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Smart Tire Pressure Monitoring & Emergency Alert System Using IoT

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***Abstract*— Vehicle safety is a major challenge, and tire pressure monitoring is essential for preventing accidents caused by underinflated or overinflated tires. This work proposes an automated Smart Tire Pressure Monitoring System (TPMS) that uses pressure sensors, a vibration sensor, GSM, GPS, and IoT to monitor tire pressure and temperature in real time. The device includes an Arduino microcontroller that continuously tracks tire conditions and sends notifications when irregularities are detected. When a tire bursts or there are other issues, GPS tracking helps locate the car, and a GSM module notifies the car caretaker of the situation. Along with a smartphone application that suggests local puncture repair shops, the device also has an OLED display for real-time information. In addition, a temperature sensor detects excessive heat in the tire, lowering the risk of fire cause by friction. By providing real-time notifications, automated emergency response, and remote monitoring through cloud connectivity, this IoT-based TPMS improves road safety. By providing intelligent tire health management, automated vehicle speed adjustments, and instant notifications, the suggested solution performs better than existing methods and guarantees a safer driving experience.**

Keywords— TPMS, GSM (Global System for Mobile Communication), GPS (Global Positioning System), IoT (Internet of Things), OLED (Organic Light-Emitting Diode)

I. INTRODUCTION

A common cause of road accidents is tire failures, which can be caused on by incorrect air pressure, overheating, and undetected punctures.

Vehicles are susceptible to unexpected tire failures because traditional tire pressure monitoring depends on manual checks or simple sensors that only offer limited real-time notifications. In order to solve this, we suggest a Smart Tire Pressure Monitoring and Emergency Alert System that incorporates an automatic speed control system, GSM, GPS, pressure sensors, a vibration sensor, and an Internet of Things cloud system. Tire temperature and pressure are continually monitored by the system, which shows data in real time on an OLED panel. It notifies the car's caregiver via GSM if there is low pressure or overheating. A vibration sensor recognizes the irregularity and transmits the car's GPS position in the event of a tire rupture, guaranteeing prompt help. In order to avoid collisions, the technology also automatically lowers the speed of the car in dangerous situations. Our technology provides real-time cloud monitoring, GPS tracking, emergency alarms, and repair shop suggestions via an Android application, in contrast to traditional Tire Pressure Monitoring Systems (TPMS). This solution improves fuel efficiency, lowers maintenance costs, and increases road safety by combining embedded technologies with the Internet of Things.

II. EXISTING SYSTEM

A. Manual Tire Inspection

- **Method:** Drivers or technicians manually check tire pressure using mechanical gauges.
- **Drawback:** Time-consuming, lacks real-time monitoring, and relies on periodic checks.

B. Indirect TPMS

- **Method:** Uses vehicle's **ABS (Anti-lock Braking System)** to detect differences in tire rotation speed due to low pressure.
- **Drawback: Less accurate**, does not detect slow air leaks, and requires calibration.

C. Direct TPMS

- **Method:** Uses pressure sensors installed on each tire to measure air pressure and send wireless signals to the vehicle's dashboard.
- **Drawback: Limited to in-car monitoring**, lacks emergency response and IoT connectivity.

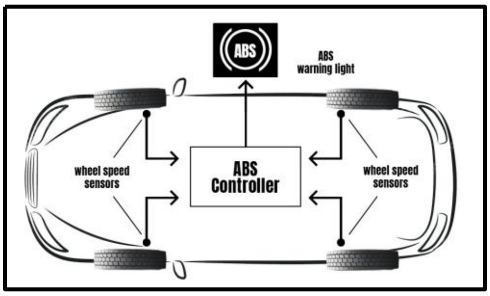


Fig 1. Indirect TPMS

III. PROPOSED WORK

A. Tire Pressure Monitoring

Tire pressure is continuously measured by sensors, sending the data to an Arduino. A GSM alert is sent and a red LED blinks if the pressure falls below the threshold.

B. Tire Burst and Emergency Response

When a vibration sensor detects a burst, GPS sends an emergency SMS. To stop further damage, the vehicle's speed is immediately decreased.

C. IoT-Based Cloud Monitoring

For remote monitoring, tire temperature and pressure readings are sent to the cloud. A online dashboard gives vehicle owners the ability to access real-time data.

D. Android Application

The software uses GPS location to recommend local puncture repair services in the event of a tire blowout. It also has a user dashboard where the user can access details of tire pressure and it also provides the previous puncture details of each tire.

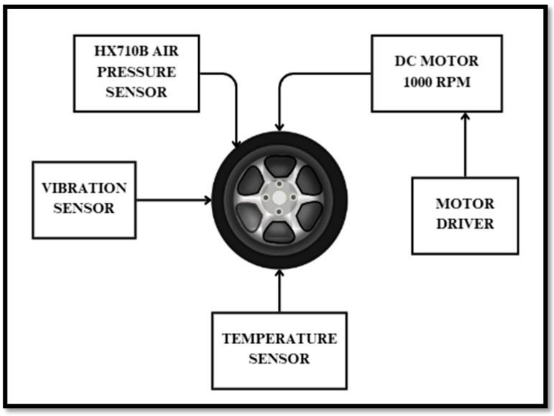


Fig 2. Sensors connected to tire

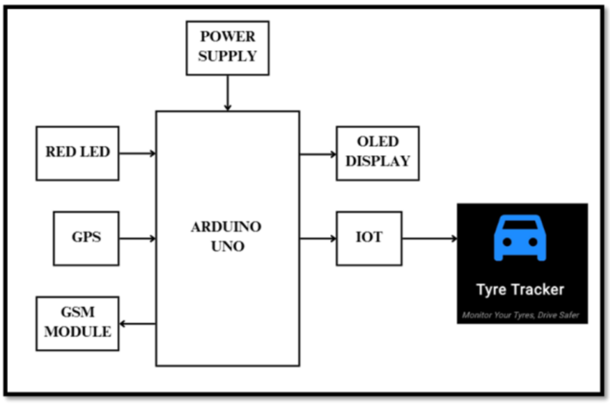
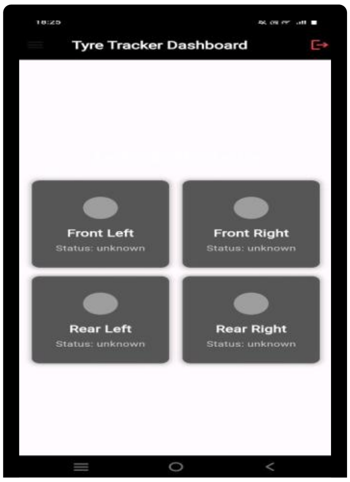


Fig 3. Real-Time Monitoring & Display

The proposed system includes various sensors, an Arduino Uno microcontroller, GSM and GPS modules, an OLED display, and a real-time monitoring Android app. A temperature sensor to prevent fire accidents by monitoring excessive tire heating, a vibration sensor to detect tire bursts or blowouts, and the HX710B pressure sensors for continuous tire pressure monitoring are some of the sensors whose data are managed by the Arduino Uno, which acts as the central controller. In case of an emergency, the GPS module gets the location of the automobile, while the GSM module notifies the caretaker by SMS. Real-time tire pressure updates are shown on an OLED display, and a DC motor with a motor driver controls the speed of the vehicle in response to tire conditions. An Android app recommends local repair providers in case of puncture. The app is designed using Flutter in which we also included the dashboard where the pressure of the tires are displayed with their names like front left or right and back left or right.

Also, cloud-based monitoring by IoT connectivity gives remote access to tire condition information. Additionally, the system has an automatic speed control system that slows vehicle speed in case of unsafe low tire pressure and temperature sensors to avoid fire threats caused by warming tires & friction. This technology improves road safety by providing real-time monitoring, quick notifications, emergency tracking, and cloud-based analysis. It also significantly reduces the risk of tire-related accidents.



IV. COMPARISON OF EXISTING SYSTEM & PROPOSED SYSTEM

Feature	Manual Check	Indirect TPMS	Direct TPMS	Proposed System
Real-Time Monitoring	✗	✗	✓	✓✓
Immediate Alerts (GSM)	✗	✗	✗	✓
Vibration-Based Burst Detection	✗	✗	✗	✓
GPS Tracking	✗	✗	✗	✓
Cloud-Based Monitoring	✗	✗	✗	✓
Temperature Sensing for Fire Prevention	✗	✗	✗	✓

The drawbacks of manual checkups, indirect TPMS, and direct TPMS are addressed by this System, which improves vehicle safety. Indirect TPMS depends on wheel speed sensors and is unable to reliably identify slow leaks, but traditional manual inspections are difficult, possible human mistake, and lack real-time alarms. Although Direct TPMS does not include GPS tracking, remote alerts, or IoT connectivity, it does employ pressure sensors for monitoring. By employing HX710B air pressure sensors to monitor tire pressure and displaying data on an OLED, the proposed system overcomes these drawbacks. A red LED blinks and a GSM SMS alert is delivered to the caretaker in the case of abnormalities. An emergency warning with real-time GPS position is sent when a vibration sensor detects tire burst, which helps quick assistance.

V. OBSERVATION & RESULTS

To evaluate its performance and reliability, the Smart Tire Pressure Monitoring and Emergency Alert System was tested undermany types of real-time tests. Parameters including GPS tracking accuracy, emergency alarm reaction time, pressure sensor accuracy, and IoT-based cloud data updates were used to evaluate the system.

Test Condition	Expected Outcome	Actual Result
Tire pressure drops below the threshold	Red LED glows, SMS alert sent to caretaker via GSM	✅ Obtained Output
Tire burst detected	Vibration sensor triggers GSM emergency SMS, GPS tracks vehicle location	✅ Achieved
High tire temperature detected	SMS alert sent via GSM, vehicle speed adjusted	✅ Verified
Tire pressure displayed on OLED and Android app	Real-time pressure readings shown on OLED and app	✅ Expected Outcome Met
Cloud data update	Tire status visible on web dashboard for remote monitoring	✅ Confirmed

Fig 4. Android Application - Dashboard

Table 2. System testing & performance analysis

RESULTS:

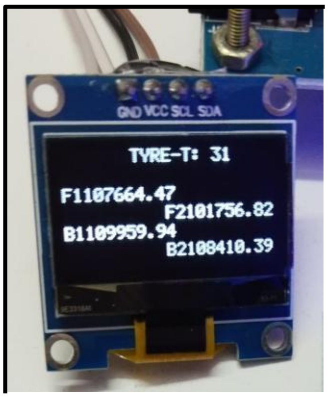


Fig 5. OLED output of tire pressure

The output of tire pressure measured by the pressure sensor and temperature measured by DHT11 sensor are displayed on the OLED. Where F1,F2 are front tire values and B1,B2 are back tire values of the automobile.

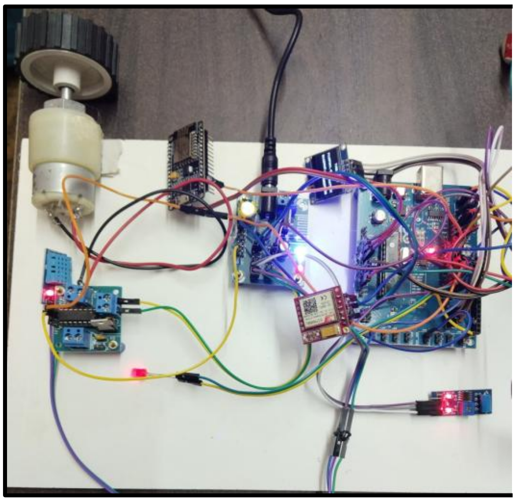


Fig 6. Prototype Output

When the vibration sensor detects the abnormality from tire it gradually reduces the speed of the vehicle and sends SMS to the concerned mobile number regarding the accident through GSM module. The LED glows when there is Low pressure detected in any of the tire.

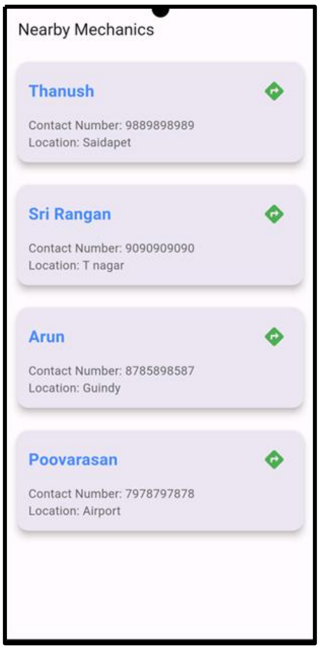


Fig 7. Android application output - Nearby mechanics

It requests for the location access, once provided it navigates to the google maps where we can locate our nearest puncture shop that we prefer. The GPS provides real time navigation and we can easily locate the prefered location.

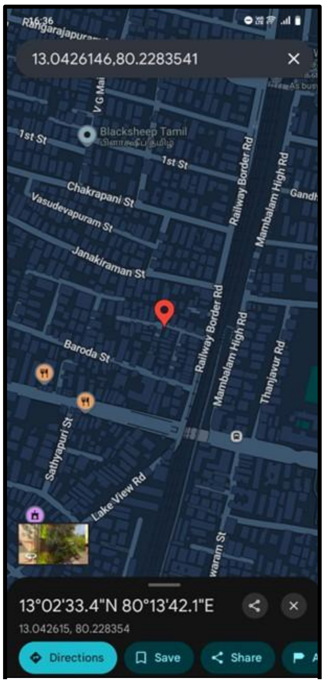


Fig 8. Location through GPS

VI. CONCLUSION

Tire-related issues, such low pressure, sudden bursts, and overheating, are major causes of road accidents because they create vehicle instability and may even be dangerous. By providing real-time monitoring, immediate notifications, and GPS tracking to improve vehicle safety, the Smart Tire Pressure Monitoring and Emergency Alert System provides an innovative solution. Using HX710B air pressure sensors, a vibration sensor, and a temperature sensor, the system continuously tracks tire health. It displays real-time pressure values on an OLED screen and an Android app, enabling drivers to monitor tire conditions remotely. The GSM module gives emergency alerts and the red LED indication provides an immediate warning in case of unusual pressure levels. If a tire bursts out, the vibration sensor senses the impact and the GPS module sends the vehicle's location for immediate help. Predictive maintenance using cloud-based data logging is made possible by the integration of internet of things (IoT) technology. The system's efficiency and reliability were shown through testing in various situations. Emergency alerts and location tracking worked well, and the OLED and app displayed correct values. Compared to manual checks, this automated system provides faster detection and response. In conclusion, an accurate and proactive method for vehicle safety is provided by this smart tire pressure monitoring system.

Road safety and driving efficiency are greatly improved by preventing tire-related incidents through real-time tracking and emergency action. Roads can become safer for everyone if this technology is widely used since it can prevent deaths and lower accident rates by providing timely alerts.

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