SSRG International Journal of Mechanical Engineering
ISSN: 2348 – 8360 /doi:10.14445/23488360/IJME-V5I3P101
Volume 5 Issue 3, 1-5, February 2018

Autonomous Tyre Pressure Maintenance System

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Abstract- *One of the most important factors in tyre care is proper tyre pressure at all times. Studies show that a drop in tyre pressure by just a few units can reduce mileage, tyre life, safety, and vehicle performance. With this project, we intend to develop an automatic, self-inflating tyre system that ensures that tyres are properly inflated at all times. Our design proposes using a portable compressor that will supply air to the tyre via hoses and a rotary joint associated with each wheel. The rotary joints effectively allow air to be channelled to the tyres without the tangling of hoses. With the recent oil price hikes and growing concern of environmental issues, this system addresses a potential improvement in gas mileage; tyre wears reduction; and an increase in handling and tyre performance in diverse conditions.*

Keywords-*Tyre Pressure, Working Unit, Control Unit, Pumping Unit.*

I. INTRODUCTION

A. General

Every section of an automobile is getting automated except one- Tyres. When tyres are under-inflated, the tread wears more quickly. According to Goodyear, under-inflation results in about 15% lesser kilometers than properly inflated tyres. Under-inflated tyres also overheat more quickly. This project is aimed at removing such unwanted strain, save time, and save money. The system has a dedicated unit for filling air whenever required.

B. Materials

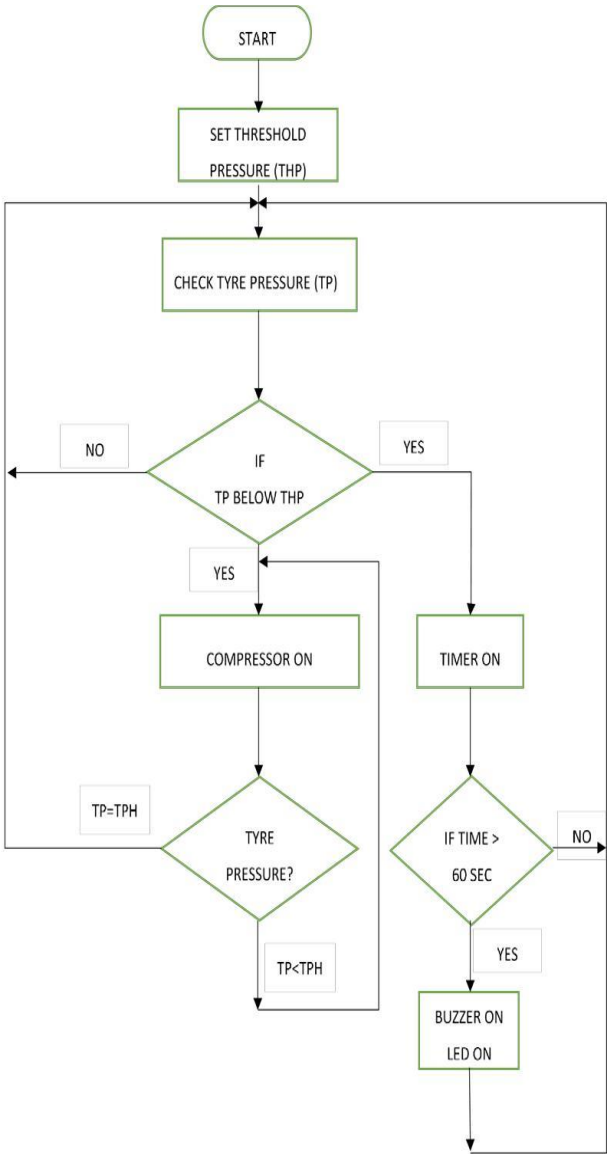
Materials used: Air Compressor, Rotary Union, Pressure Transducer, Arduino Board, XBee modules,

II. EXPERIMENTAL PROGRAMME

The system can be divided into three:

- Control Unit
- Pumping Unit
- Display Unit

The experimental program is converted into the flowchart shown below for easy assessment and easy understanding.



A. Major Experimental Program

In the part of the control unit associated with the tyre, the pressure sensor is constantly measuring the pressure. The measured pressure value is converted to a corresponding voltage by the pressure transducer and is fed to the Arduino board. It is then converted to wi-fi signals. A wi-fi receiver then receives the incoming wi-fi signals. It is then converted to the corresponding voltage value. If the incoming value is less than the value stored in the unit's memory, the

control unit sends a signal to turn on the compressor, and it works till the incoming pressure value and the stored pressure value become the same.

If the pressure doesn't reach the required value even after a long air pumping time, it is identified as a puncture. In this case, the driver is warned about the puncture by blinking the LED and producing beep sounds. At a particular instant of time, the pressure transducer acts as a sensor to sense the pressure inside the tyre and compare the threshold limit that we set by programming using the ARDUINO UNO board. This can be obtained from the following two possibilities. One is the current pressure, or can be said as the tyre's sensed pressure is equal to the threshold pressure. The second possibility is that the sensed tyre pressure is less than the threshold value that we set. If we consider the first possibility, if the sensed tyre pressure is equal to the threshold value, then there is no need for the compressed to be ON. So, nothing happens. And after a particular instant of time, again, the pressure transducer checks or senses the tyre pressure and compares the obtained value with the programmer set's threshold value. And if the second possibility obtains here, if the tyre pressure is less than the threshold limit, the program is to on the compressor and makes the air fills inside the tyre. The pressure is less than the threshold limit; the compressor gets ON and fills the tyre to the threshold value. If the pressure went below 28psi, the compressor gets ON, and the tyre gets filled with air till the pressure inside the tyre reaches 32psi, since our threshold value is 32psi. At every programmed instant of time, the pressure transducer senses the pressure. So, if the tyre pressure is again lower than the threshold limit, the compressor keeps filling the tyre with air until the tyre pressure meets the threshold value (32 psi). If the tyre pressure equals the threshold value, the compressor stops functioning. The pressure transducer is working simultaneously and monitoring whether the measured pressure is equal to threshold pressure or equal. If the measured pressure is less, the compressor remains on till the pressure become equal. When they are equal, the compressor turns off, and the monitoring of pressure inside the tyre occurs continuously.

The timer works and monitors whether the pressure is increasing when the compressor is on, and if not, it is identified as a puncture, and the buzzer and led turns on, which warn the driver. If not, the system checks the pressure continuously.

III. COMPONENTS AND SPECIFICATIONS

A. Air Compressor

In this project, an RNG EKO GREEN brand air compressor was used. It is a positive displacement pump and is a piston type. The air is pressurized by the reciprocating movement of a piston inside a chamber. It works on 12v and can be operated on a car battery. It gives an output of 70 L of air per minute. It is a low-pressure compressor having a pressure range of 0-150psi. It can be used to inflate the tyre of bikes, cars, trucks, and buses.

B. Rotary Union

The main challenge of the system is the connection between the stationary compressor unit and the rotating tyre. The rotary union is the component that makes this possible. It is a device that provides a seal between a stationary supply passage and a rotating part to permit the flow of a fluid into and out of the rotating part. While rotary unions come in many shapes, sizes, and configurations, they always have the same four basic components: a housing unit, a shaft, a bearing, and a seal.

C. Pressure Transducer

A transducer is a device that converts one form of energy to another. Usually, a transducer converts a signal in one form of energy to a signal in another. Transducers are often employed at the boundaries of automation, measurement, and control systems, where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position,etc.). The process of converting one form of energy to another is known as transduction.

In this project, a generic pressure sensor with a working range of 0 to 1 MPa is used. It works on an input of 5 volts. The sensor measures the pressure inside the tyre and converts it to corresponding voltages.

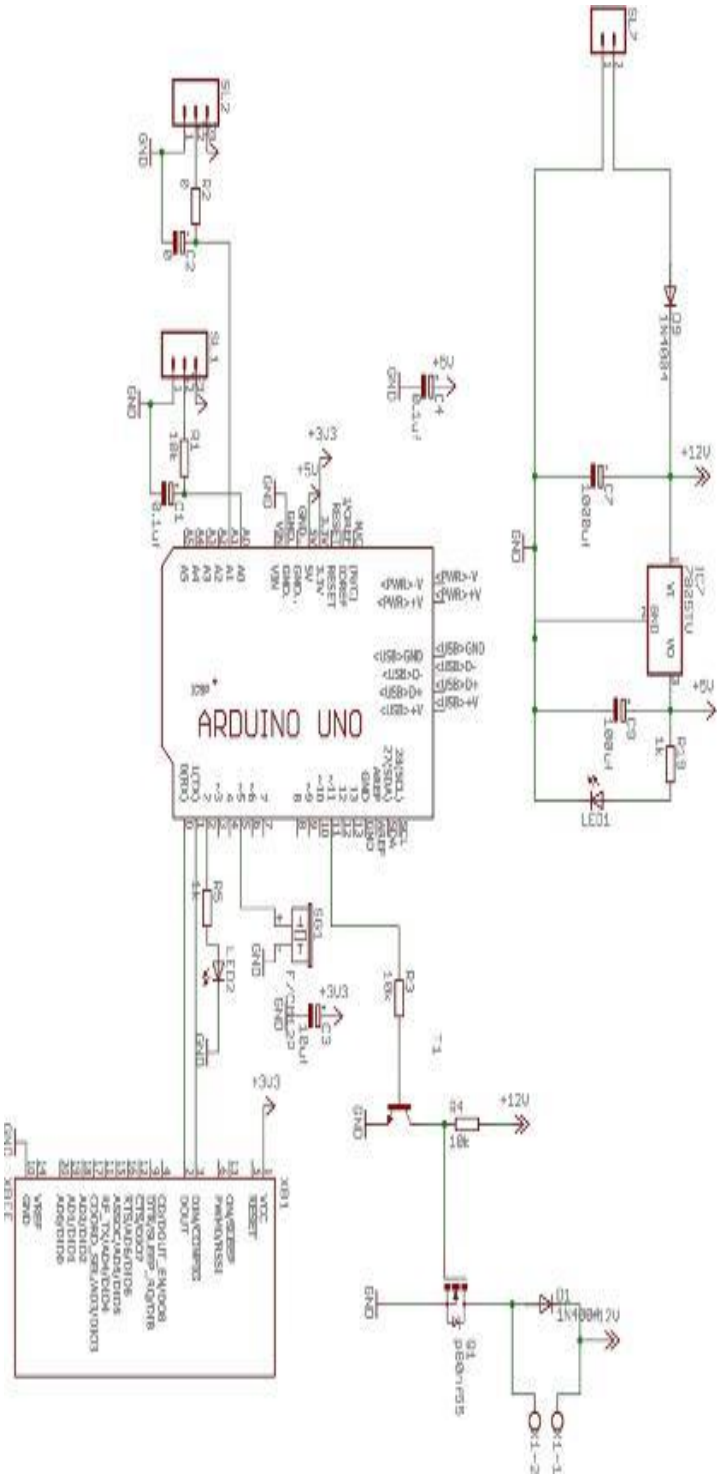
D. C-Clamp And Attachments

C clamp, which can be attached to the tyre, is made to connect the rotary union. Arrangements for connecting the compressor outlet pipe to the rotary union and the rotary union outlet to the tyre's valve are made.

E. Other Attachments

A 12v battery is placed onto the bottom platform of the frame. The compressor is also placed on the bottom layer. Power is taken from the battery for the working of the compressor. The airflow tube of the compressor is attached to the rotary union. Another tube is used to connect from the rotary union to the tyre for airflow. A wi-fi receiver and control module is placed on the upper platform, which controls the compressor's working according to the variation in pressure inside the tyre. A sensor and a wi-fi transmitter associated with an Arduino board are placed on the tyre to transmit the wi-fi receiver's pressure details.

IV. PROGRAMMING OF CONTROL UNIT



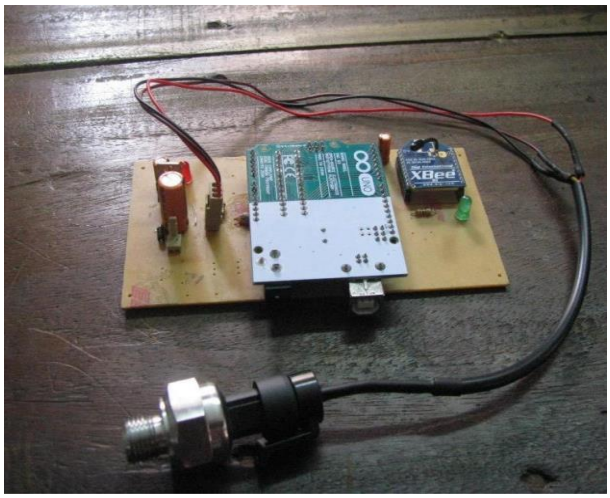
A. Program Of The Control Unit

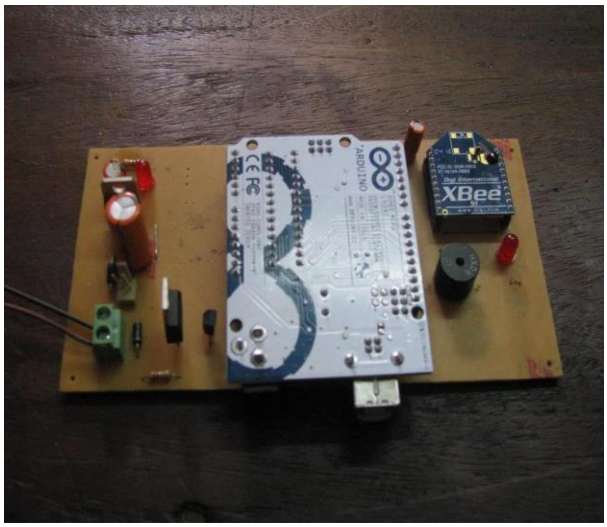
```
const int buzzer=5;
const int LED=2; const int pump=11;

int sensor value;
int blink speed;

void setup() { Serial.begin(9600);

pinMode(buzzer, OUTPUT); pinMode(LED,
OUTPUT);

digitalWrite(buzzer, HIGH);  // turn the LED on
(HIGH is the voltage level)
delay(1000); // wait for a second  digitalWrite(buzzer,
LOW);   // turn the LED off by making the voltage
LOW  delay(1000);  // wait for a second

blinkspeed=200;
} void loop()
{
if (Serial.available() > 0)
{
sensorValue = Serial.read()*4;
Serial.println(sensorValue);
}

if(sensorValue<28)        blinkspeed=1000;        else
if(sensorValue<29)        blinkspeed=250;        else
digitalWrite(LED, LOW); // turn the LED off by
making the voltage LOW

if(sensorValue<28)
digitalWrite(pump, HIGH);
if(sensorValue>30)
digitalWrite(pump, LOW);

digitalWrite(LED, HIGH);  // turn the LED on
(HIGH is the voltage level)

delay(blinkspeed);                    // wait for a
second  digitalWrite(LED, LOW);   //

turn the LED off by making the voltage LOW
delay(blink speed);
}
```

V. COMPONENTS OF CONTROL UNIT

A. Arduino boards

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may interfere with various expansion boards (shields) and other circuits. The boards feature serial.



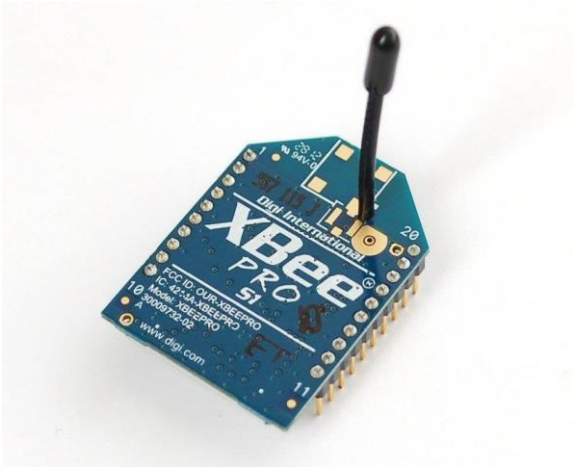


B. XBee modules

XBee module is used in the present study. This module is series #1 (802.15.4 protocol) 60mW wireless module, good for point-to-point, multipoint, and convertible to a mesh network point. These are much more powerful than the plain XBee modules, great for when you need more range.

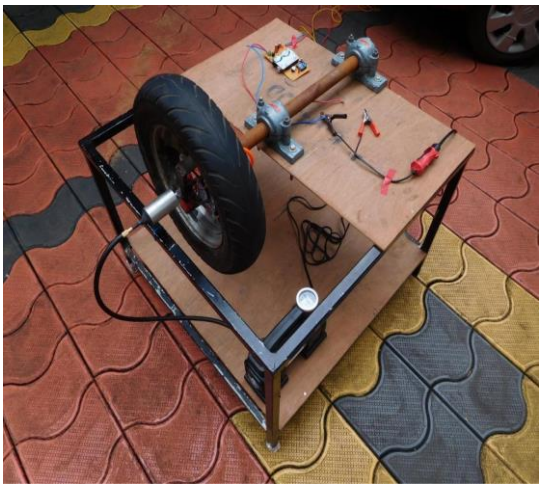
If you have two modules in range, they will automatically form a serial link with no configuration so that you can send TTL serial data back and forth. You can also configure the baud rate, as well as sleep modes, power modes, and tons more stuff using the Digi XBee tool.

The pins on an XBee are 2mm spacing, not 0.1", so they will not fit into a breadboard. This module comes with a wire antenna.



VI. TESTING OF THE SYSTEM

The components were assembled into a prototype on the frame. The tyre was initially set at a lower pressure level than the required pressure level. When the system is connected, we can see that the compressor turns on, and the tyre pressure increases. When the tyre pressure reaches the needed value, the compressor turns off automatically.



VII. CONCLUSIONS

If the system utilization is executed properly by taking and concerning all the relevant according to the project demand, the processing time, cost, and human efforts can be reduced in a great manner

The dynamic behavior of a pneumatic tyre is closely connected to its inflation pressure. Key factors like braking distance and lateral stability require the inflation pressures to be adjusted and kept as specified by the vehicle manufacturer. Extreme under-inflation can even lead to thermal and mechanical overload caused by overheating and subsequent, sudden destruction of the tyre itself. Additionally, fuel efficiency and tyre wear are severely affected by under-inflation. Tyres not only leak air if punctured but also leak air naturally, and over a year, even a typical new, properly mounted tyre can lose from 20 to 60 kPa (3 to 9 psi), roughly 10% or even more of its initial pressure.

The significant advantages of Automatic Tyre Pressure Maintenance System are summarized as follows:

1. Fuel savings
2. Extended tyre life
3. Decreased downtime and maintenance
4. Improved safety
5. Environmental efficiency

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