extend the service life of machinery.

Monitoring also involves the collection and analysis of relevant data obtained from sensors and diagnostic tools integrated into the lubrication system. This data provides valuable insights into the health and performance of the lubricant, enabling maintenance of schedules, lubricant replacement intervals, and optimization of operational efficiency.

Monitoring serves as a critical component of effective lubricant management, ensuring that machinery operates at peak performance levels while minimizing the risk of costly breakdowns or failures. By maintaining a vigilant watch over lubricant condition, businesses can uphold operational reliability, productivity, and cost-effectiveness over the long term.

The proposed Engine Oil Monitoring (EOM) system utilizing an IoT network comprises several implementation steps and procedures as depicted in Fig. 2:

• Sensor Deployment: This involves deploying sensors strategically within the engine system to monitor key parameters such as oil quality, temperature, and level.

• Data Acquisition: Sensors gather real-time data on the condition of the engine oil, including viscosity, contamination levels, and other relevant metrics.

• Data Transmission: The collected data is transmitted wirelessly or via a wired connection to a central pro cessing unit for analysis and interpretation.

• Data Analysis: The intensity of the engine oil is analyzed using LDR sensor to check the health and performance of the engine oil, identifying any abnormalities or deviations from optimal conditions.

• Alert Generation: If any anomalies are detected, the system generates alerts or notifications to prompt appropriate action from the user or maintenance personnel.

• Maintenance Recommendations: Based on the analysis results, the system may provide recommendations for maintenance actions, such as oil changes or component inspections.

• Continuous Monitoring: The EOM system will be able to continuously monitors the engine oil condition in real-time, ensuring proactive maintenance and optimal performance of the vehicle.

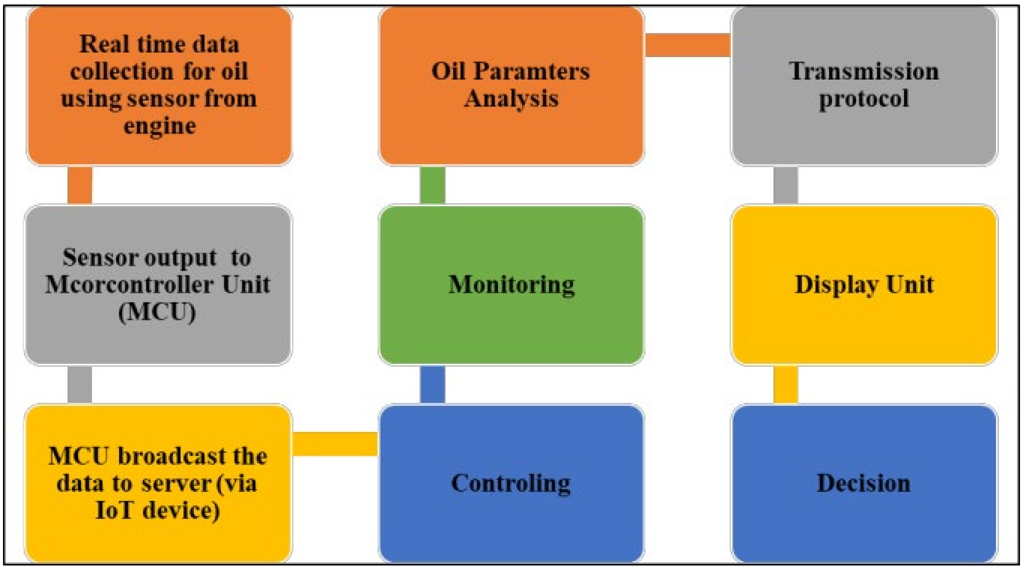

Fig. 2. Control Flow of Proposed EOM System

IV. HARDWARE REQUIREMENTS

• **LDR sensor:** The Light Dependent Resistor (LDR)[Fig. 3] , also known as a photo-resistor or photo-conductor, is a component characterized by a resistance that varies based on the intensity of light it receives. This property makes it suitable for use in light sensing circuits and op to electronic devices, particularly in applications such as light-varying sensor circuits and light-activated switching circuits. In the Engine Oil Monitoring (EOM) system, LDR sensors are employed to assess the quality of engine oil based on its transparency.

To design an LDR sensor, semiconductor substrates such as PbS (Lead-Sulphide), PbSe (Lead-Selenide), and InSb (Indium-Antimonide) are utilized. However, the most commonly used material for LDR sensors is Cadmium Sulfide (CdS), sometimes referred to as a Cadmium Sulfide Cell (CSC). The LDR sensor is represented by a specific symbol, and it serves as a crucial component within the EOM system for monitoring engine oil quality.

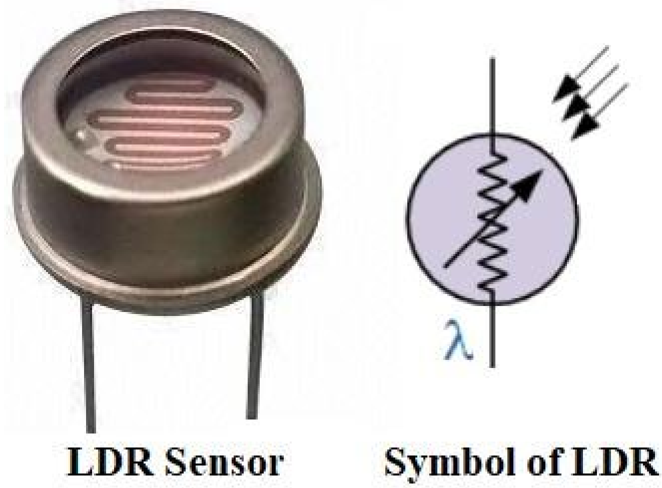

Fig. 3. LDR Sensor

• **Ultrasonic Sensor:** Ultrasonic sensing stands out as one of the most reliable methods for detecting proximity and determining engine oil levels accurately. This technology utilizes ultrasonic sound waves to measure the distance to an object. A transducer is employed to emit and receive ultrasonic pulses, which then convey information regarding the object's proximity. As high-frequency sound waves interact with boundaries, they produce distinctive echo patterns, facilitating precise detection and measurement [Fig. 4].

Fig. 4. Ultrasonic Sensor

• **MCU:** The Microcontroller Unit (MCU)[Fig. 5] serves as the interface between sensor devices, peripherals, and the overall system. It is responsible for receiving data from sensors and providing signals to display the oil condition. In the EOM model, the Arduino NANO is utilized as the MCU. This compact board includes a built-in Wi-Fi shield, enabling wireless communication via ultrasonic sound waves. However, to establish connectivity, it re quires access to a hotspot.

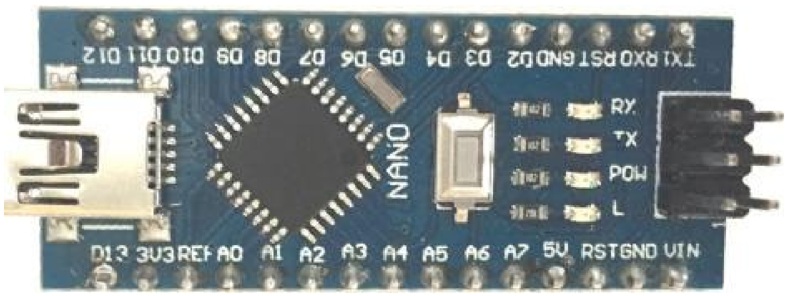

Fig. 5. MCU (Arduino NANO)

• **Display Unit:** The 16x2 LCD (Liquid Crystal Dis play)[Fig. 6] serves as the interface for displaying the achieved results and simulation status of the EOM system. This technology represents one of the latest innovations and is widely employed in various applications today. From cell phones to large advertising display boards, the versatile nature of these 16x2 LCDs is evident across a broad spectrum of devices and industries.

Fig. 6. 16×2 LCD Panel

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V. SOFTWARE REQUIREMENTS

• HP laptop: 15s-eq2xxx
• Processor: AMD Ryzen 5 5500U with Radeon Graph ics(2.10 GHz)
• RAM: 8.00 GB
• Storage: 476GB
• Internet Connection
• Operating System: Windows 11 Home Single Language, Version: 22H2

VI. IMPLEMENTATION

The proposed Engine Oil Monitoring (EOM) system's working architecture is segmented into several distinct phases: • Deployment of sensor nodes, each connected to an Arduino NANO. Sensors transmit collected information packets to the Arduino NANO when a connection is available.
• Various sensors, such as the LDR for oil quality, LM35 for temperature, and ultrasonic sensor for oil level, begin measuring values upon battery power are deployed.
• The measured values are stored in the hardware memory of the MCU or Arduino NANO.
• Based on these stored values, the MCU or Arduino NANO initiates specific actions corresponding to the engine oil conditions.
• Subsequently, the MCU or Arduino NANO wirelessly transmits oil condition information in the form of packets to the display unit, employing the IoT network concept.
The methodology steps [Fig. 7] of the EOM system follow a structured process, ensuring efficient monitoring and management of engine oil conditions.

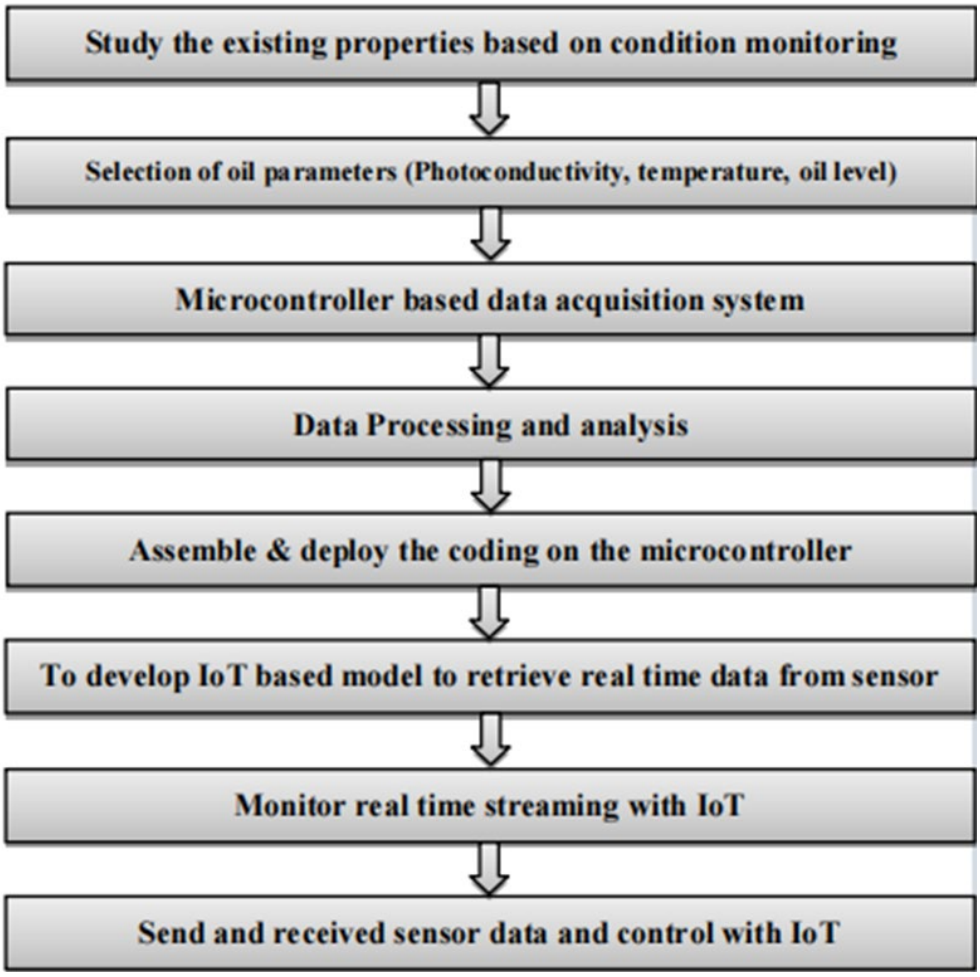

Fig. 7. Methodology Steps of EOM System

Checking the intensity of engine oil for various samples based on kilometers driven is a crucial aspect of engine maintenance to ensure optimal performance and longevity. This process involves periodic analysis of the oil's properties to assess its health and effectiveness in lubricating the engine components. By monitoring the intensity of the engine oil at different intervals, technicians can detect potential problems early on and take corrective action before they escalate, reducing the risk of costly repairs and engine damage. Regular oil analysis also helps to optimize oil change intervals, ensuring that the engine receives fresh, high-quality lubrication when needed, thereby maximizing performance and prolong ing its lifespan. Ultimately, this proactive approach of oil maintenance contributes to smoother operation, improved fuel efficiency, and greater reliability for the vehicle.

VII. RESULTS

In this section, we delve into the experimental results of the proposed Engine Oil Monitoring (EOM) System utilizing an IoT network, evaluating its efficiency. For the experimental testing of the EOM system, the speed is varied from 0 to 3000 km for the two-wheeler and monitored the engine oil status, categorizing it as Good, Moderated, or Degraded. As the covered distance increases, it is observed that there is acor responding decrease in oil level within the engine, alongside degradation in oil quality. The experimentation of the EOM system was meticulously evaluated under different conditions of the two-wheeler, yielding comprehensive insights into its performance.

To monitor engine oil quality and level at different kilometer intervals, a combination of sensors such as LDR (Light Dependent Resistor) and ultrasonic sensors can be utilized.

LDR sensors can assess oil quality by measuring its opacity or color, which tends to change as contaminants accumulate or the oil degrades. This change in opacity correlates with the oil's health, allowing for the determination of its quality level. Meanwhile, ultrasonic sensors can measure the oil level by emitting sound waves into the oil reservoir and calculating the time it takes for the waves to bounce back. The time delay corresponds to the oil level, providing an accurate reading. These sensors would be integrated into the vehicle's onboard monitoring system. At specific kilometer intervals, the sensors would activate, taking readings of both oil quality and level. The data collected would then be analyzed by the vehicle's computer, which would determine the status of the oil based on predefined thresholds or criteria.

For instance, at 0 kilometers, both oil quality and level might be considered good. As the kilometers increase, the sensors would detect changes in oil quality and level, flagging any deviations from the established norms. This could trigger maintenance alerts or recommendations for an oil change. Table I presents a comprehensive overview of the Engine Oil

TABLE I
ENGINE OIL STATUS

Sample(KM)	Oil quality	Oil level	Status of oil
0	930	47	Good
500	816	43	Good
1000	750	41	Good
1500	540	36	Moderate
2000	416	34	Moderate
2500	370	33	Degraded
3000	370	33	Degraded

Monitoring (EOM) system's performance, detailing various parameters observed at different sample intervals. Each row represents a specific sample interval, denoted by the distance covered in kilometers (KM). The ”oil quality” column indicates the measured quality of the engine oil, typically represented by a numerical value obtained from the sensor readings. Higher numerical values typically correspond to better oil quality, while lower values may indicate degradation. Similarly, the ”oil level” column depicts the measured oil level within the engine, usually represented in units such as millimeters or percentage. A decrease in oil level over consecutive intervals may signify oil consumption or leakage. The ”status of oil” column provides a qualitative assessment of the engine oil condition based on the measured parameters. This assessment categorizes the oil condition into three categories: ”Good,” ”Moderate,” or ”Degraded.” These classifications help identify the overall health of the engine oil and inform

maintenance decisions.
Overall, the table serves as a concise summary of the EOM system's monitoring capabilities, illustrating how oil quality and level evolve over time with vehicle usage. By analyzing these data points, users can make informed decisions regarding oil maintenance and replacement intervals, ultimately contributing to the efficient operation and longevity of the engine.

A comparison between the conventional engine oil monitoring system and the designed EOM system reveals the following:

Comparison Factors	Conventional System	EOM System
Oil quantity measurement	Manual and estimated	Automatically and according to condition of lubricant.
Oil test time	Manual and take about 10 to 20 minutes	Automatically and take about less than 1 minutes.
Quantity estimation	Approximately	Automatically when needed
Oil heath	May be more degraded	Not dangerous
Costs	The cost of conventional system is high	Reduce the use of the labor, so the cost is low
Power consumption	High	Low

Fig. 8. Conventional and Proposed EOM system Comparison

The table demonstrates that EOM systems outperform conventional systems.

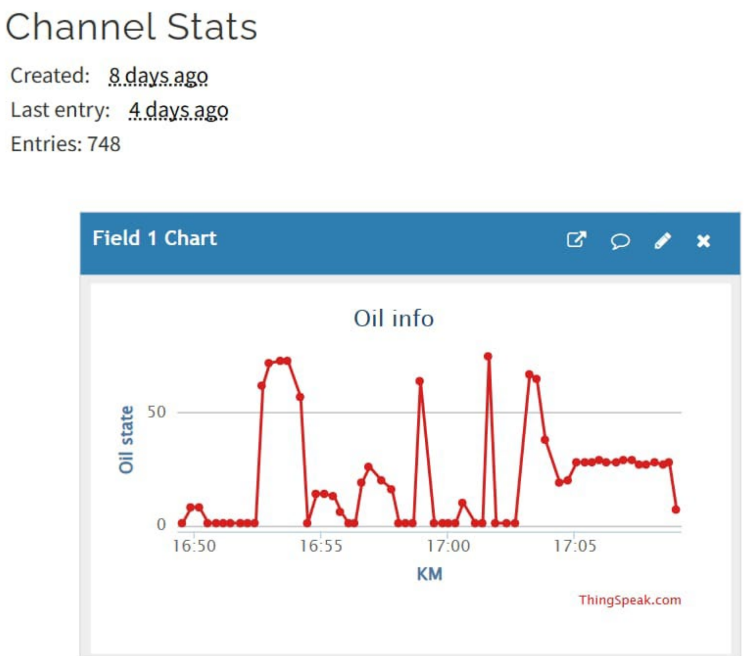

Fig. 9. Graphical representation

A graphical representation as depicted in Fig. 9 showcases the trend of oil degradation over time. As kilometers increase, oil quality typically declines due to accumulation of contaminants and degradation of additives. The graph may show a gradual decline in oil quality, with intermittent maintenance intervals indicating oil changes. A sudden drop in quality could signify abnormal conditions or issues requiring attention. This visual depiction aids in understanding the relationship between oil condition and vehicle usage, facilitating timely maintenance and ensuring optimal engine performance and longevity.

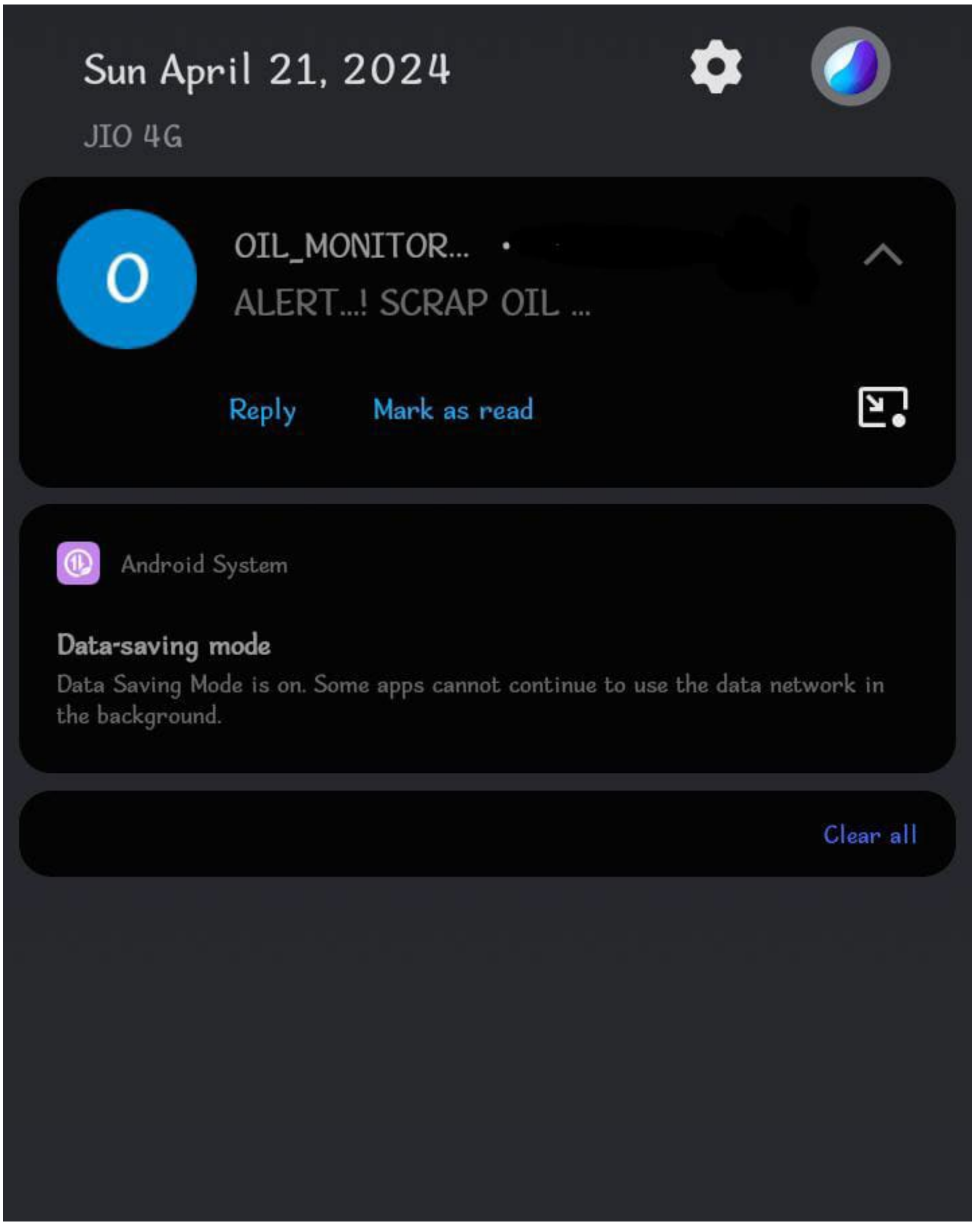

Fig. 10. Pop-up message

A pop-up message is generated and communicated to user's mobile to alert the driver or technician of scrap oil detection. As illustrated in Fig. 10 and Fig. 11, this message would indicate that the oil has reached a critical level of degradation or contamination, necessary for immediate attention or an oil change. By promptly notifying the user, this pop-up message helps prevent further damage to the engine and ensures that necessary maintenance tasks are performed in a timely manner, enhancing overall vehicle reliability and performance.

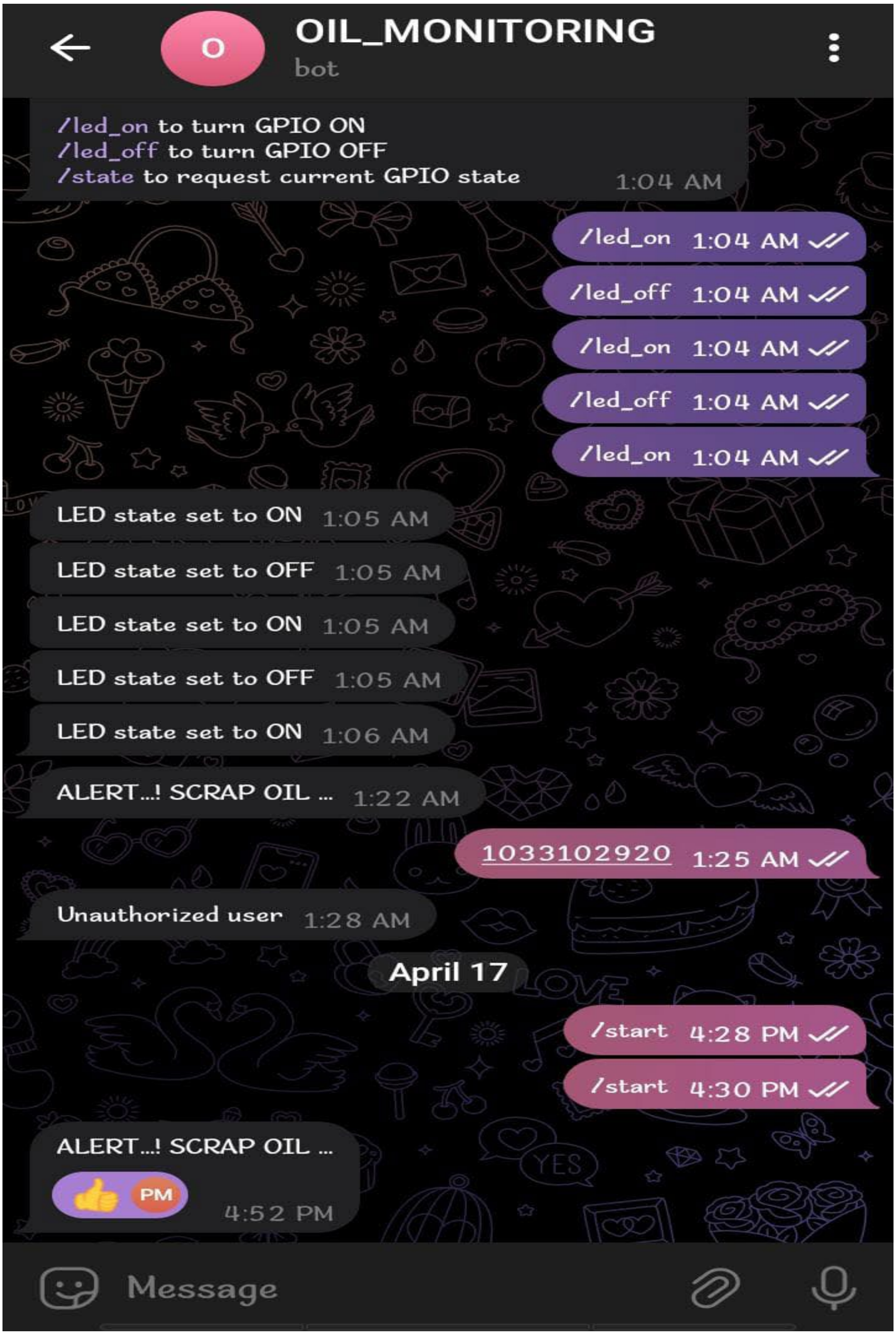

Fig. 11. Chat bot

VIII. CONCLUSION

The conventional method used to design and implement automated oil monitoring systems has proven economically superior but imprecise, leading to minor difficulties and losses in the automobile industry. In the proposed work, a real-time prototype Engine Oil Monitoring (EOM) system utilizing an IoT network is proposed, demonstrating improved efficiency through the use of cost-effective and reliable sensor devices for detecting engine oil condition and level relative to vehicle distance covered. The developed EOM system successfully transmits measured values via the IoT network, displaying them on smart device units. The output resolution of the proposed EOM system meets satisfactory levels, and engine oil data can be remotely accessed through the IoT network. Looking ahead, the future trend of automated engine oil monitoring systems will likely integrate deep learning as a classifier to train the IoT network based on sensor device information, enabling faster response times, particularly for heavy vehicles.

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