RAJALAKSHMI ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University)

Department of Mechatronics Engineering

MT19611 – Innovation and Design Thinking for Mechatronics

Report

on

DESIGN OF REAL TIME TYRE PRESSURE MONITORING FOR TWO WHEELERS

Submitted by

ABISHEK S 2116201201001

in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

MECHATRONICS ENGINEERING

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BONAFIDE CERTIFICATE

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Signature of the Faculty-in-Charge

Submitted for the practical Examination held on _____

Internal Examiner External Examiner

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CHAPTER 1

EMPATHIZE

1.1 INTRODUCTION

A tyre pressure monitoring sensor (TPMS) is a device that uses an Arduino micro controller to monitor tyre pressure and display it on an LCD. In the event that the tyre pressure drops below a predetermined level, the device is intended to warn the driver. A TPMS sensor, an Arduino board, an ESP8266 Wi-Fi module, an LCD display, and an LED make up the system.The TPMS sensor, which is mounted inside the tyre, measures the pressure inside the tube. It wirelessly transmits this data to the Arduino board. This data is delivered to the Arduino board, which processes it. When the pressure drops below a predetermined threshold, the Arduino board is configured to detect the change. The Arduino board activates the LED if the pressure drops below the threshold.This tells the driver that there is low pressure.The pressure in the tyres is displayed on the LCD screen. The display has been created to be simple to read and comprehend. The pressure may be displayed on the display in PSI or kPa.

The pressure data from the sensor is transformed by the Arduino board so that it may be displayed on the LCD. The temperature of the tyre, which can also affect the pressure, may be one of the extra information shown on the display.The technology is made to recognise when tyre pressure is low due to a change in temperature or altitude in order to avoid false alerts. These elements are taken into account by the Arduino board's programming when determining the low pressure threshold.To notify the driver when the pressure drops below the threshold, an LED is installed in a noticeable spot, such as the dashboard. Depending on how serious the problem is, the LED may be red or yellow. The LED can also be made to flash or blink so as to grab the driver's eye.

To sum up, a tyre pressure monitoring system that combines a TPMS sensor with an Arduino board, an LCD screen, and an LED provides a reliable way to keep an eye on tyre pressure. In order to assist prevent accidents and save fuel, the system is built to

warn the driver if the pressure drops below a predetermined threshold. The system can be accurate and dependable with suitable calibration and testing..

1.2 PROBLEM STATEMENT

Any vehicle, including motorcycles, must operate safely and effectively, and maintaining adequate tyre pressure is essential. Contrary to fuel, the rider is not directly aware of the tyre pressure while the vehicle is moving. So the inquiry is: Is it possible to gauge tyre pressure while the bike is in motion?

Yes, it is possible to check tyre pressure while the bike is moving, but doing so calls for certain tools and methods. There are specific methods for using sensors to gauge tyre pressure.

Other specialised tyre pressure monitoring systems can measure tyre pressure when a bike is in motion in addition to some sensors. These devices employ inside-the-tyre sensors that take a precise pressure reading. They often appear in racing bikes and high-performance motorcycles.It's crucial to remember that checking tyre pressure when the bike is moving is not an easy operation. If not done correctly, it can be risky and calls for specific equipment and knowledge. For the measurement to be accurate, the bike must be travelling at an even rate, and the rider must be able to view the pressure reading while riding. If the pressure falls below a set level, certain systems can alert the rider visually or audibly.The fact that tyre pressure can vary depending on elements like temperature, riding technique, and road conditions makes it harder to measure tyre pressure when the bike is moving. This means that if the pressure reading is recorded while the bike is travelling quickly or on a bumpy road, it might not be correct. Therefore, it's crucial to regularly check the pressure when the bike is stationary and adjust it in accordance with the manufacturer's recommendations.

In conclusion, specialised tools like sensors make it feasible to check tyre pressure while a bike is moving. To ensure the bike is used safely and effectively, it is necessary to assess tyre pressure frequently. However, this needs knowledge and caution. In order to maintain peak performance, riders should be aware of the variables that affect tyre pressure and make the necessary adjustments.

CHAPTER 2

DEFINE

Direct and indirect TPMS sensors are available. While indirect TPMS sensors utilise wheel speed sensors to estimate tyre pressure based on the rotational speed of the wheels, direct TPMS sensors employ a pressure sensor to monitor the pressure inside the tyre. **Direct TPMS sensors are more accurate and reliable than indirect sensors.** We can use Direct TPMS Sensor to measure the pressure and with the help of IoT, so that we can obtain trustworthy wireless information that will be shown on the car's analogue or digital speedometer display.

We are able to precisely gauge the tyre pressure and provide those readings on an analogue or digital display unit. The TPMS sensor functions by detecting tyre pressure and communicating that data to a receiver inside the car. We can set up the display unit to display the most recent tyre pressure data using an Arduino. We can use an LED light to inform the driver if the tyre pressure exceeds the manufacturer's limit. This will protect the tyre from additional harm and guarantee the driver's and passengers' safety.When the LED gadget indicates that the tyre pressure has exceeded the limit, the driver has two options: either fill the tyre with air at a petrol station or air station close by, or adjust the limit. This will guarantee that the tyre pressure is kept within the recommended range and that the car runs well. It is important to remember that maintaining tyre pressure within the advised range offers various advantages. It **increases the vehicle's overall handling and stability, lowers tyre wear, and increases fuel efficiency.**

Additionally, it lessens the chance of tyre failure and blowouts, which may be costly and dangerous. It's crucial to regularly check tyre pressure in addition to maintaining adequate tyre pressure. A TPMS sensor will enable you to achieve this. The use of the vehicle, the weather, and other variables will all affect how frequently the tyre pressure should be checked. However, it is advised to check the tyre pressure before long excursions and at least once each month. Additionally, it's critical to

confirm that the tyres are inflated according to the recommendations of the vehicle's manufacturer. The performance and safety of the vehicle might be impacted by either over- or under-inflation of the tyres.Overinflated tyres can result in a rough ride and early tyre wear, while underinflated tyres can cause poor fuel economy, increased tyre wear and decreased traction.

In conclusion, we can precisely determine the tyre pressure and display it in an analogue or digital display unit by keeping a TPMS sensor in the tubes and utilising an Arduino. This will protect the tyre from additional harm and guarantee the driver's and passengers' safety. For optimum vehicle performance and safety, it's also crucial to frequently check the tyre pressure and make sure the tyres are inflated appropriately.

2.1 CONSTRAINTS

- **Potholes**:Potholes' effects on the system may result in erroneous readings or damage to the sensors, which may result in system failure. The sensor may not notice a fast shift in pressure brought on by potholes.
- **Pits and Speed breakers:** While speed breakers might cause the tyre to compress and affect the pressure readings, pits can cause the tyre to strike the rim and lose pressure**.**
- **Climate Change:**The accuracy of the data and tyre pressure can both be impacted by climate change. Pressure changes can result from temperature changes; for every 10 degrees Fahrenheit drop in temperature, there is a reduction of 1 psi in pressure. This means that the tyre pressure might drop dramatically in cold conditions, resulting in under inflation and decreased fuel economy. These temperature variations can be accounted for in the system's design, and the readings can be adjusted accordingly.
- The performance of the system and the accuracy of the readings can both be impacted by wireless signal interference

- The system needs to be built to survive challenging environmental factors like high temperatures, wetness, and vibrations.
- The power source needs to be dependable and able to supply enough power to run the TPMS sensor, Arduino board, ESP8266 Wi-Fi module, LCD display, and LED.
- The LCD screen must be legible in a variety of lighting circumstances, including direct sunlight and dim surroundings.
- The entire system must be compatible with a wide range of vehicle types and models.
- The size and weight of the components must be taken into account to ensure they do not interfere with the normal operation of the vehicle or harm other components.
- To make the system affordable for the majority of car owners, the cost of the components must be acceptable.
- The software must be easy to use, and the system must be designed to require minimal maintenance.
- The system must be consistent with pertinent laws and standards for automobile safety and electrical components, and the software must be simple to use and require little maintenance

2.2 OBJECTIVE

To design a Tyre Pressure Monitoring System (TPMS) that precisely gauges tyre pressure and shows it on an analogue or digital display device. When the tyre pressure goes above the advised limit, the system will notify the driver, increasing safety and reducing the chance of tyre failure.

2.3 DESIGN CHALLENGE ISSUE

Sensor placement, measuring pressure readings in **pits, potholes, bumps in the road**, and **climate change**,**power consumption, compatibility, durability, calibration,** cost, user interface, and wireless connectivity are some of the design challenges that may be faced during the implementation of the TPMS project.

CHAPTER 3

IDEATE

3.1 GENERALISED SOLUTONS

Tyre pressure can be checked using pressure gauges found at petrol stations or houses, but having one with you all the time is not practical. When a vehicle is being driven for lengthy distances and the tyre pressure needs to be checked frequently, this can be extremely challenging.

Utilizing a mobile tyre pressure gauge is one approach to deal with this problem. These gadgets are portable and light enough to carry along. They simply function by being fastened to the tyre's valve stem and being read to determine the pressure. These gauges are practical, but they need to be calibrated frequently to remain accurate.

Tyre pressure cannot be accurately determined by just applying pressure on the tyre, though. This is due to the fact that it disregards the necessary pressure for the particular tyre and the load it is bearing. Furthermore, because it increases the risk of the tyre bursting, over-inflation is exactly as risky as under-inflation.

Another option is to use tubeless tyres. These tyres are built to automatically patch any punctures, which increases their durability and lowers their risk of blowouts. Additionally, they do not need inner tubes, which might lead to air leaks. Tubeless tyres can cost more than conventional tyres, and they also need to be balanced with greater care, which raises the price even more.

In general,each of these methods has pros and cons. A portable tyre pressure gauge is an easy and inexpensive solution, but it needs to be calibrated frequently.

3.2 PROPOSED SOLUTION

Tyre pressure monitoring systems (TPMS) are becoming more prevalent in contemporary automobiles as they offer real-time data on tyre pressure, which is crucial for upholding safe driving conditions, maximising fuel efficiency, and lowering tyre wear. The TPMS is made up of a sensor within each tyre that monitors tyre pressure and transmits the information to an inside display unit.

The pressure is measured by the TPMS sensors using a variety of technologies, including direct and indirect approaches. Direct TPMS measures tyre pressure with pressure sensors installed inside the tyre, either on the wheel valve stem or inside the tyre itself. The vehicle's receiver receives the wireless pressure data from the sensor and shows it on the dashboard. Indirect TPMS monitors the wheel speed sensors using the vehicle's ABS system to find any irregularities in the tyre pressure, including low pressure or a flat tyre.

Although TPMS is a good option for tyre pressure monitoring, installation costs might be high. Each tyre must have a sensor, which might be expensive to repair if lost or damaged, for direct TPMS to work. While indirect TPMS is less expensive than direct TPMS, it is also less precise and trustworthy. The TPMS system is more expensive because it also needs a display device in the car.

For most drivers, the advantages of TPMS outweigh the costs, though. The TPMS helps optimise fuel efficiency and reduce fuel expenditures by keeping the right tyre pressure. By detecting and eliminating under inflation, which can result in uneven wear and damage to tyres, TPMS can also assist increase tyre life. A crucial safety feature for any vehicle, TPMS also helps to avoid accidents brought on by tyre failure from underinflation.

To sum up, TPMS is a good option for tyre pressure monitoring because it gives the driver real-time information and warns them if the pressure dips below the advised limit. The majority of drivers consider TPMS to be a worthwhile investment despite the fact that it can be costly to install because to the advantages of better safety, decreased tyre wear, and improved fuel efficiency.

3.2.1 FLOWCHART OF THE PROPOSED SOLUTION

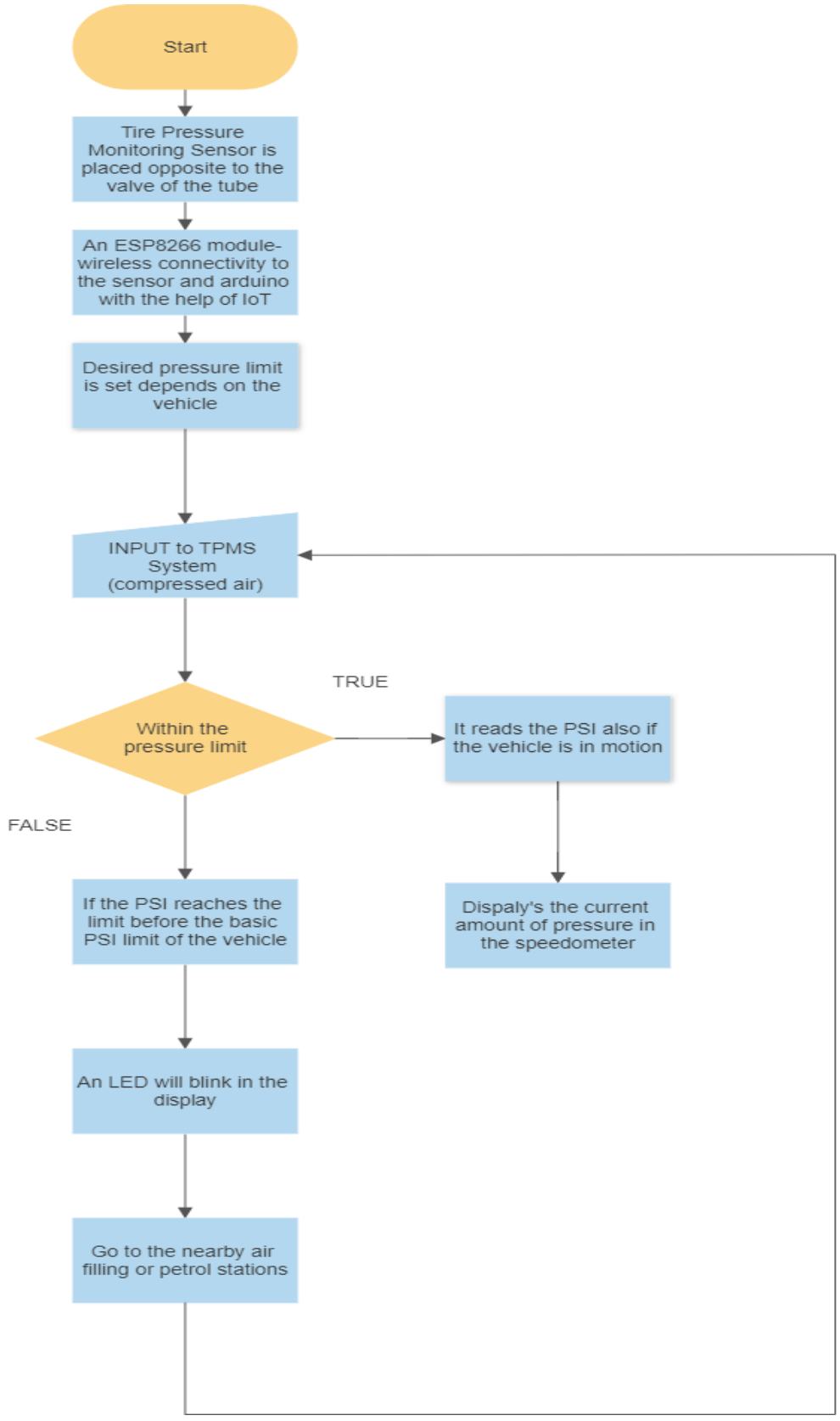

Fig 3.2: Flowchart of the proposed solution

3.2.2 WORKING OF THE FLOWCHART

The flowchart for creating and installing a TPMS system using an Arduino board and a sensor circuit offers a succinct and straightforward breakdown of the processes required in the procedure. The method begins with choosing the system's components, including the Arduino board, sensor circuit, LCD display, LED indication, and wireless connection module if necessary. It's critical to choose components that are of a high calibre, are dependable, and work together and with the intended application.

The sensor circuit that will be used to measure the tyre pressure must be designed after the components have been chosen..

The next step in the process is the Arduino board will then be programmed to gather data from the sensor circuit, show it on the LCD display, and turn on the LED indicator if the pressure exceeds the predetermined limits. Programming should be done in a dependable, efficient, understandable, and flexible manner.

After the programming is finished, the system must be tested in various weather and traffic situations to make sure it is accurate, dependable, and functioning. The system should undergo testing to ensure that it can measure tyre pressure with accuracy, display data on an LCD display, and turn on an LED alert when the pressure exceeds predetermined limits. The system should also be put to the test to see how well it handles various climatic factors including heat, cold, wetness, and vibration..

The sensor circuit should be calibrated and changed as necessary if any issues or problems are found during the testing phase to make sure it complies with the standards. To make sure that the system is operating properly, it should be tested once again after any modifications or revisions.

The system can be put for usage once it has undergone thorough testing and is in good working order. The system must be correctly installed in the car and come with detailed operating instructions for the user. To guarantee that the system keeps working properly over time, it is also crucial to provide continuing support and maintenance.

Overall, careful planning, close attention to detail, and an emphasis on accuracy, reliability, and functionality are needed when building and implementing a TPMS system using an Arduino board and a sensor circuit. With the appropriate methodology, a system that delivers real-time tyre pressure monitoring, boosts fuel efficiency, lessens tyre wear, and improves vehicle performance and safety might be created.

CHAPTER 4

PROTOTYPE

The design consists of

i. A **TPMS** sensor

ii. An Arduino board

iii. ESP8266 Wi-Fi Module

iv. An LCD display and

v. A LED.

4.1 COMPONENTS DESCRIPTION

4.1.1 Tyre Pressure Monitoring Sensor (TPMS):

A device called a Tyre Pressure Monitoring Sensor (TPMS) is used to gauge how much air is in a car's tyres. It contributes to increased vehicle safety, fuel efficiency, and tyre life, making it an essential part of contemporary automobiles. Both individual TPMS sensors and a single sensor can be utilised to wirelessly communicate and monitor all of the tyres.

The working principle of TPMS is simple in comparison. The sensors give data to a monitoring system after measuring the tyre pressure. The monitoring system then examines this data and gives the driver up-to-date tyre pressure information. The monitoring system is typically built into the dashboard of the car, and the driver may see the tyre pressure readings on a screen there.

Direct and indirect TPMS are the **two primary forms**. The direct TPMS measures air pressure using a sensor positioned inside the tyre. The monitoring system then receives this information from the sensor and shows the tyre pressure measurements on a screen. Since it offers real-time tyre pressure information, the direct TPMS is more accurate than the indirect TPMS..

The Indirect TPMS, the air pressure is not measured using a sensor, on the other hand. The anti-lock braking system (ABS) of the car is what it uses to keep track of the tyre pressure. The indirect TPMS tracks variations in the tyre's rotational speed, which is influenced by air pressure. The driver receives a warning from the monitoring system to check the tyre pressure if there is a noticeable difference in the rotational speed of the tyres.

The Direct TPMS since it gives real-time tyre pressure information, direct TPMS is more accurate than indirect TPMS. However, installing and maintaining a direct TPMS is more expensive than doing so with an indirect TPMS. Although the indirect TPMS is less expensive to install and maintain than the direct TPMS, it is less precise.

The sensor, antenna, receiver, and control module are the four essential parts of the TPMS system. The sensor, which detects tyre pressure, is positioned inside the tyre. Data is transmitted from the sensor to the receiver through the antenna. The data is received by the receiver, which is within the car, from the antenna. The data is processed by the control module, which then gives the driver a real-time reading of the tyre pressure.

Either a battery or the vehicle's electrical system can provide power for the TPMS sensors. Since battery-powered sensors are simpler to install and maintain, they are more popular. The battery-operated sensors need to be changed after a lifespan of roughly 5 to 10 years. On the other hand, the sensors that are powered by the vehicle's electrical system do not have batteries. These sensors outperform battery-powered ones in terms of dependability and longevity.When the tyre pressure is excessively low or high, the TPMS system can be set up to warn the driver. The system can be set up to notify the driver if the tyre pressure deviates from a predetermined range.Using the monitoring system, the driver can also manually change the tyre pressure settings.

In summary, the TPMS is a crucial part of contemporary cars that serves to raise vehicle safety, fuel economy, and tyre longevity. The tyre pressure is measured by the sensors, which then relay this information to the monitoring system. The system can

be set up to notify the driver when the tyre pressure is too high or low, and the driver can also manually change the tyre pressure settings.

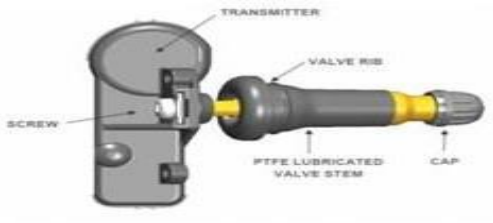

Fig 4.1.1: TPMS SENSOR

4.1.2 Arduino UNO:

The open-source Arduino hardware and software platform is made for creating electronic projects. It is built on a micro controller, and users can write and upload code to the board using a programming environment. The Arduino platform is well-liked by professionals, academics, and hobbyists who seek to develop interactive projects and prototypes.The Arduino Integrated Development Environment (IDE) is used to programming the Atmel AVR microprocessor that serves as the foundation of the Arduino board. Users can create code, compile it, and upload it to the board using the IDE, a straightforward yet effective programming interface. Digital input/output, analogue input, and serial connection pins are just a few of the input and output options available on the Arduino board.

Sensors, actuators, displays, and other parts can be connected to the board using these pins.Arduino's simplicity is one of its best qualities. Even for novices with little to no programming knowledge, the platform is made to be simple to use. For usage as a jumping off point when creating projects, the IDE offers a library of pre-written code and examples. Users can learn about Arduino and exchange knowledge through a variety of online forums, tutorials, and other resources.Arduino's adaptability is another important characteristic. The platform is highly adaptable and suitable for a variety of

applications. Users can alter the platform's code, hardware, and software to meet their own requirements thanks to its open-source nature.Due to this, numerous versions of Arduino boards have been created, including more powerful boards for sophisticated robotics and automation projects and smaller, more portable boards for wearable technologies.

In broad terms, Arduino is a robust and flexible platform that is suitable for a variety of electronic applications. Its ease of use and simplicity make it the perfect platform for new users, while its open-source status and flexibility make it a potent tool for experts and seasoned users.

Fig 4.1.2: Arduino UNO

4.1.3 ESP8266 Wi-Fi Module:

A low-cost Wi-Fi microprocessor called the ESP8266 was created by Chinese company Espressif Systems. It is a strong tool with a wide range of Internet of Things (IoT) applications. With its integrated TCP/IP stack, the ESP8266 Wi-Fi module can connect to a Wi-Fi network and communicate with other devices online.

You can use the Arduino IDE or the Lua scripting language to programme the ESP8266. The development of unique applications for the module is made simple by this. It can be used as a standalone micro controller and is also compatible with a wide range of other development boards.

Low power consumption is one of the ESP8266's main benefits. It includes a deep sleep mode that utilizes just a few micro amps of electricity and can run on as little as 3.3V. It is therefore perfect for battery-powered applications like wearables, smart homes, and sensors.With its integrated Wi-Fi antenna, the ESP8266 can connect to both 2.4GHz and 5GHz Wi-Fi networks.

Additionally, it contains GPIO pins for attaching sensors, actuators, and other electronic components. Additionally, a UART interface that supports serial communication is present.The ESP-01, ESP-12E, and ESP-32 are a few of the ESP8266's variants. The quantity of flash memory, the processing power, and the number of GPIO pins vary between versions.

In general, the ESP8266 Wi-Fi module is a strong and adaptable component that is suitable for a variety of IoT applications. It appeals to both developers and enthusiasts due to its low price, low power consumption, and simple programmability.

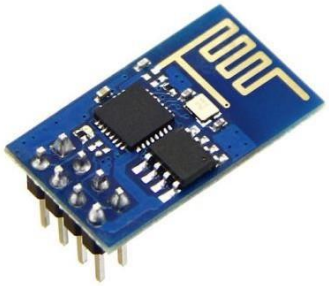

Fig 4.1.3: ESP 8266 Wi-Fi Module

4.1.4 Liquid Crystal Display (LCD) Display:

A flat-panel display technology known an LCD (Liquid Crystal Display) creates images using liquid crystals. Because they are portable, power-efficient, and can show data, text, and images, LCDs have gained popularity as a technology.Electronics including televisions, computer monitors, smartphones, and calculators frequently employ LCD displays. They are made up of two sheets of polarising material and a layer

of liquid crystal material. The crystals align themselves when an electric current is supplied, allowing or blocking light from flowing through the polarizing layers to produce an image.In comparison to other display technologies, LCD displays provide a number of benefits. Compared to CRT displays, they use less energy, provide finer images, and are smaller and lighter.

They are also more dependable and have a longer lifespan.Since LCD displays can easily be connected to a micro controller or computer via a variety of interfaces like SPI, I2C, or parallel, they are frequently used in embedded systems and micro controller-based projects. An LCD display is a common option for projects like weather stations, temperature monitoring systems, and more since it enables the user to display information in a user-friendly and readable way.

Overall, LCD displays are a flexible and extensively used technology for information display, and their interoperability with micro controllers and other electronic devices makes them a popular choice in embedded systems and DIY projects.

Fig 4.1.4: LCD Display

4.1.5 Light Emitting Diode (LED):

A semiconductor device known as an LED (Light Emitting Diode) emits light when a current flows through it. Indicator lights in electrical gadgets and appliances are a frequent application for LED's, but they are also employed as light sources in lighting systems, automobile illumination, and even outdoor displays.Compared to other light

sources, LED's provide a number of benefits. They last longer, use less energy, are more resilient to stress, and are more durable. They also come in a variety of colors, and with the aid of a current-limiting resistor or PWM (Pulse Width Modulation), they may be readily dimmed or brightened.

In micro controller-based projects, LED's are frequently utilized as a visual indicator to show the state of a system or to give the user feedback. An LED can be used, for instance, to show the level of a sensor reading or to show whether a button has been pressed or whether a device is switched on or off.

In general, LED's are a flexible and popular technology for giving visual feedback and displaying a system's or device's condition. They are an appealing option for both DIY projects and professional applications because of their low power consumption,durability, and long lifespan.

Fig 4.1.5: LED

4.2 BLOCK DIAGRAM OF THE PROPOSED SOLUTON

Fig 4.2: Block diagram of the proposed solution

4.3 WORKING OF THE COMPONENTS

The suggested project seeks to create a TPMS sensor and Arduino board-based tyre pressure monitoring system. A vehicle's tyres' air pressure will be monitored by the system, and readings will be shown on an LCD panel. Additionally, if the pressure falls below a predetermined level, it will warn the driver using an LED.To gauge air pressure, the TPMS sensor will be installed into each tyre of the car. The sensor will wirelessly connect to the Arduino board and transmit the pressure values there. The data will be processed by the Arduino board, and the readings will be shown on an LCD panel.An LED will be mounted on the dashboard to notify the driver in the event of low tyre pressure.

The user can additionally specify the tyre pressure threshold. The LED will turn on if the pressure falls below this mark, allowing the driver to fill the tyre as needed.When the car is not in use, the system will also be built to conserve energy by placing the Arduino board and the TPMS sensor into sleep mode. This will increase the battery life of the TPMS sensor and the Arduino board.

In conclusion, the following may be said about how the project is run: The TPMS sensor will monitor the tyre pressure and transmit the information to the Arduino board. Data processing and LCD screen readings are done by the Arduino board. The dashboard LED will turn on to warn the driver if any tyre's pressure falls below the user-set threshold level. The Arduino board and the TPMS sensor will be put into sleep mode when not in use as part of the system's power-saving architecture.

The advantages of tyre pressure monitoring devices are evident overall. It improves safety, lowers fuel consumption, increases tyre life, and assures regulatory compliance. A worthwhile investment for every car owner, TPMS systems are becoming more accessible and affordable for all drivers. Therefore, developing and implementing a TPMS system could be a crucial undertaking with important advantages for both individuals and enterprises.

CHAPTER 5

TEST

Maintaining the ideal tyre pressure is crucial for safe and efficient driving. Low tyre pressure can increase fuel consumption, limit tyre life, and compromise safety since it causes less traction and stability. However, overinflated tyres are more likely to blow out, lose traction, and wear unevenly, all of which can lead to accidents.

The tyre pressure monitoring system (TPMS), a critical safety feature in modern vehicles, solves this issue. Sensors in the TPMS assess tyre pressure and alert the driver if it varies from or exceeds the recommended range. By ensuring that the tyres are always inflated to the recommended pressure, the TPMS system increases tyre life, safety, and fuel efficiency.

Outside of boosting safety, TPMS has financial benefits. Drivers may incur annual costs of several hundred dollars due to reduced fuel economy brought on by overinflated or underinflated tyres. The proper tyre pressure may be maintained with the aid of a TPMS system, saving drivers money on petrol and tyre replacement costs.

The use of tyre pressure monitoring systems is also becoming more and more common in other countries due to safety concerns. The National Highway Traffic Safety Administration (NHTSA) in the United States, for instance, requires the installation of TPMS as a safety feature on all new cars. All new cars sold in the European Union must have TPMS as of 2014.

Furthermore, TPMS is not only for cars and trucks. Additionally, it is essential for commercial vehicles like buses, delivery trucks, and heavy equipment that have strict requirements for safety and fuel efficiency. Because of the more difficult road and weather conditions that these vehicles commonly experience, it is especially crucial to ensure that the tyres are properly filled.

An important added benefit is the real-time data that TPMS provides that may be used for preventative maintenance. Because TPMS sensors can detect slow leaks or

punctures, drivers can take the necessary action before the tyre fails or blows out. This feature reduces maintenance expenses and downtime for commercial fleets and aids in preventing accidents caused by tyre blowouts.

Overall, it is clear that tyre pressure monitoring technology has benefits. It extends tyre life, decreases fuel consumption, and ensures regulatory compliance. TPMS systems are becoming more widely available and reasonably priced for all drivers, making them a reasonable investment for all automobile owners. As a result, creating and implementing a TPMS system may be an essential task with significant benefits for both individuals and businesses.

CHAPTER 6

DESIGN CHALLENGE

Sensor placement: Figuring out the ideal location to put the sensor in the tyre so that it can correctly monitor pressure without affecting the tyre's performance

Measuring the pressure readings during pits, potholes, speed breakers and climate change: Unexpected vibrations and shocks that cause errors. The sensors may produce misleading readings as a result of these abrupt shocks and vibrations, which may reduce the tyre pressure monitoring system's accuracy. Incorrect tyre pressure adjustments brought on by inaccurate measurements might compromise safety and increase tyre wear.

Power consumption: Selecting the proper sensor with low power consumption to ensure long battery life and reducing the display unit's power consumption.

Compatibility: Choosing a sensor and display unit that are compatible with the electrical system of the car as well as one another.

Durability: Making sure the sensor and display unit are able to withstand difficult terrain and adverse conditions.

Calibration: In order to provide precise readings and prevent false alarms, the sensor and display unit must be calibrated.

Cost: Weighing the system's price, effectiveness, and precision.

User interface: Creating a simple, user-friendly interface for the display device to make it simple to monitor tyre pressure and take appropriate action as necessary.

Wireless connectivity: Including wireless connectivity for safe data transmission, remote monitoring, and warnings.

How to overcome these challenges?

Sensor placement: Choosing the best location for the sensor inside the tyre and creating a sensor with the least amount of interference with tyre performance.

Measuring the pressure readings during pits, potholes, speed breakers and climate change: More durable sensors that can endure the impact of speed bumps and potholes can be used in TPMS systems. It is also possible to configure the system to overlook brief, abrupt variations in pressure readings brought on by speed bumps and potholes. This is possible by putting in place filtering algorithms that examine the pressure measurements over time and remove any rapid spikes that last for only a brief period of time.

Power consumption: Utilizing power-efficient sensors and displays, as well as power-saving features like sleep mode and power management.

Compatibility: Choosing regulated components and ensuring compatibility with the electrical system of the vehicle, the sensor, and the display unit.

Durability: Choosing robust parts and supplies and testing the system in adverse weather and driving situations.

Calibration: The sensor and display unit are calibrated on a regular basis to preserve accuracy, and sophisticated algorithms are used to prevent false alerts.

Cost: Weighing cost-saving strategies like modular design and mass production against effectiveness and precision..

User interface: Creating a user-friendly display unit interface with controls that are simple to understand and displays that are easy to read.

Wireless connectivity: Including encrypted data transmission and secure wireless access to enable remote monitoring and alarms.

CHAPTER 7

CONCLUSION

In conclusion, the tyre pressure monitoring system project, which makes use of a TPMS sensor, Arduino, ESP8266 Wi-Fi module, LCD display, and LED, is a vital one for contemporary cars. In order to provide safe driving conditions, avoid accidents, and save fuel consumption, the system offers real-time tyre pressure monitoring. The technology also assists in extending tyre life by identifying and preventing under inflation, which can result in uneven tyre wear and damage.

The project has substantial effects on environmental sustainability and traffic safety. The technique helps to make driving safer by lowering the amount of collisions brought on by under-inflated tyres failing. The system is a crucial part of sustainable transportation because it also aids in lowering fuel usage and emissions.

The installation of a TPMS system is an easy-to-integrate, simple-yet-effective option for most automobiles. It is a practical solution that offers real-time tyre pressure monitoring, making it a necessary part of contemporary automobiles. Additionally, the system is adaptable and may be enhanced in the future by adding cutting-edge features like automated pressure adjustment and preventative maintenance based on tyre wear trends.

The tyre pressure monitoring system is a useful project that can help make driving safer, more effective, and sustainable. It uses a TPMS sensor, Arduino, ESP8266 Wi-Fi module, LCD display, and LED. It is a superb illustration of how technology can be used to address issues in the real world, and it has enormous potential for advancement in the future.

CHAPTER 8

PROTOTYPE IMAGES

Fig 8.1: Isometric view

Fig 8.2: Front view

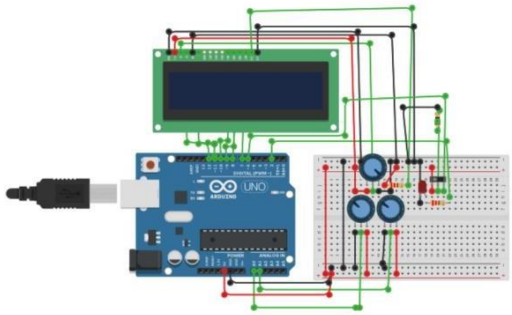

Fig 8.3: A circuit is developed in TINKERCAD

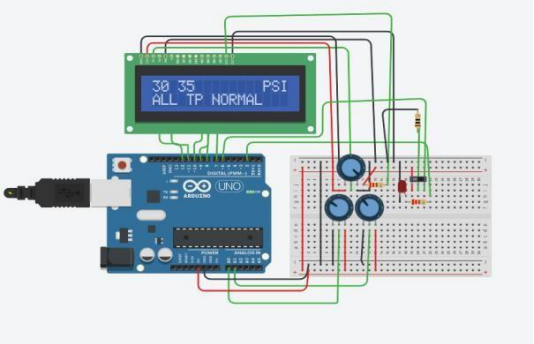

Fig 8.4: The pressure in both the tyres are within the limit

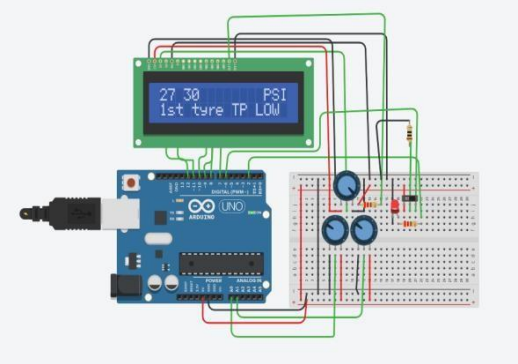

Fig 8.5: The LED indicates that the amount of of pressure in front tyre is low

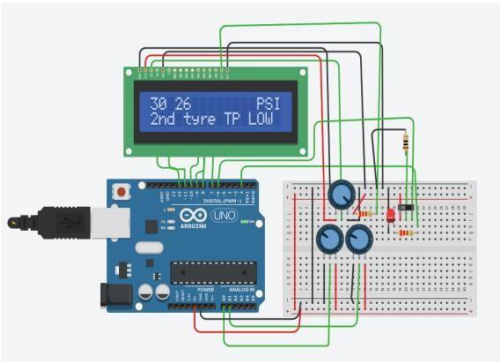

Fig 8.6: The LED indicates that the amount pressure in back tyre is low

CHAPTER 9

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