

# Vehicle Safety implementing tyre pressure monitoring system For Maharashtra State Road Transport Corporation

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## 1. INTRODUCTION

Maharashtra State Road Transport Corporation state has made many improvements in vehicle safety in the recent past. One such fast growing application is the Tyre Pressure Monitoring System (TPMS).

A tyre can lose about half of its air pressure without appearing to be under inflated. [3] Apart from causing a higher risk of accidents due to loss of control, improper pressure in tyre also leads to tyre damage and ultimately leads to faster replacement.

According to MSRTC more than 250 deaths occur on our country's roads every day and also 75% of vehicles run on incorrect tyre pressure. Apart from causing a higher risk of accidents due to loss of control, improper pressure in tyre also leads to tyre damage and ultimately leads to faster replacement. Additionally, under-inflated tyres have increased rolling resistance requiring more fuel to maintain the same speed thus affecting fuel efficiency.

TPMS is an electronic safety system that is used to monitor the air pressure inside the tyres of a vehicle and provide the driver with proper warning signal on the mobile application. Application is connected with the using Bluetooth. Thus, it can be referred as a Driver Assist System [3].

[4] The monitoring system is carried out to monitor all activities that occur at a time deemed important to be safeguarded. Therefore, it is necessary for to be informed about the tyre pressure to ensure the vehicle's safety performance at a high velocity.

Motorized vehicle consists of a sensor module mounted on a vehicle's tyre valve and an attached receiver module. This sensor module is responsible for monitoring the pressure on the tyre, afterwards, the tyre pressure data is sent to the receiver module wirelessly through Bluetooth.

Meanwhile, the receiver module serves as the recipient of the data which are subsequently processed in order that it can be displayed on the mobile application to inform the user.

## 2. Existing Systems

Nowadays most of the products of TPMS sold in the market, which is costly and sometimes inefficient. As such, there is a high demand for cheap and efficient TPMS. So, to fulfill this demand, we developed tyre pressure monitoring system, which could meet this demand, i.e. cheap and efficient TPMS system. Most of the Drivers ignore their tyres.

Greatest risk of being involved in a fatigue related accident are:

1. Improper pressure
2. Young Drivers.

## 3. OBJECTIVES

1. Implement Dynamic tyre pressure monitoring, usage of Bluetooth technology, using BLE network to send data from the Esp32 module to the mobile application.
2. Continuous monitoring of tyre parameters in the mobile application.

3. Providing alerts about improper tyre pressure.

4. Reduce power consumption by invoking the transmitter only when data is needed and sending warning message to the MSRTC depo using mobile application.

5. Increases safety, comfort and fuel efficiency of the vehicle.

#### 4. Advantages of TPMS

- Deliver actual tyre pressure readings from inside the tyre.
- Not prone to inaccuracies because of tyre rotations or tyre replacements.
- Simple resynchronization after tyre rotation or tyre replacements.
- Batteries inside the sensors usually last for about a decade.
- Monitor up to 64 tyres at a time.
- TPMS units can transmit while vehicles is moving as well as at parked.

#### 5. Methodology

A tyre-pressure monitoring system (TPMS) is an electronic system designed to monitor the air pressure inside the pneumatic tyres on various types of vehicles. [2]A TPMS reports real-time tyre-pressure information to the driver of the vehicle, either via a gauge, a pictogram display, or a simple low-pressure warning light.

TPMS directly measures tyre pressure using hardware sensors. In each wheel, most often on the inside of the valve, there is a battery-driven pressure sensor which transfers pressure information to a central control unit which reports it to the mobile application. Some units also measure and alert temperatures of the tyre as well.

These systems can identify under-inflation for each individual tyre. Although the systems vary in transmitting options, many TPMS products (both OEM and aftermarket) can display real-time, individual tyre pressures whether the vehicle is moving or parked.

TPMS sensor consists of the following main functions requiring only a few external components.

Battery, housing, PCB to get the sensor module that is mounted to the valve stem inside the tyre:

- Pressure sensor CC2500
- Microcontroller Esp32 BLE module.
- Bluetooth transmitter.
- Voltage regulator (battery management).

Most originally fitted TPMS have the sensor mounted on the inside of the rim and the batteries are not exchangeable. A discharged battery means that the tyre must be dismantled in order to replace it, so long battery life is desirable.

To save energy and prolong battery life, many TPMS sensors do not transmit information when parked (which eliminates spare tyre monitoring) or apply a more expensive two-way communication which enables wake-up of the sensor.

For OEM auto TPMS units to work properly, they need to recognize the sensor positions and must ignore the signals from other vehicles.

Aftermarket dTPMS units not only transmit while vehicles are moving or parked, but also provide users with some advanced monitoring options including data logging, remote monitoring options and more. They are available for all types of vehicles, from Bus to heavy equipment, and can monitor up to 64 tyres at a time, which is important for commercial vehicles.

Many aftermarket dTPMS units do not require specialized tools to program or reset, making them much simpler to use.



Fig -1: Transmitter on tyre rim [3]

## 5.1 Mobile application

We are developing the mobile application using flutter app development and Bluetooth technology

Flutter is Google's open-source UI toolkit to develop cross-platform apps using a single codebase. Developers can build seamlessly-performing native apps for iOS, Android, and web platforms with the help of Flutter. UI performance, source code maturities, security tests, and functionalities are some of the challenges that developers have to face while developing the same app for different platforms. Flutter app development can resolve these issues with ease. Flutter apps are written in Dart, Google's object-oriented programming language. Dart was selected by keeping four criteria in mind- Developer productivity, Object orientation, faster allocation, and high performance.

Flutter is an easy-to-use and extremely powerful language for fresh and experienced app developers alike. This language can increase their productivity exponentially and the Flutter app developers can provide a powerful UI experience thanks to Flutter widgets.

## 5.2 Bluetooth Technologies

Bluetooth technology is a wireless system that uses radio waves for communication purposes. It has the capability to communicate with many different devices at once without interface. It is an open standard for short-range transmission of digital voice and the data support from point to point and multiplier to point applications. It has a short-range radio link and the price is also low. When two Bluetooth devices are in a 50 meters range, then they have the connection probability. When the Bluetooth is cut, the cord is used in digital devices. It operates with the speed of 2.45 GHz, which is available in all cases and it has some variations in location and bandwidth. For mobile phones and business users, the range is set at 10 to 100 meters. It is possible to increase the range the speed of the gross data rate is 1bit/s, and the speed of the second generation is increased up to 2bit/s. One-to-one Bluetooth connections are allowed for a maximum speed of data transfer, which is 723 kbit/s. The standby mode is only 0.3 ma and it has low power consumption.

Bluetooth supports wireless point-to-point and point-to-multiple devices in Pico net

A point-to-point link has a master and slave relation and the Bluetooth function is also the same as a master and slave; the figure below shows the master and slave relation.

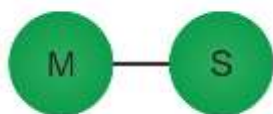


Fig. 2. Point-to-point

Point-to-multiple links is a network function; it functions like a master-to-one or more slaves, but the maximum number of slaves should be 7; the below diagram shows a clear picture of point to multiple links.

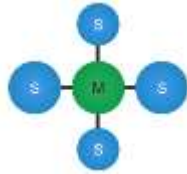


Fig.3.Point-to-multiple

According to the dTPMS and Bluetooth technology each tyre having it separate Esp 32 board with it unique id set by the developer. All this board are connected using the Bluetooth Network CAN communication protocol with the mobile application. Using this application we are fetching the sensor data form the Esp32 module. This packet of data will be transmitted in the JSON format. When if tyre pressure is lower or high form the given threshold than it is should send Alert message will directly to driver's mobile application. From mobile application it we be send to MSRTC depo and store in GCP cloud

### 5.3 Software and Hardware Requirements

- Software Requirements:

1. Flutter app developer
2. Arduino IDE.
3. ESP IDF.
4. Python.
5. GCP (Google cloud platform)

- Hardware Requirements:

1. Pressure sensor CC2500
2. ESP 32 BLE module
3. Latium Battery

### 5.4 Project Modules

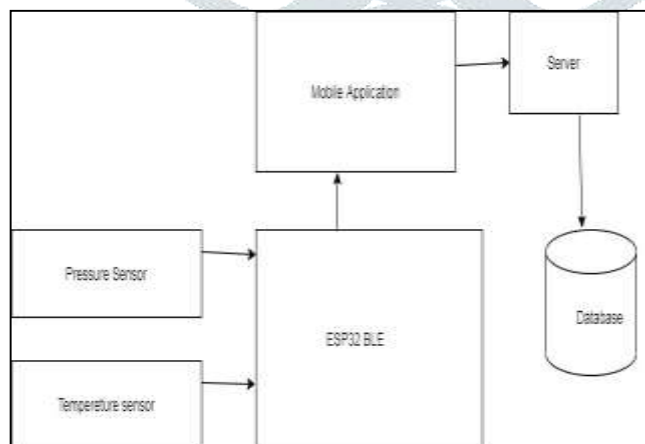
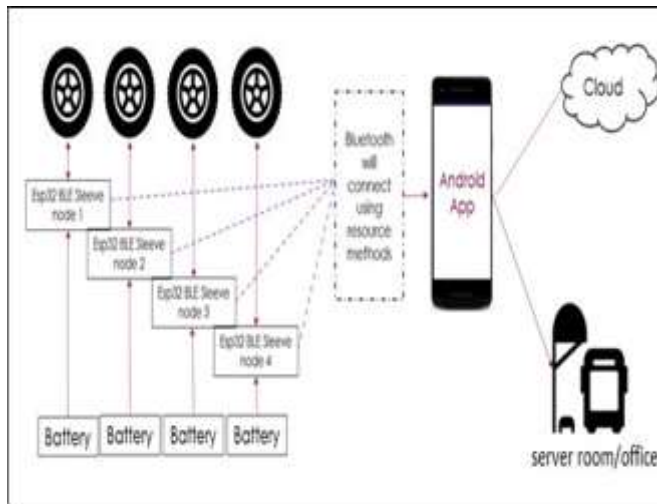


Fig -4: Project modules of TPMS

### 5.3 Architectural Mode



**Fig -5:** Block Diagram of TPMS

According to the dTPMS and Bluetooth technology each tyre having it separate Esp 32 board with it unique id set by the developer [1].

All this board are connected using the Bluetooth Network CAN communication protocol with the mobile application.

Using this application we are fetching the sensor data form the Esp32 module. This packet of data will be transmitted in the JSON format. When if tyre pressure is lower or high form the given threshold than it is should send Alert message will directly to driver's mobile application.

From mobile application it will be send to server room/office and store in GCP cloud All the tyre pressure data are storing in the GCP cloud (Google Cloud Platform) for the future reference.

## 6. CONCLUSIONS

The Tyre pressure monitoring system Integrated circuits along with its other components to measure a real time pressure of the Tyre and displays the values on the App.

This system also alerts the driver and to MSRCT of the pressure when the pressure values reaches below 25% of the required accurate pressure on which the Tyre must operate.

Tyre is an important and essential component of the vehicle and this must be made mandatory in all the vehicle.

Also, this system has many benefits like prevention of road accidents, improves Tyre life, improves the handling of the vehicle and reduces fuel consumption.

## 7. REFERENCES

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- [2] S. Yogashri, S. Jayanthy and A. Rathinavel, "Real Time Tyre Pressure Monitoring System in Automobiles using SPLUNK Enterprise", International Journal of Recent Technology and Engineering (IJRTE), pp. 406-410, June 2019
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- [4] Lukman Medriavin Silalahi<sup>1</sup>, Mudrik Alaydrus<sup>1</sup>, Agus Dendi Rochendi<sup>1</sup> and Muhtar Muhtar<sup>2</sup>, "DESIGN OF TYRE PRESSURE MONITORING SYSTEM USING A PRESSURE SENSOR BASE" SINERGI Vol. 23, pp. 70-78, February 2019