Design and Implement of Wireless Tire Pressure Monitoring System

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Abstract
Tire-break-avoiding is very important for safe driving in a super highway. Therefore the tire pressure monitoring system (TPMS) is attracting a great deal of interest from researchers and engineers. This paper presents a new kind of TPMS scheme, introduces the selection of main chips and the principle of the system. Three key issues of the system are discussed: the design of antenna, realization of low power and wireless signal transmission. Finally, the performance of the system is tested and analyzed. The test results show that it can meet the needs of the practical application.

Keywords
Tire Pressure; Temperature; Wireless Communication

I. Introduction

In a super highway, tire fault is very hard to prevent and a severe problem to drivers. It is one of main reasons of the sudden traffic accidents. Statistics shows that the number of the traffic accidents happened owing to tire break is about 70% of the whole. In the United States, the proportion is even high, which is nearly up to 80%. Tire-break causes big economic losses. So, tire pressure monitoring is absolutely necessary to guarantee the safe driving [1]

There are twotypes of TPMSs: direct and indirect method [3]. This project focuses on the issues of a direct TPMS [4].

TPMS systems measure the actual tire pressure using sensors which incorporate radio transmitters. The radio signals are picked up by a receiver unit which provides an alarm signal to the driver. Various types of information can be provided for the driver (alarm lamp, actual pressure, audible alarm, voice), and the sensors are either internally wheel mounted or may be externally fitted on the tire valve in place of the valve cap.

More advanced TPMS show the actual tire pressure on a display/ receiver unit inside the vehicle. Actual tire pressure is measured by miniature sensors in each wheel which each transmit an encoded radio signal. The receiver/display is a digital back-lit display unit which recognizes your vehicles pre-coded radio signals and sounds an alarm at high or low pressure conditions. Some also indicate and monitor tire temperature.

To measure parameters of the tire such that pressure and temperature using sensors and display these information on the display to the driver. Hence by monitoring tire conditions continuously, avoiding tire faults. sets the time intervals of the data transmission and the intervals of testing pressure and temperature, to make sure that the interval of the data transmission and the interval of testing pressure and temperature become some longer when the speed is low, and become some shorter when the speed is high [4].

II. Transmitter Unit

In the system, how to effectively transmit the wireless radio frequency signal is a key technique and RF transmission costs most of power [5], but we can use Zigbee for wireless communication

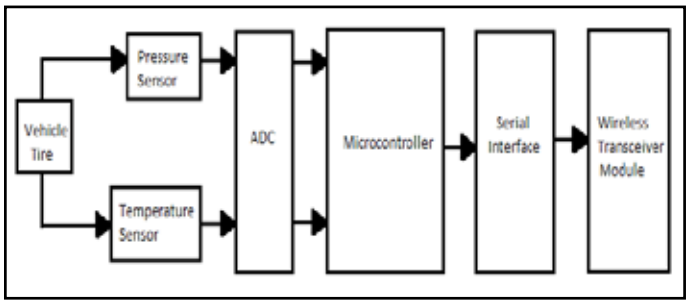

Fig. 1:

Block diagram of Transmitter Unit consist of:

- Pressure Sensor: To sense pressure of the tire.
- Temperature Sensor: To sense temperature of the tire.
- ADC (Analog to digital Converter): To convert analog physical quantities into digital signal for microcontroller operation.
- Microcontroller: To accept data from the sensors, manipulate it and transfer it serially to wireless transceiver.
- Wireless Transceiver: To communicate wirelessly with the receiver unit.

III. Receiver Unit

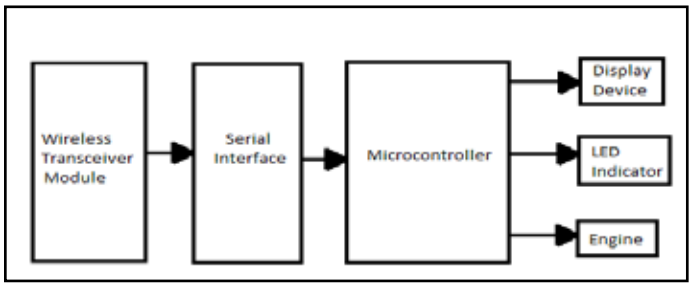

Fig. 2:

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 tire ID with 4 IDs stored in the memory of the MCU to make sure that which tire the data frame comes from. After choosing the right one, the pressure value and temperature value will be stored in the right memory [4].

Block diagram of Receiver Unit consist of:

- Wireless Transceiver: To accept data from transmitter unit and send it serially to the microcontroller.
- Microcontroller: To accept data from transceiver module, manipulate it and the result on the output devices.
- Display Device: To show the output to the driver.
- LED Indicator: To show the warning by LED.
- Engine: It gets stop working if temperature of the tire is above the threshold value.

A. Pressure Sensor

The MPXM2202 device is a silicon piezoresistive pressure sensor providing a highly accurate and linear voltage output — directly proportional to the applied pressure. The sensor is a single, monolithic silicon diaphragm with the strain gauge and a thin–film resistor network integrated on–chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation.

B. Precision Centigrade Temperature Sensors

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air.

C. Actual Setup in the Tire

Fig. 3:

Fig. 4:

IV. Dashboard Display

A typical tire-pressure monitoring system integrates many functions. Sensors in each wheel measure temperature and pressure at regular intervals. That information is sent by radio-frequency signal to an electronic control unit inside the vehicle. The unit analyzes the data it receives. Initiators interrogate sensors as needed to rapidly confirm possible warnings and to ensure that accurate information is sent to the driver. A display warns the driver in real time of any critical deviations from normal conditions.

A. Wireless Signal Transmission

A key technique in TPMS is the stability and reliability ofthe wireless signal transmission, especially in super highway. Many factors, such as disadvantageous working environment in high speed and signal-shielding, may produce disturbances to signals. Besides, when we use handset and electronic devices in the car, signals will interfere with each other, and the stability of the signal transmission will also be affected. Thus, when choosing wireless signal transmission module, we choose the RF MODULE or ZIGBEE MODULE. In the meantime, in order to improve the disturbance-rejecting capability, we choose the Manchester coding, the FSK(frequency-shift keying) mode. Further, we adopt CRC checkout to check data errors. These measures can ensure the stability and reliability of the wireless signal transmission.

V. Conclusion

1. Researches show TPMS has a bright prospect.
2. Properly maintained tires can provide safety, operational reliability, and economic benefits.
3. TPMS ensures correct tire pressure which is essential for car safety, handling, and comfortable driving and tire lifetime.
4. TPMS system is not only used in automotive industries but also used in industrial application where accurate pressure measurement is required.

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