Smart Tire System

An intelligent and compact system that makes driving hassle-free.

[1]Aarti Mohan Jathar, [2]Suchita Shekar Ghatikar

[1]Associate Professor, [2]Associate Software Engineer
[1]Engineering Science, & Dept. of Electrical Engineering, SPPU,
[1]Dr. D. Y. Patil Unitech Society's Dr. D. Y. Patil Institute of Technology,
Pimpri, Pune, Maharashtra, India.

Abstract: We frequently fret about under- or over-inflated tires. Misalignment and excessive wear and tear are two key issues with tires that can cause serious accidents as well as increase fuel consumption and negatively affect fuel economy. These issues have an immediate negative effect on the environment and increase carbon footprint.

In order to address these issues and give the driver a hassle-free and worry-free driving experience, we have integrated a solution made up of numerous small sensors that are yet powerful enough to address the problem at hand. Together, this will produce a sophisticated system that can examine practically all of the issues a driver encounters.

Index Terms - **Tires, Sensors, Misalignment, Fuel economy, Carbon Footprint.**

I. INTRODUCTION

The most frequent issues, such as a flat tire, worn tires, or misalignment, can have a significant negative influence on both the vehicle and the occupants. The only part of your vehicle that makes contact with the road is your tires, so recognizing the symptoms of potentially hazardous problems will assist to keep you and other drivers safe.

Tire failure can make your car lose control, which can lead to an accident that leaves people hurt or killed. According to the National Highway Traffic Safety Administration, vehicle malfunctions account for 2% of all vehicle crashes, with tire issues accounting for 35% of these.

A failed tire might have disastrous effects. Your automobile might flip over, veer towards oncoming traffic, or leave the pavement altogether. You and your passengers may be injured but also innocent pedestrians and occupants of other vehicles. The following are the most typical tire flaws:

- faulty manufacturing
- worn-out, older tires that nonetheless look good
- incorrectly repaired punctures
- inappropriate tires for the vehicle
- Due to the challenge of securing steel to rubber, steel belt and tread separation occurs.
- produced tires lacking sufficient separation prevention design elements
- damage to tires while mounting

Different risks are caused by these flaws. For instance, a blowout might result from the separation of rubber and metal, especially at high speeds, which puts the vehicle in danger of losing control. Nowadays, there have been a ton of inventions in the vehicle industry, from humanoid-enabled car systems to self-driving cars.

All of the ideas are related to the next technology, but by making a few adjustments to the tire system, an ambassador can be transformed into a smart car.

Here, we'll introduce a tiny device that can be installed in any vehicle and utilized to solve all tire-related issues. To make driving a worry-free experience for everyone, we will be integrating a variety of sensors and technologies.

II. LITERATURE SURVEY

Most buyers of used cars are worried about finding a particular make, model, body type, performance package, amenities, or even color. The car's tires are one aspect that consumers might overlook. Although they might not be among your first considerations when buying a car, the tires really ought to be. Despite the fact that they frequently go unnoticed, tires are undoubtedly the most crucial part of your car. After all, it's because to your tires that you and your car can travel along the highway.

An average 33,000 accidents happen annually because of tires, according to the National Transportation Safety Board. At least 2,000 of those are blowout-related. Tires are one of the many minor things that frequently cause big problems.

Most of the prior research has focused on maintaining proper tire pressure utilizing pressure sensors, which will inform the user of the proper pressure. The majority of the work on a vehicle's safety and security has been done in the dashboard area, leaving them with a rather unfinished appearance.

Through the addition of a direct feedback contribution that improves state estimation robustness with respect to the errors of the tire force models, the introduction of tire sensing systems, offers the possibility of making the tire an active component of the estimation algorithm.

With regard to the development of vehicle state estimation and control systems, these solutions provide encouraging views. Well-known tire manufacturers have also incorporated sensing systems into their tires, which are typically only temperature and pressure sensitive.

Every component of your car serves a purpose, but the tires are one that is frequently overlooked. Having the right tires for your automobile can enhance its handling, fuel efficiency, and overall safety. The sources we cite are those whose work has been done in relation to accident prevention and traffic safety, in which tire-related issues have not been taken into consideration, precisely the subject of our work.

III. SOFTWARE & HARDWARE REQUIRED

The hardware and software needed to implement the desired recommendation system are listed below:

A. Software Necessary

1) The open-source Arduino IDE software makes it simple to develop code & has almost all the sensors that are required in the system. It consists of Arduino as well as raspberry pi that we have considered as our base.

2) Windows, Linux (both 32 and 64 bits), and Mac OS all support the usage of the Arduino IDE.

B. Hardware necessary:

1) Pressure Sensor
2) Temperature Sensor
3) Vibration Sensor
4) Friction Sensor
5) GPS & GSM module
6) Arduino/Raspberry pi

IV. COMPONENTS

All of our sensors will be connected to a microprocessor, and this microprocessor will act as the brain of our intelligent system. We have considered Arduino and raspberry pi both as a base for our system considering their various advantages and disadvantages. Raspberry pi will have a higher edge over Arduino due to it's Wi-Fi connectivity option.

Let's talk about how each sensor will assist us in the process:

1) Pressure Sensor

Figure 1: Pressure Sensor

The pressurized pocket created by a wheel and tire contains a small, programmable electrical device called a tire-pressure sensor that continuously checks the tire's air pressure.

The pressure sensor will assist us in identifying tires that are 25% or more, below the advised level and alerting the driver via the app. Batteries power the tire-pressure sensors, which are typically mounted to each tire's valve-stem assembly.

When the tire pressure in your car is low or about to go flat, a pressure sensor alerts you. By assisting you in maintaining optimum tire pressure, your car's handling, tire wear, braking distance, and fuel efficiency will all improve, increasing your safety on the road.

2) Temperature Sensor
In order to record, monitor, or communicate temperature changes, a temperature sensor is an electronic device that monitors the temperature of its surroundings and turns the input data into electronic data.

An ultra-wide 16-channel infrared sensor monitors the lateral temperature distribution of the inner tire carcass.

Figure 2:Temperature Sensor

3) Vibration Sensor

A bad shaking or vibration might affect the car's handling and ability to be driven. Uneven tread wear is another factor in vibrations at higher speeds. A tire will begin to wear more quickly on one side after being on a vehicle for a year or longer.
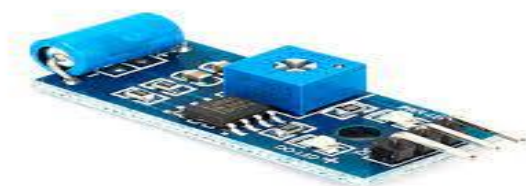

Figure 3: Vibration Sensor

The quantity and frequency of vibration in a system, machine, or piece of equipment are measured by a vibration sensor. These metrics can be used to identify imbalances or other problems with the asset and foresee upcoming failures.

Vibration sensors are a great method to keep an eye on the condition of important assets. They offer exact data on how various pieces of equipment are performing, and the knowledge they offer can assist you in determining when potential future maintenance requirements may arise.

4) Friction Sensor

The deterioration of the car tires is caused by friction. The motion known as friction only operates in the direction that it is opposed to.

Figure 4: Friction Sensor

Therefore, the tires experience an opposing force as the automobile travels forward, which causes them to wear down. Surface sensor/Friction sensor can measure friction and shear force in real time. It reads the deformation of a flexible sheet sensor and maps the in-plane distribution of friction and shear forces.

5) GPS & GSM Module

We can connect to the app with the assistance of the GPS and GSM module. The user's app will receive the data gathered by all the sensors and provide real-time info.

Latitude and longitude are the two coordinates that the GPS module uses to determine its location. This data is processed by the microcontroller and sent to the GSM modem. The owner's mobile phone receives the information from the GSM modem after that.

Figure 5: GPS & GSM Module

This might also aid in enhancing the vehicle's security and safety. Using GPS coordinates; we can locate the vehicle in the event of theft. All the sensors will communicate with the GSM module, which will send real-time data to the user. The user can then monitor all the components.
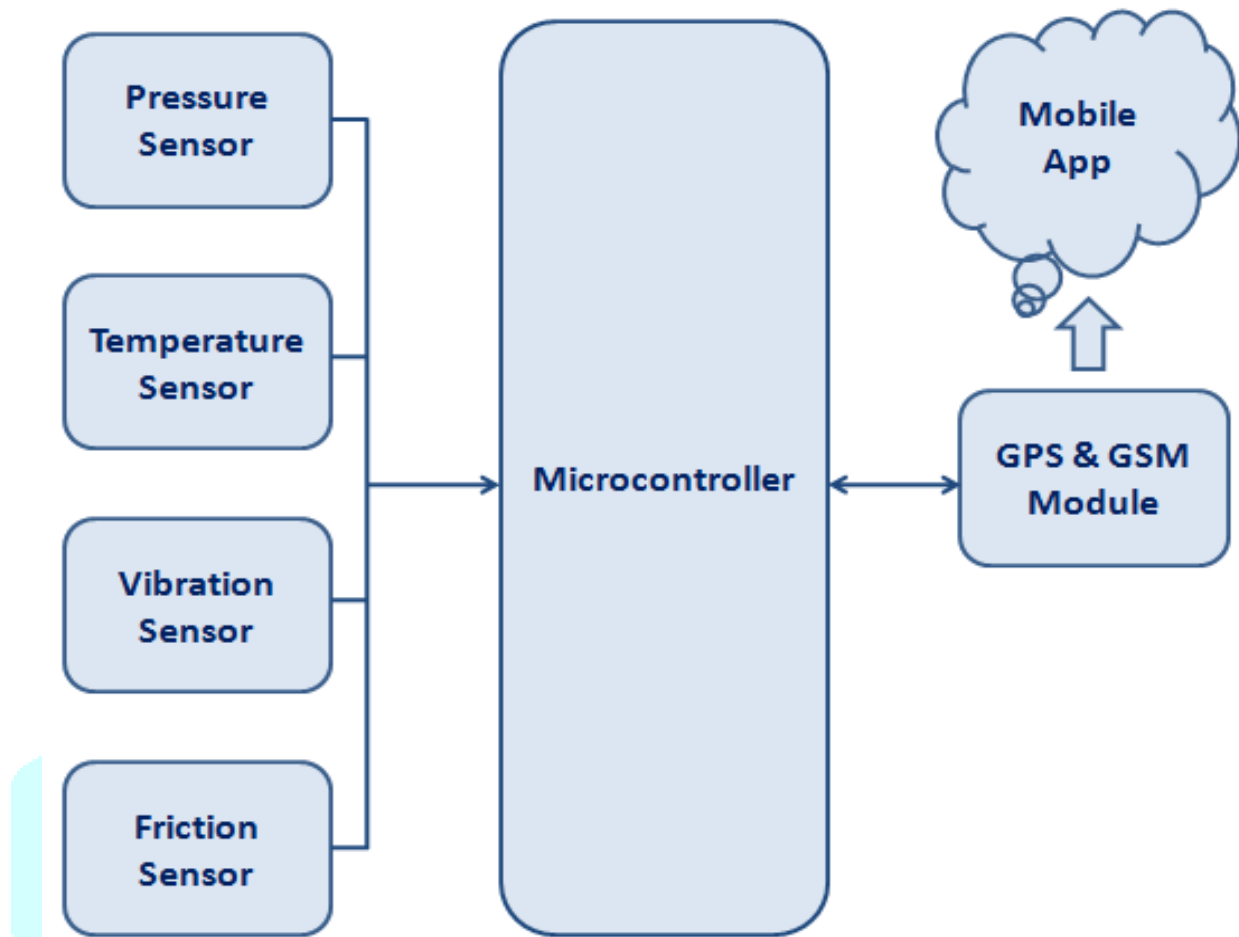
V. BLOCK DIAGRAM

Figure 6:Block Diagram of Smart Tire System

VI. WORKING

The system created by the aforementioned sensors will communicate real-time data to the GSM module, which will subsequently connect to the user's mobile app. In the meantime, the GPS module will assist us in tracking the car and ensuring its security. The pressure sensor will first provide information on the tire pressure. If the tire pressure is less than 25% of the desired value, an app alert will be issued to the user.

Continuous temperature monitoring with a temperature sensor helps stop tires from overheating and reduce wear and tear. Friction sensors will allow us to determine whether there are any bulges or cracks around the tire, and if there is any increased friction, the driver will be alerted.

The GSM module will serve as an interface between the sensors and the mobile application by receiving all of this sensor data. However, GPS will enable us to follow the vehicle for increased security & safety.

VII. RESULTS & DISCUSSIONS

As was already noted, 35% of car accidents are the result of tire-related problems. These estimates may significantly alter if we can successfully apply this technique in vehicles. This device is inexpensive and simple to use because it can be added to already-existing tires.

This technology stands out from the competition because it takes into account all the factors that can lead to tire failure. Prior smart tire technologies have largely concentrated on the pressure sensor and mobile applications.

A. Advantages

- The communication is greatly accelerated via Wi-Fi technology.
- GPS module helps us to locate exact co-ordinates.
- Sophisticated & compact system
- Reliable & Affordable
- Can be mounted onto any tire.
- Helps to maintain Tire Health.
- Helps in reducing carbon footprint.
- Enhance Tire Runout
- Save Costs of Labour & Maintenance
- Reduce Breakdowns on the Road
- Increased Safety

B. Dis-Advantages

- Although simple, resynchronization may need expensive gear.
- The entire sensor must be replaced if the battery is discharged.
- Sensors can sustain damage while being mounted or unmounted.

VIII. CONCLUSION

Different accident detection and notification systems have been researched and developed over time. In order to make driving stress-free, this article aims to establish a system that will almost eliminate problems brought on by tires.

The system's hardware is readily available and convenient, but before using the hardware, a software version of the system can be made to ensure that all relevant elements are taken into account.

This system is an all-around protection system for you and your vehicle since we have taken into consideration every circumstance that can have an impact on a tire.

IX. FUTURE SCOPE

The system can be expanded to include more sensors to provide total vehicle prevention. The system can be improved to increase security and dependability by upgrading the WIFI and GPS module. This system can be connected to the dashboard or the airbag sensor to provide comprehensive vehicle security

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