AUTOMATIC TYRE PRESSURE MONITORING SYSTEM USING WIRELESS COMMUNICATON

Prof. Mr. Prashant. G. Salunkhe [1], Mr. Harshal R. Kulthe [2], Mr. Saiprasad N. Kolhe [3], Mr. Ayaan A. Khan[4]

[1] Guide Department of Electronics and Telecommunication, [2 3 4] Research Scholar, Sandip Foundation, SITRC College, Nasik, Maharashtra (India)

ABSTRACT

Tyre pressure monitoring system (TPMS) is an electronic system that monitors the air pressure of an automobile tyre and alerts the driver by displaying the real pressure or just a warning light. This project is focused on designing and developing a direct TPMS which the measurement of the air pressure is taken directly using pressure sensor. Suitable components are researched to design the prototype. Main components needed are pressure sensor, voltage-to-frequency converter, transmitter, receiver, and frequency-to-voltage converter. To power the prototype, energy is chosen through wheel rotation. Main components need to be calibrated to ensure the consistency and precision of the prototype in reporting the pressure. Calibration for pressure sensor is performed by simply applying a known value of pressure and the output voltage is measured. For voltage-to-frequency and frequency to-voltage converters, a known value of voltage or frequency is applied and the output is monitored using voltmeter and oscilloscope. The results show promising data by proving the relationship between the input and output for each component. As for the conclusion, although there are many problems and limitations faced, this prototype is a promising product in real world application.

I. INTRODUCTION

Every year, many accidents occurred and for certain cases, accidents are caused by under-inflated tyres. Under-inflated tyres could promote to problems such as blowouts, decreased tyre life, and handling. Due to this awareness of the importance of tyre pressure, US government has introduced Transportation Recall Enhancement Accountability and Documentation (TREAD) Act (www.nhtsa.gov, February 2010). This act requires all passenger cars, van, and light trucks to include low tyre pressure warning systems as standard equipment. The National Highway Traffic Safety Administration (NHTSA) oversees the TREAD Act and has expressed an interest in extending the legislation to other types of vehicle. As a result, NHTSA established Federal Motor Vehicle Safety Standard which requires the installation of tyre pressure monitoring systems (TPMSs) that warn the drivers when a tyre is significantly under-inflated (25% of the right pressure). The significant of running the tyres at the specified pressure helps provide proper vehicle handling (thus, reducing the chance of accident) while avoiding premature tyre wear. The right pressure for a vehicle is well-stated on the tyre information label or tyre placard located on a door edge or door jamb, or inside the glove-box door. The label also lists maximum load and tyre size (including spare). Underinflated tyres wear on the outsides of the

tread. Also, the tyres flex excessively which produces extra heat and more rapid wear. Over inflation causes the center of the tread to wear. The tyre cannot flex normally and this puts stress on the sidewalls and plies.

It is not convenient to frequently check the tyre pressure using pressure gauge.For long journey, tyre pressure may vary from time to time due to load, road irregularities, and temperature. Hence, one could not possibly know the condition of the tyre and that had caused many tyre blowouts especially for heavy trucks. Hence, TPMS is introduced. TPMS is an electronic system that observes and monitors the air pressure. Certain TPMS also monitors the temperature of the automobile tyre. The system alerts the driver of the vehicle of the air pressure inside the tyres by displaying the real pressure or just a warning light. Some of the car manufacturers already installed their own TPMS on their vehicles.

II. LITERATURE SURVEY

Loya Chandreshkumar describes in Indirect TPMS system is nothing but there is no requirement of the physical pressure sensors but instead of that here in this indirect TPMS the measurement of an air pressure is done by monitoring the individual wheel rotation speeds. The 1st generation of an TPMS system is basically depends on the particular principle; that means under-inflated tyres consist the smaller diameter than the correctly inflated tyres.

V. L. Jogdand presents whereas in receiver section you receive the pressure along with the temperature data that is being sent by the transmitter. It is extremely small in size and light in weight. The receiver is operated at 5V. After receiving the data from transmission module and demodulating it, receiver sends data to main chip microcontroller through serial interfacing through hardware serial port, microcontroller checkout first and compares it with data frame received before. After affirming the data frame, system compares tyre ID with 4 IDs stored in the memory of the MCU for making sure that which tyre the data frame comes from.

Ambarish G. Mohapatra presents Important aspect to be taken care of is the particular Transmission as well the reception of sensor data that play very important role in any TPMS system. The sensor data get transmitted to a central receiver unit with a specific serial ID and displayed in an LCD driver. The transmission as well the reception of data was done over ISM band at a frequency of 433.92MHz. The transmitted data was arranged in a header of preamble, sensor ID and pressure data. The display driver used was made by using a microchip PIC16F877A microcontroller and an LCD. The data encoding method used in this project is based on PWM format with TE (basic pulse element) time of 400 s µ.

III. SYSTEM DEVELOPMENT

Both sections that means Transmitter and Receiver section is works at 3-12V. The transport speed is 4 KB/S. The transmit frequency is 315MHz. The range of communication is 80 meters. The most important parameter in transceiver is its length which is a quarter of the wavelength we use. For this system, the frequency we use is 315MHz,so the

Wavelength = c/frf|- = 3 * 108 m/s / 315 * 106 = 0.95m .. (1)

Where, is the wavelength of the radio wave, c is the Speed of light, f rf is the frequency of the radio wave. From the formula above (1), we have /4=23.8cm Hence the formula used at the Receiver section to display the calculated pres-sure becomes,

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Pressure = Vin * Vref * 27 / 1023 * 3.3 PSI (2)

Where,Vin = Input to ADC

i.e. output of Pressure Sensor Vref = Reference voltage of the ADC.Here it is 3.3V This data can be displayed on the LCD which is interfaced with the Microcontroller.

3.1. SELECTION OF FORCE SENSOR OR FORCE-SENSITIVE RESISTOR (FSR)

A force-sensor (alternatively called a force-sensing resistor or simply an FSR**)** has a variable resistance as a function of applied pressure. In this sense, the term "force-sensitive" is misleading – a more appropriate one would be "pressure-sensitive", since the sensor's output is dependent on the area on the sensor's surface to which force is applied.

These devices are fabricated with elastic material in four layers, consisting of:

- A layer of electrically insulating plastic;
- An active area consisting of a pattern of conductors, which is connected to the leads on the tail to be charged with an electrical voltage;
- A plastic spacer, which includes an opening aligned with the active area, as well as an air vent through the tail;
- A flexible substrate coated with a thick polymer conductive film, aligned with the active area. This polymer is very often replaced by a layer of FSR ink.

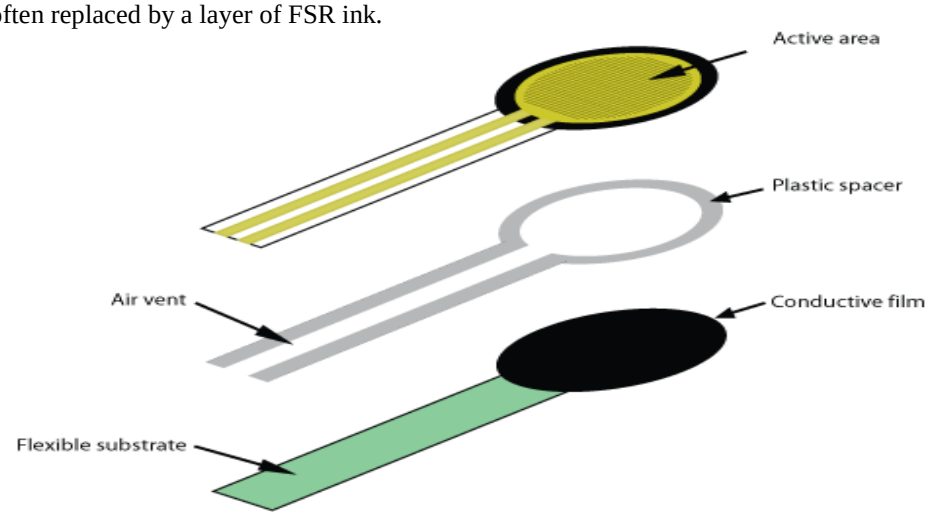

Figure 2.1.Force Pressure Sensor

Output

The FSR's output signal is a monotonic function of area and pressure. When enough force is applied, this function changes slope quickly due to sensor saturation. After this point output will not be significantly affected by an increase in applied pressure.

This sensor is known to have poor accuracy, with errors up to 25% of output but can be a good choice if only qualitative measurements are needed.

3.2 SELECTION OF PIC18F452

It has the following features

- 40 MHz Max. Speed
- Self-Programming
- Program Memory Type – Flash
- Program Memory (KB) – 32

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- CPU Speed (MIPS) -10
- RAM Bytes -1,536
- Data EEPROM (bytes) – 256
- Digital Communication Peripherals - 1-UART, 1-SPI, 1-I2C1-MSSP(SPI/I2C)
- Timers - 1 x 8-bit, 3 x 16-bit
- ADC - 8 ch, 10-bit
- Temperature Range (C) - -40 to 125
- Operating Voltage Range (V) - -2 to 5.5
- Pin Count - 40

3.3 SELECTION OF CC2500

The **CC2500** is a low-cost 2.4 GHz transceiver designed for very low-power wireless applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various modulation formats and has a configurable data rate up to 500 kBaud.CC2500 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication and wake-on-radio. The main operating parameters and the 64-byte transmit/receive FIFOs of **CC2500** can be controlled via an SPI interface. In a typical system, the **CC2500** will be used together with a microcontroller and a few additional passive components.

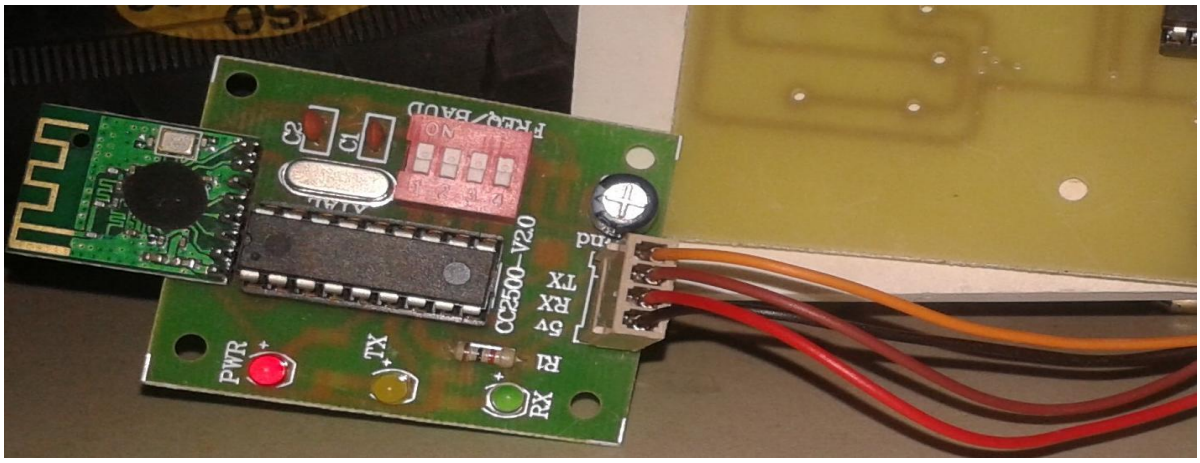

Figure 2.3.CC2500

IV SYSTEM WORKING

Detailed working of TPMS is as shown in above figure 3.

- **Transmitting Section**

When the sensor starts sensing of pressure it transmit the value of pressure along with temperature to the CC2500 Transceiver Module (RF transmitting module).

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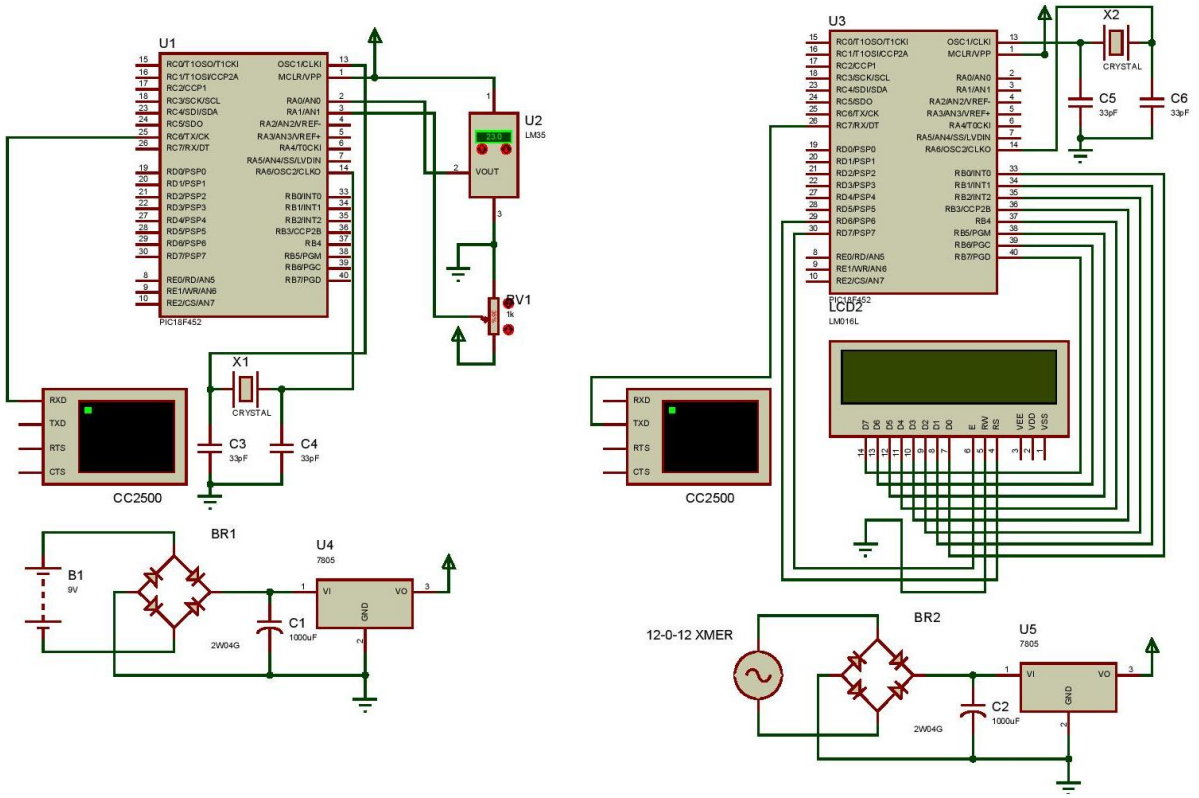

Figure 3.System Working

Then PIC 18F452 microcontroller analyze these values and transmit these data with the help of RF Transmitter to the RF Receiver and the current pressure and temperature data are displayed on the LCD screen. In this we use LM 7805 voltage regulator IC to maintain the voltage level automatically. RF communication works by creating electromagnetic waves These electromagnetic waves travel through the air at near the speed of light. The wavelength of an electromagnetic signal is inversely proportional to the frequency; the higher the frequency, the shorter the wavelength.

- **Receiving Section**

The RF communication system then utilizes this phenomenon by wiggling electrons in a specific pattern to represent information. The receiver can make this same information available at a remote location i.e. communicating with no wires. It features are;

• Receiver frequency: 433MHz. • Receiver typical sensitivity: 105Dbm. • Receiver current supply: 3.5mA.• Receiver operating voltage: 5V. • Low power consumption.

V. PERFORMANCE ANALYSIS

The system is tested for all the functions of the developed TPMS as pressure detection for high-pressure, low-pressure, high-temperature, low temperature and high temperature of engine in artificial simulation conditions. It displays the pressure and temperature of the tyre on LCD in time and also warning on LCD. From the input to the output, a sensor may have several conversion steps before it produces signal.

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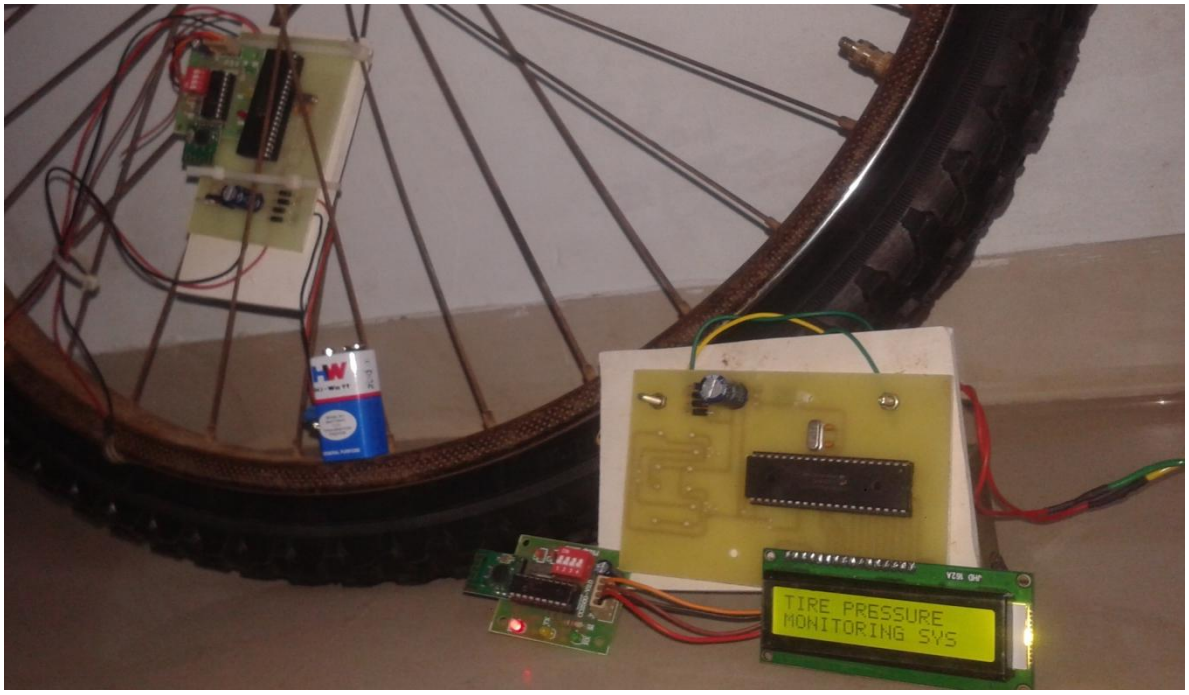

Figure 4.The Tyre Pressure Minitoring System Performance Analysis

The various conditions are illustrated below

Condition 1 – When Temp.=26deg. C and Pres.=28PSI Then **Tyre Pressue Droping** as shown below in fig.4.1

Figure 4.1

Figure 4.2

Condition 2 – Tyre Almost Flat shown in fig.4.2 **&** **Condition 3 – OK Pressure** shown in fig.4.3

Figure 4.3

EXPERIMENTAL ANALYSIS

By analyzing the systems types we get different data about the same system and the two subsystems of the TPMS are nothing but Direct TPMS and Indirect TPMS systems, the table 4.2 shows different types of TPM/s system. Which represents uses a sensor mounted in the wheel to measure air pressure in each tire and represents works with the car's Antilock Braking Systems (ABS) wheel speed sensors which are collective data about the two types of TPMS systems. Following Table 1 shows the result or experimental analysis.

Table 1.Result Analysis

Indirect TPMS System	Direct TPMS System
Indirect TPMS do not use physical pressure sensors but pressure is get measured by monitoring individual wheel rotational speed.	It uses a pressure sensor mounted in the wheel to measure air pressure in each tire.
When the tire pressure decreases, the vehicles weight causes the tires diameter to decrease, which causes the tire to rotate at a different rate than when it is at full pressure.	In contrast, measurements such as wheel speed are used in in-direct TPMSs. A direct TPMS can inform the driver about pressure deviations as low as 0.1 bar, that is, 1.45 psi.
Therefore, only software is needed to implement an indirect TPMS. However, several shortcomings are associated with indirect TPMS.	In this method the sensor has low accuracy and cannot communicate data to the driver. Alternatively, a more sophisticated version of a direct
First, the system does not provide the actual pressure of each tire and works only when the vehicle is in motion.	TPMS consists of sensors, radio frequency transmitters and receiver, and a warning system. Each tires pressure is measured and transmitted through its sensor and transmitter.
It warns the driver only when the pressure drop is more than 25% and, moreover, may generate false warnings when the vehicle is moving on a curved road or during tire slip on snowy roads.	The transmitted signals are received, decoded, and processed by the receiver to trigger the warning system through an alarm lamp, audible alarm, voice, or pressure display. The proposed system uses the direct tpms scheme for our system.

VI.. CONCLUSION

This system utilizes the techniques to provide a solution that analyze the measurement of the real-time tyre pressure. Therefore it provides the information to the driver that is basically related to the tyres which are improper and may be not useful. The system also provides the calibrated pressure of the tyre that is very essential and important for the tyre life. Due to which it reduces the various damages and the accidents respectively. The invention could be made with respect to automatic generation of energy through rotation of wheels. Although the life of tyres and the durability of the tyres are also incremented if we make a use gas that is known as a Nitrogen gas. Therefore these types of the tyres that are containing a nitrogen gas can be useful up to the Six Months.

FUTURE SCOPE:

- The future work faces one fundamental question that is one tyre sensor sufficient for monitoring tyre-road contact. Should we carry on the work based on a more enhanced theoretical model, or should there be more empirical approach adopted.
- Furthermore, more work in the signal processing area is needed to better understand the tyre behavior. Some test results are indeed promising also for the accelerometer, since clearly different signals are obtained on different road surfaces.
- Another question posed is nothing but there are other sensors available that can be used to support or even substitute the accelerometer as a tyre sensor in determining friction available.
- On-line monitoring adverse road conditions seems to be more of a technical problem than a marketing issue.
- Owing to a great potential of friction information to enhance the functioning of a number of driving dynamics applications, there is demand for a road surface monitoring system in the automotive sector - provided the costs for such a system are reasonable.
- Also external users, especially road operators are in a need of continuous information along the road network rather than on cross-sectional points as turned out in the project by Finnish Road Administration.

APPLICATIONS:

- It is used in the all vehicle manufacturing industries.
- As of the 2008 model year, the National Highway Traffic Safety Administration (NHTSA) now requires that all passenger cars and light trucks feature the Tyre Pressure Monitoring System (TPMS).
- TPMS report real-time tyre-pressure information to the driver of the vehicle, either via a gauge, a pictogram display, or the simple low-pressure warning light.
- TPMS can be divided into two different types direct (TPMS) and indirect (TPMS).So it is used as direct TPMS or as indirect TPMS according to the applications.

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