IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 3, April 2026
Impact Factor: 8.2

IoT-Based Fuel Theft Detection, Vehicle Tracking, And Accident Detection System

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Abstract: *The IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System is a smart and efficient vehicle monitoring solution developed using Internet of Things (IoT) technology. The main purpose of this system is to improve vehicle safety, security, and fuel management by integrating multiple functions into a single embedded platform. The system is designed using an ESP32 microcontroller as the central processing unit, which is interfaced with an ultrasonic fuel level sensor, GPS module, GSM module, ADXL345 accelerometer, LCD display, and buzzer. The project focuses on solving common vehicle-related problems such as fuel theft, lack of real-time tracking, and delayed accident reporting.*

The fuel level sensor continuously monitors the amount of fuel present in the vehicle tank and detects any sudden or unauthorized decrease in fuel level. If the system identifies an abnormal drop beyond the predefined threshold, it interprets the event as possible fuel theft and immediately triggers an alert. At the same time, the GPS module provides the exact real- time location of the vehicle in the form of latitude and longitude coordinates. This location data is included in the alert message and helps the owner or fleet operator identify the exact position of the vehicle during theft or emergency situations

Keywords: *IoT, ESP32, Fuel Theft Detection, Vehicle Tracking, Accident Detection, GPS Module, GSM Module, ADXL345, Ultrasonic Sensor, Smart Vehicle Monitoring*

I. INTRODUCTION

Transportation has become an essential part of daily life as well as commercial operations. With the increasing use of vehicles in logistics, public transport, and personal travel, issues related to vehicle safety and security are also increasing. Problems such as fuel theft, vehicle misuse, and road accidents cause serious financial loss and safety risks. Conventional monitoring methods are mostly manual and do not provide real-time information, which makes them less effective in today's fast-moving environment [1][2].

Fuel theft is one of the major concerns in transport and fleet vehicles. In many cases, fuel is stolen without the knowledge of the owner, leading to higher operating costs and reduced efficiency. Similarly, road accidents often become more dangerous due to delays in reporting and emergency response. At the same time, vehicle owners and fleet managers also need a reliable way to know the exact location of the vehicle at any moment for better security and management [3][4].

The development of Internet of Things (IoT) technology has made it possible to solve these issues through smart and connected systems. By using sensors, communication modules, and microcontrollers, a vehicle can be monitored continuously in real time. IoT-based systems can collect live data, process it, and send alerts immediately whenever an abnormal condition is detected [5][6].

The proposed IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System is designed to provide a complete monitoring solution in a single setup. The system uses an ESP32 microcontroller along with a fuel level sensor, GPS module, GSM module, and ADXL345 accelerometer. It can detect sudden fuel loss, track the live

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location of the vehicle, and identify accident conditions automatically. When any emergency occurs, the system sends an alert message along with the vehicle location to the registered user [7][8].

This project is useful for both personal vehicles and commercial fleets because it improves safety, reduces fuel- related losses, and supports quick emergency response. It is also low-cost, compact, and easy to implement, making it suitable for modern smart vehicle applications [9][10]. The project therefore provides a practical and effective approach to enhancing vehicle security and monitoring using IoT technology.

II. PROBLEM STATEMENT

In the present transportation system, vehicle owners and fleet operators face several challenges related to fuel security, accident response, and real-time vehicle monitoring. One of the major problems is fuel theft, which often occurs during parking, transit, or unauthorized handling of the vehicle. Since traditional fuel monitoring methods are mostly manual, it becomes difficult to identify sudden fuel loss immediately, resulting in financial losses and poor fuel management. Another serious issue is the lack of a reliable accident detection and alert system. In many cases, road accidents are not reported instantly, which delays emergency response and increases the risk to the driver and passengers. Without an automatic alert mechanism, valuable time may be lost in informing family members, vehicle owners, or emergency services.

III. OBJECTIVES

- To continuously monitor the fuel level in the vehicle tank and identify sudden or unauthorized fuel loss.
- To detect possible fuel theft and immediately generate an alert to inform the vehicle owner or concerned authority.
- To track the real-time location of the vehicle using GPS technology for better security and monitoring.
- To detect accidents automatically using motion and vibration sensing for improved passenger and vehicle safety.
- To send instant alert messages with location details through GSM communication during theft or accident conditions.

IV. LITERATURE SURVEY

Sanketh B. Prabhu et al. (2022), in the paper "IoT Enabled Fuel Level Monitoring and Automatic Fuel Theft Detection System," proposed an IoT-based fuel monitoring system developed to reduce fuel theft and improve vehicle security. The system continuously monitors the fuel level using sensors and detects sudden drops in fuel quantity in real time. An ESP32 microcontroller is used as the main control unit to process sensor data and generate alerts during suspicious fuel loss. The system also integrates GPS and GSM modules to track vehicle location and send notifications to the vehicle owner. The proposed model improves fuel management, minimizes unauthorized fuel removal, and enhances the overall reliability of vehicle monitoring systems.

N. Yamini (2020), in the paper "Smart IoT Based System for Monitoring and Detecting Fuel Theft," presented a smart monitoring system designed to identify abnormal fuel level changes and improve fuel security in vehicles. The system uses IoT technology to monitor fuel level before and after usage and compares the readings to detect theft or irregular fuel consumption. A microcontroller-based unit is used to process the collected data and trigger alert messages whenever suspicious activity is found. The system also supports vehicle location tracking and remote monitoring, making it useful for fleet management applications. The proposed approach improves transparency, reduces manual checking, and supports efficient fuel usage analysis.

Dibyendu Sur et al. (2021), in the paper "IoT Based Fuel Level Monitoring and Fuel Theft Detection System," proposed a real-time fuel monitoring system that helps detect unauthorized fuel loss using sensor-based measurement techniques. The system continuously reads the fuel level and compares it with predefined threshold values to identify unusual drops that may indicate theft. A microcontroller is used to process the sensor data and generate warning alerts whenever abnormal behavior is detected. The system is designed to improve fuel security, reduce financial losses, and support remote monitoring of vehicle fuel status. The model also provides a simple and low-cost solution for modern transportation and fleet management systems.

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Sun J. et al. (2016), in the paper "The Intelligent Crude Oil Anti-Theft System Based on IoT," proposed an intelligent IoT-based anti-theft system for monitoring fuel and oil transfer conditions. Although the study mainly focuses on crude oil pipeline protection, the concepts are highly relevant to vehicle fuel theft detection systems. The system uses multiple sensing techniques to identify abnormal activity, leakage, or theft conditions and generates real-time alerts. A control unit continuously analyzes the sensor data and initiates immediate response actions whenever suspicious conditions are found. The proposed method improves safety, reduces losses, and demonstrates the effectiveness of IoT in fuel monitoring applications.

S. Patel and V. Desai (2021), in the paper "Real-Time Vehicle Tracking and Accident Detection System Using IoT," proposed an advanced IoT-based vehicle safety system that combines live vehicle tracking and accident detection features. The system uses a GPS module to obtain the real-time location of the vehicle and an accelerometer sensor to detect sudden impact, vibration, or abnormal motion during accidents. A microcontroller-based system processes the sensor data and immediately sends alert messages through a GSM communication module. The proposed system improves emergency response time, enhances vehicle safety, and provides accurate location information during critical situations.

Comparison Table

Author & Year	Technology Used	Key Feature	Limitation
Sanketh B. Prabhu et al. (2022)	ESP32, Fuel Sensor, GPS, GSM, IoT	Real-time fuel theft detection and alert	Sensor accuracy may vary
N. Yamini (2020)	IoT, Fuel Monitoring Sensor, GPS	Detects abnormal fuel changes	Limited accident detection
Dibyendu Sur et al. (2021)	Fuel Sensor, Microcontroller, IoT	Threshold-based fuel theft monitoring	No advanced tracking support
S. Patel and V. Desai (2021)	GPS, GSM, Accelerometer, IoT	Vehicle tracking and accident alert	Does not focus on fuel theft
M. Verma and P. Joshi (2020)	IoT, Fuel Sensor, Motion Sensor, GPS	Combined safety and fuel management	System complexity is high

IV. WORKING OF SYSTEM

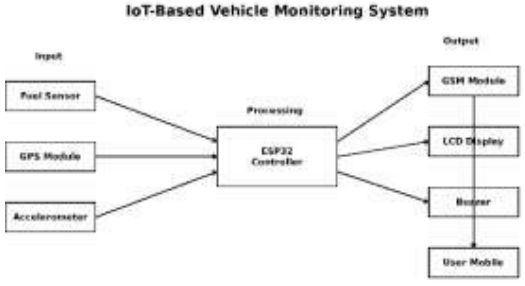

Fig 1: Design of the system

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The IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System works by continuously monitoring the vehicle using multiple sensors and communication modules. The ESP32 microcontroller acts as the central control unit of the system and processes all incoming sensor data.

The fuel level sensor is used to measure the fuel quantity inside the tank. It continuously checks the fuel level and sends the readings to the ESP32. If the system detects a sudden drop in fuel beyond the predefined threshold, it identifies the condition as possible fuel theft and immediately activates the alert mechanism.

The GPS module continuously tracks the real-time location of the vehicle by receiving signals from satellites. It provides accurate latitude and longitude coordinates, which are sent to the ESP32. This location data is used whenever the system needs to send an alert to the vehicle owner.

The ADXL345 accelerometer sensor is used for accident detection. It monitors sudden vibration, tilt, and impact of the vehicle. If abnormal movement or collision is detected, the ESP32 interprets it as an accident condition and initiates emergency response.

Whenever fuel theft or an accident is detected, the GSM module is activated. It sends an SMS alert and can also make a phone call to the registered mobile number. The alert includes the vehicle status and current GPS location, helping the owner or emergency contacts respond quickly. The LCD display shows real-time information such as fuel percentage, system status, and alert messages, while the buzzer provides an immediate local warning signal. In this way, the complete system works automatically to improve vehicle safety, fuel security, and live monitoring.

V. SYSTEM DESIGN

The IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System is designed as a smart embedded system that continuously monitors the vehicle using sensors and communication modules. The system is mainly divided into input section, processing section, and output section. All components are interconnected through the ESP32 microcontroller, which controls the complete operation of the system.

5.1 Components Used in System Design

1) ESP32 Microcontroller

The ESP32 is the main controller of the system. It receives data from all sensors, processes it, and gives output to different modules. It acts as the brain of the project and controls fuel monitoring, accident detection, GPS tracking, and alert generation.

Fig.2.ESP32

Function

Reads sensor values

Processes data

Controls GSM, GPS, LCD, and buzzer Makes decisions based on system conditions

2) Fuel Level Sensor

The fuel level sensor is used to measure the amount of fuel present inside the fuel tank. It continuously checks the fuel level and sends the data to the ESP32. If there is a sudden drop in fuel, the system identifies it as a possible fuel theft condition.

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Fig.3. Fuel Level Sensor

Function
Measures fuel level
Detects sudden fuel decrease
Helps in theft detection

3) GPS Module (Neo-6M)

The GPS module is used to track the real-time location of the vehicle. It receives satellite signals and provides the latitude and longitude coordinates of the vehicle. This location is sent along with alert messages during theft or accident conditions.

Function
Detects vibration and tilt
Identifies accident conditions
Improves vehicle safety

Fig.4.GPS Module (Neo-6M)

4) GSM Module (SIM800L)

The GSM module is used for communication purposes. It sends SMS alerts and can also make a phone call to the vehicle owner when fuel theft or accident is detected. It acts as the communication link between the system and the user.

Fig.5. GSM Module (SIM800L)

Function
Sends SMS alerts Makes emergency calls

5) ADXL345 Accelerometer

The ADXL345 accelerometer is used for accident detection. It continuously monitors motion, vibration, and tilt of the vehicle. If a sudden impact or abnormal movement is detected, the system considers it as an accident and generates an alert.

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Fig.6. ADXL345 Accelerometer

6) LCD Display (16x2 with I2C)

The LCD display is used to show the current system status and real-time data. It displays information such as fuel percentage, alert condition, and system messages.

Function

Tracks vehicle location Provides real-time coordinates

Helps in vehicle monitoring and alert location sharing

Fig.7. LCD Display (16x2 with I2C)

Function

Displays fuel level Shows system status

Provides visual output to user

7) Buzzer

The buzzer is used as an audible alert device. Whenever the system detects theft or accident, the buzzer gives a warning sound to indicate emergency conditions.

Function

Gives local alert sound

Warns during emergency situations

8) Power Supply

The power supply provides the required voltage and current to all components in the system. It ensures proper and stable operation of the entire circuit.

Function

Supplies power to all modules Maintains stable operation of system

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VI. RESULTS

The IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System was successfully designed, implemented, and tested under different working conditions. The system performed effectively in monitoring fuel level, tracking vehicle location, and detecting accident situations in real time. All hardware modules such as the ESP32 microcontroller, fuel sensor, GPS module, GSM module, ADXL345 accelerometer, LCD display, and buzzer worked properly in coordination and produced the expected output. During testing, the fuel level sensor continuously monitored the fuel level and accurately detected sudden decreases in fuel quantity. When the fuel level dropped beyond the predefined threshold, the system identified it as a fuel theft condition and immediately generated an alert. The GSM module successfully sent an SMS notification to the registered mobile number, confirming the proper functioning of the fuel theft detection feature.

The GPS module was able to receive and provide the real- time location of the vehicle in the form of latitude and longitude. This location information was successfully included in the alert messages sent to the user. The tracking feature helped in identifying the exact position of the vehicle during simulated theft and emergency conditions.

The ADXL345 accelerometer successfully detected sudden vibration, impact, and abnormal movement during accident simulation. When the sensor values crossed the set threshold, the system identified the condition as an accident event and triggered an emergency alert. The GSM module then sent an SMS alert and also initiated a call to the registered user, proving the effectiveness of the accident detection and emergency response mechanism.

The LCD display showed useful real-time information such as fuel percentage, system status, and warning messages. The buzzer also provided an audible alert during emergency conditions, which improved the local warning capability of the system.

Overall, the system showed stable, reliable, and accurate performance during testing. The results confirm that the project is capable of reducing fuel theft, improving vehicle security, and enhancing passenger safety through real-time monitoring and alert generation.

VII. CONCLUSION

The IoT-Based Fuel Theft Detection, Vehicle Tracking, and Accident Detection System has been successfully designed and implemented as a smart vehicle monitoring solution. The system effectively integrates multiple functionalities such as fuel level monitoring, real-time location tracking, and accident detection into a single platform using the ESP32 microcontroller and various sensors.

The project successfully detects fuel theft by identifying sudden drops in fuel level and immediately sends alerts to the vehicle owner. It also provides accurate real-time tracking of the vehicle using the GPS module, which enhances vehicle security and management. In addition, the system improves safety by detecting accidents through the accelerometer sensor and sending emergency alerts with location details.

The use of GSM communication ensures that alerts are delivered instantly, helping in quick response during critical situations. The system is cost-effective, reliable, and easy to implement, making it suitable for both personal vehicles and commercial fleet applications. It reduces manual monitoring, minimizes fuel loss, and enhances overall vehicle safety. In conclusion, the developed system provides a practical and efficient solution for modern vehicle monitoring challenges and demonstrates the effective use of IoT technology in improving transportation safety and security.

VIII. FUTURE SCOPE

The proposed system can be further improved and enhanced with advanced features to increase its efficiency and usability. In the future, the system can be integrated with cloud platforms to store and analyze vehicle data remotely. This will allow users to monitor fuel usage, vehicle history, and alerts through a web or mobile application.

A dedicated mobile application can be developed to provide real-time notifications, live tracking on maps, and better user interaction. The system can also be enhanced using machine learning techniques to analyze fuel consumption patterns and detect suspicious activities more accurately, reducing false alerts.

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Additional features such as engine health monitoring, temperature sensing, speed tracking, and driver behavior analysis can be added to make the system more advanced and suitable for smart transportation systems. The accident detection system can also be improved by directly notifying emergency services such as hospitals or police for faster response.

Furthermore, the system can be upgraded using IoT dashboards (like Blynk or ThingSpeak) for real-time online monitoring and visualization. The design can also be miniaturized and made more robust for industrial and commercial deployment.

Thus, the project has wide future scope and can be developed into a complete smart vehicle safety and monitoring system with advanced automation and intelligent features.

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