

RESEARCH ARTICLE



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Wireless tyre pressure measurement

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Abstract

Objectives: To create a low-powered, smaller-size vehicle tyre pressure and temperature measuring unit and tracking of sensor values using ESP8266 as a core component in a mobile app. **Methods:** The IoT technique is applied remotely to measure the tyre pressure and temperature sensor. With the aid of Firebase, the mobile app tracks and displays the input signals from the tyre pressure and temperature sensor continuously. This study includes the NodeMCU, MLX90614 temperature sensor and SPD030G pressure sensor to incorporate a direct tyre pressure monitoring system. **Findings:** The setup is in charge of continuously controlling the tyre's pressure and temperature. This will be shown via Firebase on the mobile app. Much like MQTT, the mobile app is linked to firebase. **Novelty/Applications:** The proposed setup is a wireless MQTT-based device designed to transmit data to the Smartphone (Mobile) app, enabling tyre wellbeing to be controlled from anywhere in the globe. It is possible to monitor the pressure and temperature of the tyre wirelessly. No need to use a separate sensor reading controller for wireless communication due to the use of ESP8266. This can be seen in air conditioning devices, BP/health control, and handheld pressure sensors.

Keywords: Direct and indirect TPMS; Node MCU; MLX90614; SPD030G; firebase; MQTT

Introduction

As seen in ⁽¹⁾, the use of a wireless network to track tyre pressure. The pressure sensor senses the pressure inside the tyre and sends it to the unit, and if the pressure is above the threshold, the sound alarm triggers. The transmission of a signal is accomplished through Bluetooth or Wi-Fi. The battery is charged by a wireless power transmission system. The auto-learning sensor ID method using a fuzzy logic algorithm is seen in ⁽²⁾. The inputs of this fuzzy controller are drive time, acceleration data, some spinning messages obtained and conveyance speed, and all this information is processed by the sensors state as the output. The algorithms that use the interframe Spacing Pattern for the Global Identifier to define the position of each tyre were implemented in ⁽³⁾. With different patterns of interframe spacing, the pressure and acceleration sensors are used to convey the frame after receiving the authority to join the channel. Slotted ALOHA

is used after all information is obtained to study the probability of a packet collision. Indirect software was implemented by the author. The tyre pressure monitoring method is shown in ⁽⁴⁾. It utilizes the Real-time controller and a Simulink model for system emulation. This model will identify the tyre dimensions, speed and steering wheel angle, track, wheelbase and submit the command according to the input data at each wheel rotation speed. To display all sensed data to send the driver the same, an Android application is built so that drivers can settle the case in the tyre.

In, ⁽⁵⁾ a pressure sensor, a microcontroller, an RF transmitter and a long-life battery are included in this device to measure tyre pressure in stationary and moving conveyance mode. RF communication is linked with the sensors as well as the display dashboard. This paper communicates orally in ⁽⁶⁾ that Bluetooth or Zigbee modules can be used between the sensors and the dashboard for wireless communication. This further notes that solenoid valves should be used to make inflation and deflation easier. In ⁽⁷⁾ SP37 chips were used to capture and transmit conveyance tyre pressure data, and the MAX1473 chip collects this data. To prevent accidents, MSP430 chips do the tyre pressure mechanism and give a warning to the driver in case of any problems. The automatic tyre pressure monitoring and controlling system are addressed in ⁽⁸⁾. A pressure sensor determines the pressure, and with the help of ZIGBEE, the data is transmitted to a microcontroller. The frequency analysis for tyre Pressure monitoring is suggested in ⁽⁹⁾. The purpose of this method is to research the cognition of frequency and tyre-pressure. For the detection of the Eigen frequency of the tyre, Fast Fourier Transform (FFT) based techniques are used. This article examines the tyre pressure in ⁽¹⁰⁾, through the use of a pressure sensor and switch, signal conditioning unit, microcontroller, RF transmitter and battery. RF communication is related to the TPMS and the dashboard. The multiple IDs are used by the system and each TPMS unit to separate the system from another system. The warning signals are produced if the tyre pressure reaches the maximum or minimum threshold pressure level. This method allows the individual the independence to modify the threshold value of Maximum and minimum pressure. In ⁽¹¹⁾ the pressure of the tyres is controlled using the pressure sensor and the temperature sensor. Sensor data is processed and logged by the Splunk Enterprise using the Machine learning algorithm.

The tyre pressure monitoring system is an electronic unit mounted inside every conveyance tyre to control the air pressure and to transmit the correct warning signal to the driver. The health of their conveyance tyres is not considered by most people. However tyres, which require safety maintenance, are one of the most important components of a conveyance. The friction between the road and the tyre increases as the car travels on the road. Due to rugged roads, rigorous driving, terrible road conditions, this friction increases. This impacts the vehicle's reliability and average. Because of this, sudden tyre failure causes serious crashes, especially when a car is driving at high speed on the highway. This will mitigate injuries caused by low or flat tyre air pressure. This would increase the fuel efficiency, the life of the tyre and reduce the tyre's wear & tear. This is critical for long-driving vehicles, such as the conveyances used as carriers of goods, passenger conveyances and other conveyances that run regular and long-distance. Direct TPMS is a type of TPMS in which a sensor is mounted in the wheel to measure each tyre's pressure. The sensor transmits the low-pressure information to the car's computer system when the air pressure decreases below the recommended low threshold level and displays an indication on the dashboard. Indirect TPMS is another type of TPMS in which wheel speed sensors operate with the car's Antilock Braking Systems (ABS). If the friction of a tyre goes down, it will roll at a wheel speed different from the other tyres. This data is visually analyzed by the computer system of the vehicle, which provides the dashboard indicator light with a signal.

The pressure level on the conveyance dashboard is currently seen by TPMS, but there is no way to remotely monitor the tyre status. In the present work, To solve this problem, a wireless MQTT-based system was built that transfers data to the mobile app so that tyre health can be tracked remotely from anywhere in the world. The Node MCU Wi-Fi facility and the Firebase web facilities have made it easy to incorporate such TPMS remote monitoring.

Materials and Methods

2.1 Block Diagram

The block diagram of the setup device is shown in [Figure 1].

It comprises

- Node MCU
- MLX90614 temperature sensor
- SPD030G pressure sensor

The pressure and temperature are linked to node MCU. The data from both sensors is received and processed by the Node MCU. The Node MCU sends the data via Wi-Fi connection to the firebase. Data is collected on the device and seen in the mobile app with the assistance of appropriate firebase account authentications.

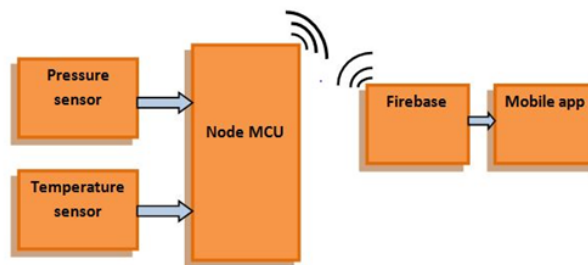


Fig 1. Block diagram

2.2 Software Description

2.2.1 Firebase

Firebase has many cloud services that range from web application hosting, authentication, storage, and cloud features. There are two facilities used in this article: Real-time Database and Hosting. Firebase provides a hosting service that can be used instead of maintaining the server and struggling with settings for deployment and networking to house the software. It is free (yet limited) and relatively easy to use. Firebase is a platform developed by Google that is used to create mobile and web applications.

2.2.2 MIT App Inventor

MIT App Inventor is an integrated development environment for a web application. It uses a graphical user interface (GUI) that is somewhat similar to the Scratch (programming language) and StarLogo programming languages, allowing users to drag and drop visual objects to create an app that can run on Android devices while being an App-Inventor Companion (The software that sanctions running and debugging the app) that runs on IOS running devices is still being developed.

With the assistance of Eagle Software, a circuit diagram is developed. Pin connections of components as seen in the following [Figure 2].

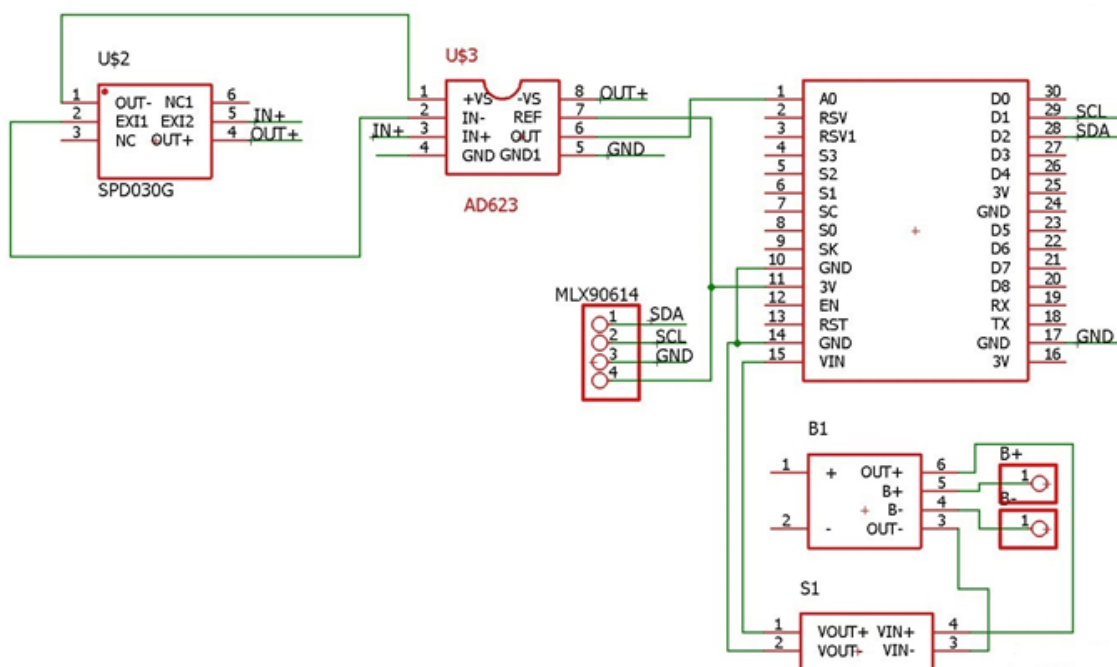


Fig 2. Circuit diagram

[Figure 3] In the right orientation, parts are arranged and the eagle software prepares the final configuration. For the PCB design, Eagle PCB design software is used. This software is basic and has several functions for designing PCBs for simple or complicated circuits. We may also build new libraries.

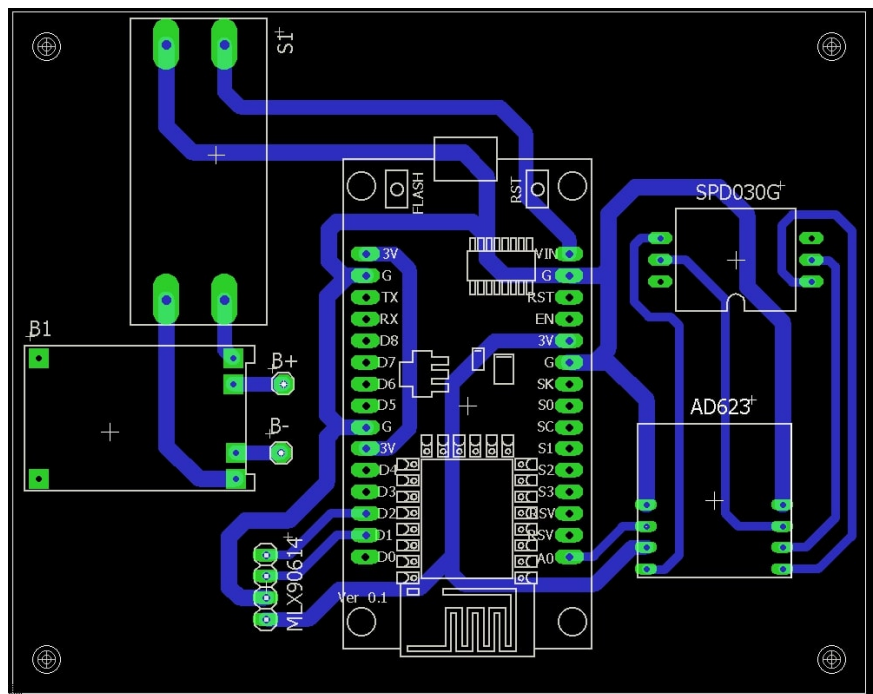


Fig 3. Circuit layout

[Figure 4] the circuit is fabricated with the help of the above configuration. Both parts are properly soldered and ready for the experiment.

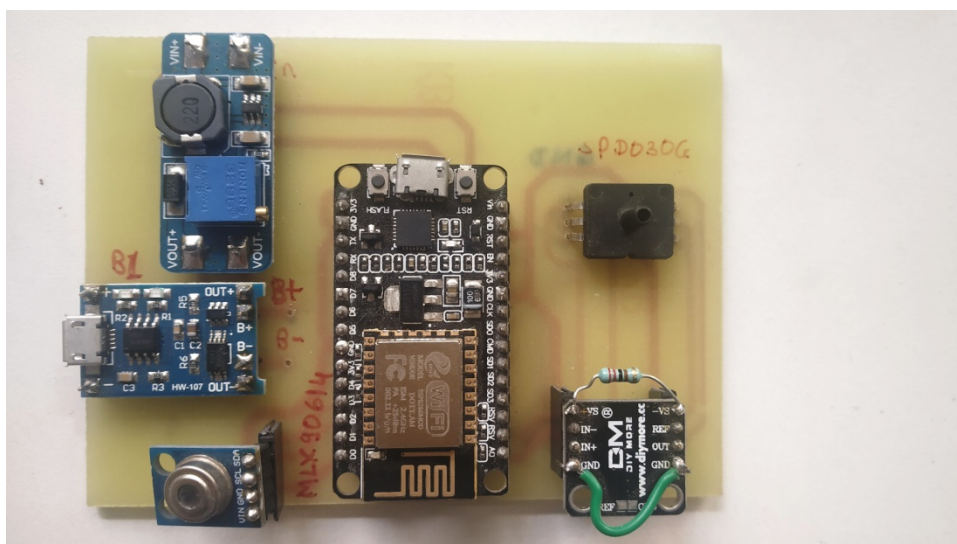


Fig 4. Circuit board

[Figure 5] shows the flowchart

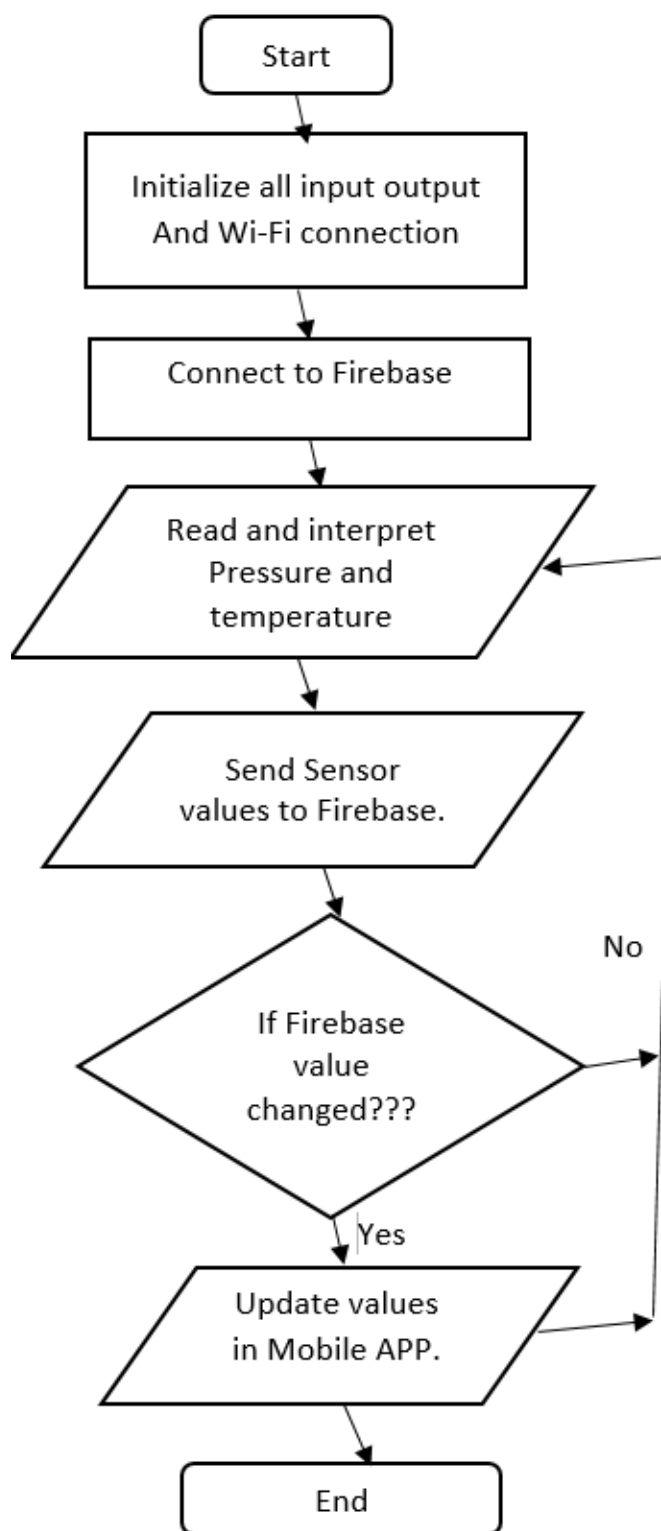


Fig 5. Flow chart

Results and Discussion

The experimental set-up is shown in [Figure 6]. The circuit is battery-powered. The air in the tube can be filled with the aid of a handheld air compressor. PVC tubing is used for air filling. The pressure sensor is attached to the air-filled pipe parallel to the sensor. The circuit is held close to the tyre so that it is possible to sense the temperature of the tyre. The SPD030G sensor used here is a gauge type sensor. Inside the SPD030G, four sensing elements are shaped like a Wheatstone bridge, and the SPD030G sensing range is $0-2 \times 10^5$ Pa. The DC voltage is supplied as the bridge excitation between pins 5 and 2. The output of the bridge is available between pins 4 and 2. For conditioning, the output voltage from the pressure sensor, an op-amp AD623 based instrumentation amplifier is used. The differential voltage between the output pin 4 and 1 of the pressure sensor is amplified by the instrumentation amplifier. The instrumentation amplifier output is attached to the NodeMCU's A0 analogue input pin. This input voltage is digitized by the NodeMCU, transformed into millivolts and sent to the firebase.

The MLX90614 is a temperature sensor based on infrared technologies for measuring non-contact temperatures. It can measure temperatures within the range of -70 to 380 degrees Celsius at room temperature with a precision of approximately 0.5 C. MLX90164 has a lens in front of a detector that focuses on the infrared radiation produced by the sample. The detector transforms the energy into an electrical signal to be translated and transmitted to the firebase by the NodeMCU.

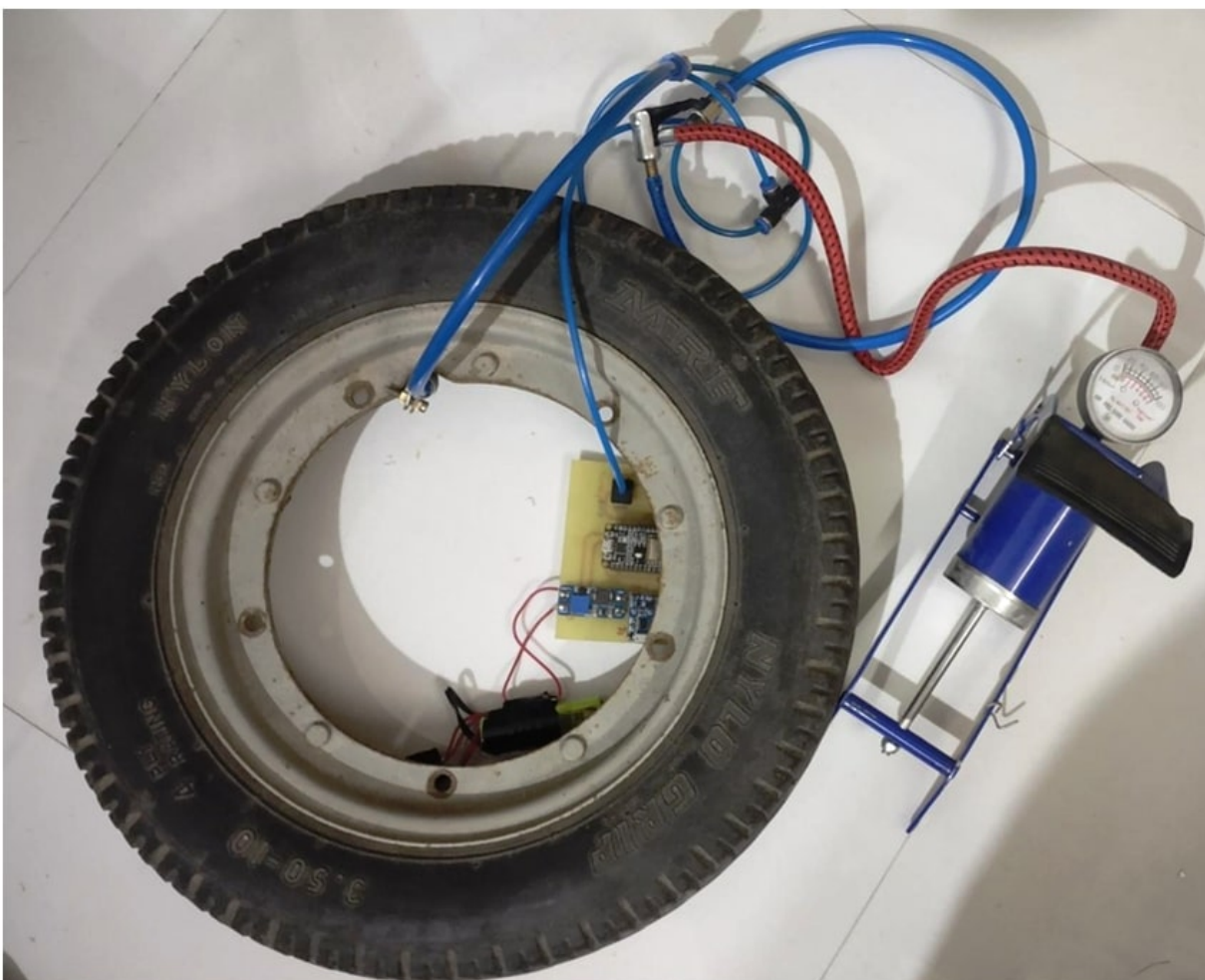


Fig 6. Experimental setup

The above [Figure 6] configuration constantly detects the pressure and temperature of the tyre and sends this value to the respected firebase account. In Node MCU, the ID and password of the respected Firebase account are programmed. Firebase receives Node MCU input and displays as seen in [Figure 7] with the aid of these credentials on its respected real-time dashboard.

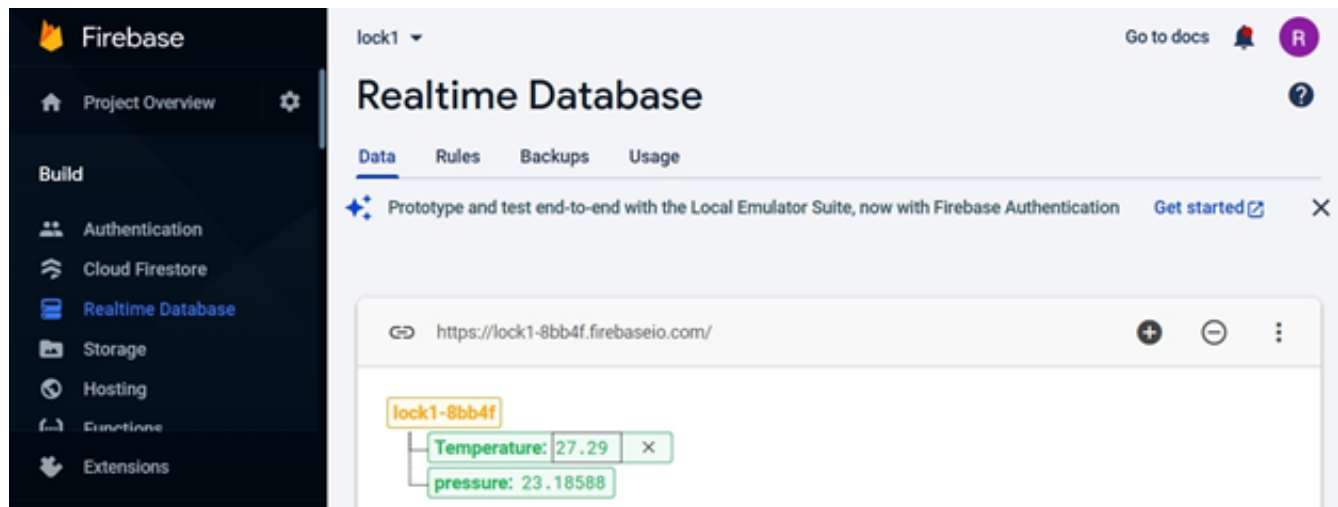


Fig 7. Temperature and pressure displayed on firebase

An easy and user-friendly creator of mobile apps is the MIT App Inventor. It facilitates connectivity between firebase and mobile. With a long page, the safe and user-friendly software creates a proper dashboard. Whenever the value changes on the respected firebase values are collected by the app inventor and shown in the respected value field as seen in [Figure 8].



Fig 8. Temperature and pressure display on the android mobile application

In comparison to others, for sensor readings and Wi-Fi connectivity, we have used a single processor that reduces the expense needed for two separate processors. This leads to a decrease in the size of the hardware too. With the help of the MLX90614, without actual physical contact, we can calculate tyre pressure. The same sensor will simultaneously detect the ambient temperature.

Conclusion

In this study, tyre pressure monitoring systems using NodeMCU, AD623 and MLX90614 are presented. To link the sensors and also for wireless communication, it is best to use NodeMCU. Because of the low power consumption of the processor and all sensors, the entire device is ideal for operating on a small DC voltage battery (3.7v/36000mA). Firebase is used as a server view and mediator between a proposed device and a mobile app.

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