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Automated Vehicle Tyre Monitoring System

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Abstract: This research work presents a system which automatically monitors the tyre condition of vehicles, namely pressure and temperature and using ESP32 microcontroller and sensors like pressure sensor and temperature sensor to monitor the overall wellbeing of a vehicle tyre. This work considers the physical parameters which affect the health and functioning of tyres and present an optimal way to monitor tyre condition. The system consists of two parts, one of which is directly screwed onto the valve stem of tyres and the other is placed inside the vehicle to relay information to the driver about the tyre condition. Data transfer between the isolated modules on tyres and the onboard module happens wirelessly. Issues such as reduced or increased tyre pressure and overheating of tyres can be detected using this system by necessary computations at the main controller and indicated to the driver.

Keywords: ESP32**,** LCD display, I2C serial interface, MPX5700 Pressure sensor, TCMS

I. INTRODUCTION

Today with the quick development in number of vehicles the auto collisions are likewise expanding which makes harms vehicles just as human body. The most significant reasons of genuine auto collisions are tyre blasting. Tyre blasting is troublesome to counteract and subsequently it is one of the significant worries for the driver. It is seen that tyre burst is for the most part because of strange tyre weight and higher tyre temperature.

It likewise seen that the passing rate is 100 when the speed of the vehicle is excessively high from ordinary speed. In this way the unusual tyre weight influences the quality and the security of the vehicle driving. Research demonstrates that if the tyre weight kept up close to its standard esteem then the street mishaps will be anticipated Introduction section should include the background and aims of the research in a comprehensive manner

(i)Hot Molecules - All materials are comprised of particles and atoms. At the point when atoms get hot, they begin to vibrate strongly. The vibration causes development. Being that there are atoms noticeable all around, presently it's straightforward why air-filled tyres extend in the late spring.

(ii)Erosion - As you drive not far off your tyres are scouring against the black-top. This produces a considerable measure of grinding, and grating makes heat that makes your tyres significantly more sweltering.

(iii)Elastic - The third piece of the trifecta is the thing that tyres are made of elastic. Elastic atoms are connected together in long, curving chains (polymers). At the point when the polymers vibrate, they contract instead of growing. Tyre elastic is made so that the polymers can't loop in on themselves, yet everything has a limit. Think about an elastic inflatable. On the off chance that you continue blowing air into it in the end it will blast. Something very similar can happen to a tyre.

Tyre pneumatic stress increments as the temperature goes up. Researchers have made sense of that for each 10 degrees (Fahrenheit) that the temperature rises the tyre weight will increment by one pound for every square inch (PSI). Doesn't seem like much however there's ordinarily just 30-35 PSI in the feels sick of traveler vehicles. The well-known axiom "where the elastic meets the street" as a rule implies something will achieve a basic point. Normally the articulation alludes to vehicle tyres, since those critical bits of elastic are the just piece of your vehicle or truck that should reach the asphalt. That is the reason it's imperative to know and keep up the right measure of air weight in your vehicle's tyres.

Presently Tyre Pressure Monitoring System (TPMS) can be partitioned in to two sorts; One depends on the wheel speed called as circuitous TPMS. Furthermore, other depends on the weight sensor called as direct TPMS. This system utilizes weight sensor which introduced in each tyre to quantify the tyre weight legitimately and show and screens the weight of each tyre. TPMS is intended for decreasing the capability of mishap what's more, vehicle breakdown because of tyre related issues, expanding the exhibition of the vehicle, and decreasing the general vehicle upkeep.

Tyre Condition Monitoring System (TCMS) is a system utilized for observing the weight and temperature. It is an utilization of sensors, for example, weight sensor and temperature sensor, which are utilized aberrant estimating strategy to screen tyre conditions. TCMS comprises of wheel module and dashboard (vehicle) module. The wheel module comprises of equipment segments, for example, battery, smaller scale controller (MCU), sensors, and transmitter. For the dashboard module, it has miniaturized scale controller, module to display, LEDs and collector. Direct technique

estimates conditions, for example, weight and temperature legitimately from the tyre. In this technique, TCMS parts are put in the tyre. This is more solid than the backhanded estimating strategy, which uses wheel speed sensor and ECU in Anti- lock Braking System (ABS). The working standard of this strategy is by utilizing the moving span of the wheel, which relies upon the air weight inside the tyre. In any case, this does not make the framework dependable since the sweep of the wheel likewise relies upon numerous different elements.

There are various focal points in executing TCMS. In any case, the significance of looked after weight, temperature, and vibration are regularly neglected by the open. One of these is the astounding clear that eco-friendliness increments by 5 percent at the point when the tyres are swelled at the suggested nominal weight. Well-kept up tyre weight likewise builds the security in quickening, braking, and cornering. Next to the expansion in tyre hold, warmth of the tyre is likewise decreased. This implies the diminished shot of vehicle breakdown, and the general support of the tyre and vehicle is diminished also. Next to these preferences, TPMS is intended to check the weight and temperature of the tyre at unsurpassed consequently, particularly at the point when the vehicle is navigating out and about. Along these lines it will caution the driver when there are changes in heating brakes, pressure and temperature.

II. METHODOLOGY

Figure 1. Block level flow diagram

Here we build our own low cost Tyre Condition Monitoring System that is TCMS. First part is we need to know about tyres and what is optimum temperature and pressure of a tyre. So the study is made on that. We need pressure sensor and temperature sensor to measure pressure and temperature of the tyre. Once the values are obtained, they are calibrated and send to the slave. LCD which is interfaced with the slave will display pressure and temperature values as shown in Figure 1.

A. *TCMS Tansmitter stage*

The fundamental block diagram of transmitter of TCMS is demonstrated in Figure 2. Having the right tyre weight is critical for getting great gas mileage and the most life out of tyres. Car has a prescribed tyre weight that give the best mileage, handling and tyre life for the car. So as to screen the weight of a tyre, MPX5700 weight sensor is utilized to gauge the weight of a tyre. Most vehicle traveler autos will prescribe 32 psi to 35 psi in the tyre when they are cold.

Temperature is also another important parameter. Here LM35 which is a temperature sensor is used to measure the temperature of a tyre. Temperature and pressure values are fed into a microcontroller which converts these analog values into digital form and transmit to the dashboard.

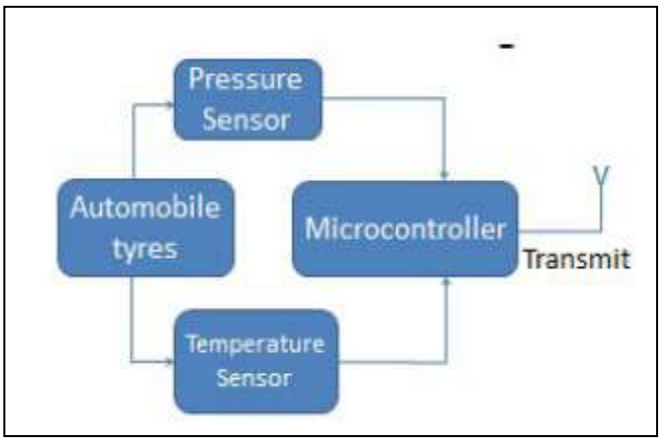

Figure 2. TCMS Transmitter

B. *TCMS Receiver stage*

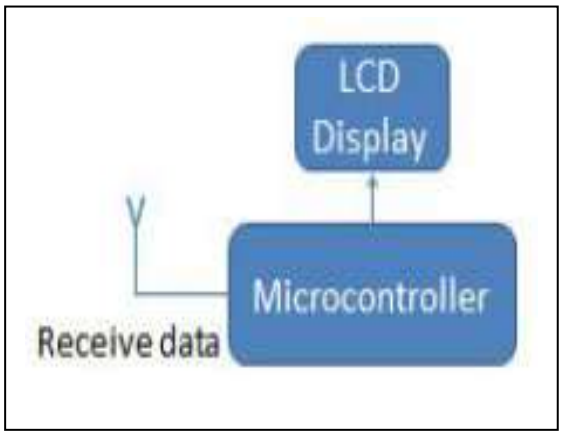

Figure 3. TCMS Receiver

The basic block diagram of receiver is shown above. It consists of a receiver and a display unit. The pressure and temperature values of tyre which are transmitted in the

transmitter will be received by the receiver and it will be displayed on the LCD display.

III. IMPLEMENTATION

A. SENSORS IMPLEMENTATION ON TYRE

Figure 4. Implementation of sensors

Sensors implemented on a tyre is shown in Figure 4 above. As it seen pressure sensor in the casing is connected to stem valve of a tyre through polyurethane compressor hose tube with connector spiral spring with thermoplastic air filling pipe. The pressure in the tyre is passed through the hose tube and it is sensed by the pressure sensor. Temperature sensor is placed on the side walls of a tyre to measure temperature. Both the values are sent from the master ESP32 microcontroller.

The Figure 5 shows the connection of slave ESP32 with the LCD Display. SCL and SDA pins of I2C module are connected to 22nd and 21st GPIO pins of ESP32.This displays the values of pressure and temperature of a tyre which are received from the transmitter.

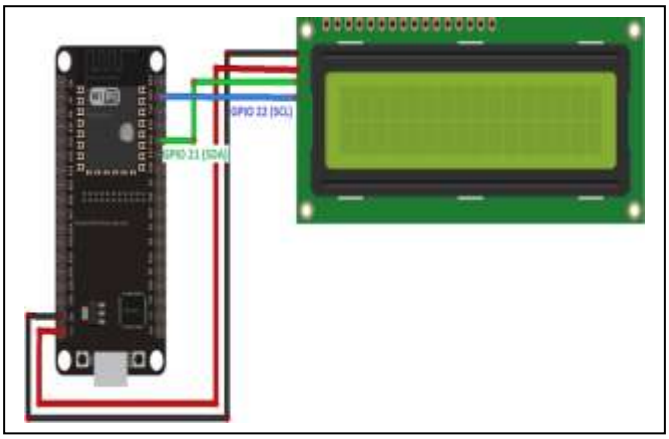

Figure 5: LCD display with ESP32

B. ESP NOW Protocol

The generated commands are given to ESP32 module (i.e. slave) placed on the dashboard wirelessly. This wireless communication between the tyre and the dashboard is obtained using ESP-NOW protocol.

ESP-Now is a convention created by Espressif, which empowers numerous gad- gets to impart without utilizing a typical portal framework. The convention is like the low power 2.4 GHz remote availability that is frequently conveyed in remote mouse. Along these lines, the matching between gadgets is required preceding the correspondence. After the matching is done, the association is tyreless, distributed, and no handshake signals are required. ESP NOW gives the accompanying highlights:

- Unicast communication with encryption and decryption
- Contains both encrypted and unencrypted peer devices.
- Carries upto 250-byte payload. The sending call back function that can be set so as to inform the application layer of transmission success or failure.

The challenges that are faced by ESP-NOW technology are as follows:

- Communicate isn't supported. Limited scrambled friends. 10 scrambled friends at the most are upheld in Station mode; 6 at the most in SoftAP or SoftAP + Station mode. Numerous decoded peers are bolstered; notwithstanding, their complete number must be under 20, including scrambled companions.
- Limitation of payload is 250 bytes.

C. ESP-NOW steps

i)Disconnect the wifi.

ii)Initialize ESP-Now and check whether it has got initialized or has failed.

iii)Select the role. The multiple roles of ESP-Now.

iv)Add peers MAC address and register send callback function to check if the connection is established or not. If the connection is established, we can start sending the data.

We use ESP-Now to create a peer to peer connection between the ESP32 connected to the tyre and the ESP32 connected to the LCD Display

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The block diagram is implemented; measuring of pressure and temperature is carried out using Node MCU, pressure and temperature sensors. The applications are: 1) Car and bike tyres. 2)Light trucks

ESP32 microcontroller accurately detected the variation in pressure and temperature values of automobile tyres. Every 30 mins after which the on tyre module goes into deep sleep to save power. The on tyre module proved to be a rigid and feasible solution for everyday application on vehicle tyres.

Figure 6. Implementation of TCMS on tyre

The wireless communication between the tyre modules and dashboard module is also achieved effectively. The dashboard module effectively displayed the individual values of each Tyre separately and any changes in the respective values of the tyres were updated precisely.

Figure 6. Implementation of display module inside the car

V. CONCLUSION

This work introduced the plan and usage of a free tyre weight checking frame- work. The framework can gauge the weight estimation of the tyre under fixed or condition of development also. In any case, there are still such weaknesses like the condition of soundness of the framework in a condition of development to be improved even more. The framework can viably screen the tyre weight. It has a benevolent interface of human-PC cooperation and great expansibility.

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