Detection and Prevention of Wheel Unbalancing and Tire Burst in Moving Vehicles

Dipak Ranjan Jana, Sumalatha Emmela, Ch.Monika, D.Archana, K.Thulasi Priya, K.Yamini

ABSTRACT- Fatal accidents are increasing day-by-day due to the failure of wheel bearing, unbalancing of wheel and tyre bursting due to increase in the temperature. Bearing is the most important mechanical device on which the wheel performance of a vehicle depends. Lack of proper periodic maintenance of the bearing leads to the failure of bearing, which results in wheel misalignment. Hence, tyres with wheels come out from the axial in moving condition, which results in accidents. Bearing failure can also be due to bearing buckling, scratches, nicks, discoloration, corrosion and crack. This can be due to lack of lubrication or overheating etc. Also due to improper tyre pressure, harsh braking and increase in the temperature of the tyre, tyre gets heated up causing tyre bursting which leads to fatal accidents. The main objective is to detect tyre temperature and wheel alignment deviation, thereby providing indication through audio-visual system which prevents accidents of the vehicle and the driver from an injury or death. Hence, we have used ARDUINO UNO, ULTRASONIC SENSOR, LEDS, DHT-11 SENSOR and BUZZER.

KEYWORDS: Wheel Bearing, Unbalancing, Maintenance, Alignment

I.INTRODUCTION

This paper focuses on a new idea to prevent vehicle accidents due to tyre bursts and wheel misalignment. Tyre bursts are common on highways where vehicles move at very high speeds which lead to fatal crashes when the vehicle loses stability.

Fig 1: Tyre Burst

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The new design prevents this stability loss due to improper tyre pressure [1], harsh braking and increase in temperature by providing an indication. There is no need for the driver to get panic as the vehicle will be completely stable.

This will completely avoid accidents and provides safety for the passengers. Similarly, wheel misalignment due to bearing failure is common. By providing an indication to the driver to stop the vehicle, prevention of driver from an injury or death can be done successfully. Also, the damage being done to the vehicle can be avoided.

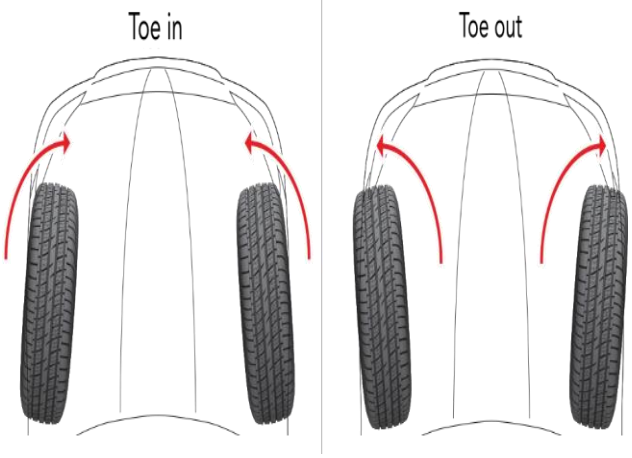

Fig 2: Wheel Misalignment

II.RELATED WORKS

Ryosuke Matsuzaki et al. discussed the key technologies of intelligent tires focusing on sensors and wireless data transmission. Intelligent tires are smart tires equipped with sensors for monitoring air pressure, applied strain, temperature, acceleration, wheel loading, friction and tread wear which improve the reliability of tires and tire control systems such as Anti-lock Braking Systems (ABS) [2].

S Patwardhan et al. presented the scenario of tire blow out and its effects on lateral control of automobiles in Intelligent Vehicle Highway Systems (IVHS) environment [3].

Mulla Minaz et al. proposed a TPMS system (Tyre Pressure Monitoring System) which detects the tyre pressure and gives indication to the driver about the tyre pressure. Sensor is used to detect the changes in the tyre pressure. This prototype is fully based on software version of Raspberry Pi [4].

Balakrishnan.T et al. stated the use of vehicle dashboard for the measurement of automobile wheel parameters such as camber and toe. The alignment of the wheel is monitored using accelerometer sensor which is fixed in the rear axle [5].

III. PROPOSED MODEL

Bearing is the most essential mechanical device [6], which takes the axial and radial load in the vehicle. This is an important component, which depends upon the wheel performance of a vehicle. The mileage of vehicles depends upon the bearing serviceability, but maximum safety and reliability of the wheel performance depends upon the wheel bearing reliability. The failure of the bearing, resulting in wheel misalignment, is due to lack of proper periodic maintenance of the bearing. Hence, in moving condition, tyres with wheel come out from the axial. As a result, fatal accidents take place. And also, due to unawareness, accidents take place. Here, an automatic indication is provided when the distance between the axial rod and bearing is greater than the set/fixed value.

When the tyre temperature increases from the fixed or set temperature, automatically, water or liquid Nitrogen spray will be done all over the tyre. These all will be automatically processed by providing an indication through audio-visual system. Thus, safety can be provided to the driver as-well-as the vehicle.

IV. EXPERIMENTAL SET-UP

In this, we used Arduino Uno [7][8], which is a microcontroller board based on ATMEGA328P. An Ultrasonic Sensor (HC-SR04) is used to detect the distance between the bearing and axial rod by using ultrasonic waves. DHT-11(Digital Humidity Temperature) temperature sensor is used to detect the temperature in the tyre. Buzzer is used to provide alerts to the driver, if there is any possibility of danger. RED andGREEN LEDs are also used for the indication. During critical conditions, automatically RED LED glows and Buzzer will be ON. The 12V DC motor is used to pump the water on the tyre. A 5V Relay module is used for ON/OFF purpose. If there is any change in the tyre temperature, then automatically relay becomes ON and at the same time, the motor will also be in ON and water is sprinkled on the tyre. 16*2 LCD is used to display the tyre temperature and the distance between axial rod and bearing, which is present at the driver canvas. Figure 3 shows the experimental setup used in the work

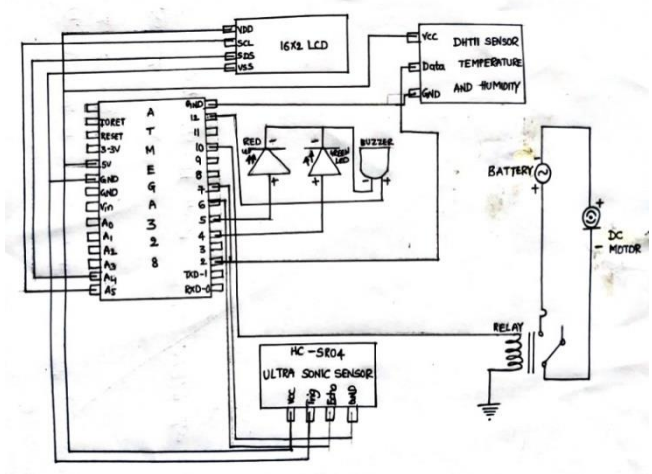

Fig 3: Circuit Diagram of the Proposed Model

The problems that we have solved in this research work are:

1. Detection of tyre temperature and its indication.
2. Detection of Wheel misalignment and its indication with respect to axial and clearance between axial and bearing inner race.

V. WORKING PRINCIPLE

In this paper, we proposed mainly for two types of applications. They are:

1. Detection of tyre temperature and indication

In moving condition of vehicles, when the temperature of the tyre increases from the fixed temperature or set temperature (as per the specification of the tyre), tyre burst occurs and also due to improper tyre pressure, harsh braking and increase in the temperature of the tyre, tyre gets heated up causing tyre burst[13]. To overcome this problem, we proposed this prototype. For detecting the tyre temperature, we used DHT-11 (Digital Humidity Temperature) sensor. The temperature reading which has been detected by the sensor will be continuously displayed on the driver canvas.

Case i:

If the tyre temperature is less than set temperature, then the vehicle is under normal condition. This normal condition is indicated with green LED.

Case ii:

If the tyre temperature is greater than set temperature, then the vehicle is in danger condition. This condition is indicated through red LED and buzzer. Automatically water is sprinkled on the tyre to decrease the tyre temperature and to prevent the tyre burst. As a result, the tyre gets cooled as well as gets cleaned. Hence, fatal accidents can be prevented.

Note: Set-Temperature is the temperature which is set to a fixed value in the program as per the tyre specification.

2. Detection of wheel imbalance and indication

Due to the bearing failure or axial failure, the wheel gets imbalanced. Lack of proper periodic maintenance of the bearing, bearing failure such as bearing bucking, scratches, nicks, dents, poor quality bearing, discoloration, corrosion, crack etc., leads to wheel misalignment and the wheel deviates from the set position in the wheel axial[10][11]. Hence, tyres with wheel come out from the axial in moving condition. For detecting the wheel misalignment, HC-SR04 Ultrasonic Sensor is used. The function of the ultrasonic sensor is to continuously transmit and receive the ultrasonic waves. By using this ultrasonic waves, distance between the bearing and axial rod is measured. This distance values which have been detected by the sensor will be displayed continuously on the driver canvas.

Case i:

If the clearance between the axial rod and bearing is less than the set position value, the wheel is under the normal condition. This normal condition is indicated through green LED.

Case ii:

If the clearance between the axial rod and bearing is greater than the set position value, the wheel is imbalanced and the vehicle is in danger condition. This danger condition is indicated through red LED and buzzer and thereby, fatal accidents can be prevented. In both the cases i.e. tyre burst and wheel misalignment, under danger conditions, an indication is provided through audio-visual system which prevents the accidents of vehicle and the driver from any injury or death.

VI.RESULTS AND DISCUSSION

Figure 4 shows the simulation results of tyre temperature and the distance between axial rod and bearing displayed on the serial monitor which is a part of the Arduino IDE software. Successful detection of wheel unbalancing from the axial is done.

Figure 5 shows the Detection of Tyre Misalignment and Indication. When the distance between the axial rod and inner race of the bearing is greater than the set/fixed value (Here the set/fixed value is 10cm), an indication is given through red LED and buzzer.

Detection of the increase in temperature of the tyre from the fixed/set temperature is done. Figure 6 shows the Detection of Tyre Temperature.

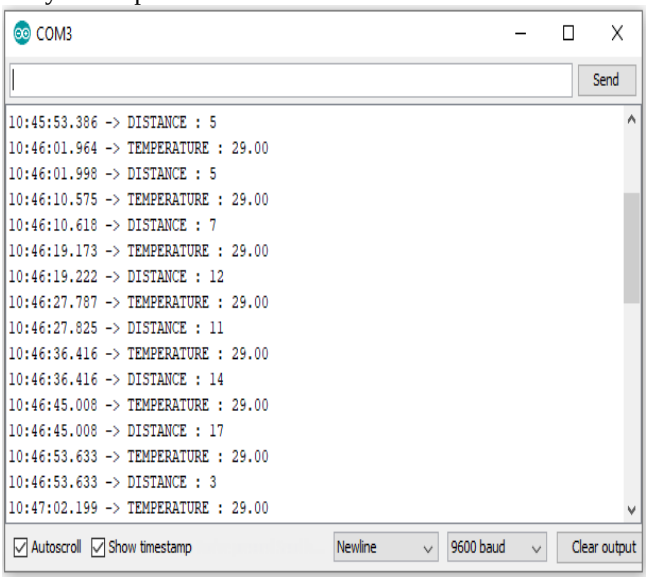

Fig 4: Serial Monitor showing Distance and Temperature Values

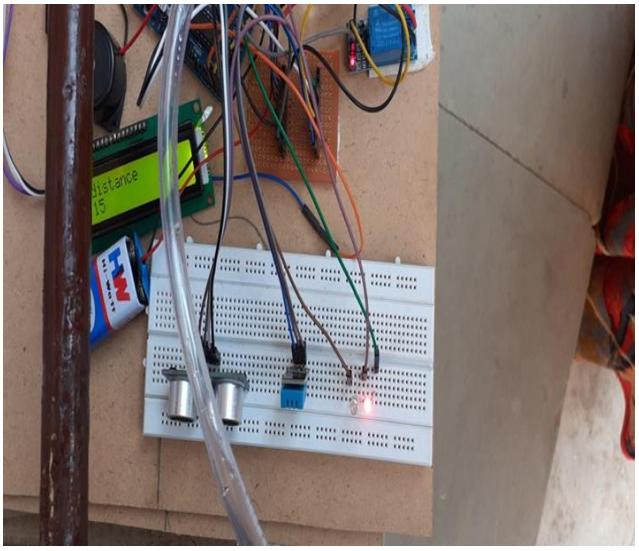

Fig 5: Detection of Tyre Misalignment and Indication

When the tyre temperature exceeds the set temperature (Here the set/fixed value is 30°), an indication is given through red LED and buzzer and automatically Water Spray or Nitrogen Spray occurs all over the tyre. Prevention of accidents is done successfully through the work carried out.

Fig 6: Detection of Tyre Temperature and Indication with Automatic Water/N_2 Spray

VII. CONCLUSION

By implementing this system, we can take preventive as-well-as corrective action, when the tyre temperature is greater than the set or fixed temperature and when the clearance between the axial rod and bearing is greater than the set position value.

Preventive action is prevention of accidents and providing safety to human's as-well-as vehicles. Corrective action is providing an audio-visual indication through buzzer and LED with which one can stop the vehicle and make necessary servicing i.e. removal of tyre or replacing the unserviceable parts with a serviceable one.

FUTURE SCOPE

To show the exact degree of inclination of wheel with tyre, tilt sensor can be used.

Calculation of the volume of water/liquid Nitrogen required to cool the tyre as per requirement. Also calculation of time of spraying can be done to cool the tyre.

For more efficiency and accuracy, we can go for any of the above two results.

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