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Disc Brake Run-Out Detection System

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Abstract: Disc brakes failure had become a major issue in vehicles these days, some of the common reasons for brake failures are reported to be a disc wobble, as it affects the overall braking, and the wobble caused on disc brakes generates a shudder at the passenger cabin through the brake pedal, which adds to a jagged movement of the vehicle. After carrying out deep research on this issue, an idea was formed to sense the wobble on the disc rotor. So, based on this idea a new concept for the Data Acquisition system is presented, namely: a Brake Disc Run-Out Sensor, which is designed on browser-based simulation software, Tinker-Cad. A Circuit diagram along with a block diagram is displayed and explained, addressing the main idea and objective of this prototype, this system will show the disc brake wobble or run-out data to the driver or controller via a visual indication. In this system, a tilt sensor is used and is interfaced with a microcontroller, every code is explained in detail with comments on each step. This system will increase the overall life of the brake rotor and the vibrations caused on the vehicle will be avoidable up to some extent. Therefore, reducing the maintenance cost of the vehicle.

Keywords: Tilt sensor, Disc Run-Out, Arduino, Microcontroller, Brake Shudder, disc brake, Wobble, TinkerCAD, Disc Brake, Arduino Uno, C++.

I. INTRODUCTION

In recent times, vehicles are becoming more advanced as they are improving in structural strength, engine refinement, appearance, high-speed low fuel consumption, etc. With high speeds the vehicle also requires a good stopping power which required a good quality brake, brakes in the sense the quality of the brakes should be robust and efficient, these brakes are built perfectly by the OEMs, but the only problem that occurs is while maintaining the brake system. The brake system acquires a brake pad, rotor brake disc, and caliper with a couple of sensors and hydraulic hoses. When the brake rotors are not maintained properly, they can give out vibration by wobbling or sometimes make a squeaking sound, these are the phenomenon of poor maintenance of brakes. Sometimes, due to rash driving or uneven road surface, vehicle axles tend to damage the alignment of both wheels as well as the braking components. Problems like the brake disc judder also known as wheel wobble arise due to such problems. Otherwise, due to loose nut or bolt in the wheel can cause such a problem. So, to identify such a problem and alert the driver about the situation, a brake disc run-out sensor is presented, this sensor tells or indicates the driver with the current condition of the disc wobble. Manufacturers produce a disc brake with minor deformation in their circular disc rotor structure to keep away the brake pads from locking to the surface of the rotor. This report shows the simulation of the tilt sensors with a micro-controller, the process of how the sensor is interfaced with the circuit is explained along with the codes and syntaxes. The LEDs that alert the driver are also taken from the same software. A set of a small spring-loaded rod with a high-velocity heat-sensitive rubber roller at the brake disc and the other part of the rod will be connected to the tilt sensor. The tilt sensor will be fixed in such a way that, if the disc rotor goes beyond the threshold value the sensor will notify the driver. The max wobble value for the disc rotor is approx. 0.08mm and min value is 0mm. [1]

II. LITERATURE REVIEW

[2] This paper was made on a purpose by an undergraduate researcher to figure out some of the crucial parameters by identifying and reasonably estimating the actual cause of brake disc run out. Several types of precise motionless experiments are performed to examine the rotor disc. A Static type of analysis showed an important effect on rotor wobble magnitude when reimbursement for varieties in controlling the bolt puckering along with setting the torque and adjusting the bolt puckering methods was done. When brake rotors were diagnosed by keeping the hub in consideration it has extreme and low rotor wobble angles. When doing and researching for more analysis a variation in the assembly had been analyzed with the help of the “computational finite element” part structure. The structure examined is practiced for evaluating thermic outcomes concerning manufacturing varieties in the changes in the cores of the rotor. The different type of analysis called Qualitative analysis of a collective result of changes in the core and its thermal changes generated due to abrasion from the event of stopping via braking demonstrates the importance of different variations in the manufacturing process and its vital outcomes disk thickness dissimilarity as well as its runout.

[3] This paper represents the learning outcome and the possible effect of brake disc rotor structure constraints on brake flutter, it says it has recognized a remarkable dynamic model with 2 degrees of freedom. They have analyzed the effect of stopping force at the beginning velocity, pressure applicable on braking, total stiffness of the system, and suppressing the kinetic features of the featured brake system, in this paper, they have used MATLAB software to conduct numerical based imitation studies via analysis. After the analysis, an accurate translation curve and phase illustration were gained in the form of a conclusion. The conclusion showed a gradual decrease in the viscous phase of the proposed system along with a gradual increase in the beginning velocity of braking and steadily becoming stable. When brake compression stayed small, there was a steady-state measured in the braking system, when brake compression gradually rose, there was a steady amplification in the trembling volume of the abrasion plate and the disc brake rotor.

[4] When there is friction-persuaded vibration also with sound stemming from the car's brake disc system, it is a foundation of a lot of tenderness, and it is connected to the overall customer displeasure. A large frequency sound of more than 1 kHz, which is called a squeal, is said to be extremely maddening and is hard to remove. The author says there are naturally two approaches you need to identify a vehicle disc rotor squeal; it is known as "complex eigenvalue analysis" which is used in analysis and the other one is "dynamic transient analysis". So, "complex eigenvalue analysis" is known for having a standard procedure that is implemented in the brake study, an analysis known as the transient study is said to gain popularity progressively. In distinction with "complex eigenvalues analysis" for evaluating only the steadiness of a given organization, the transient type of analysis is so skilled that it can determine the shaking levels and when said in a concept it may cover up the effect of any thermal circulation because of heat exchange between brake system parts and distributing it into the environment. Physical wear in the disc rotors is another way of a discrete feature of a system of brake, which is influenced by the generous squeal, and it is also affected by the roughness generated at the surface of the disc. The journal focuses on the latest study carried out at Liverpool University on the brake rotor squeal. A comprehensive and completely refined finite element structure of an actual brake rotor reflects the total amount of exterior unevenness of rotor pads and moves the information forward to the examination, also consists of "transient analysis" measurement of total thermal travel. At last, a "transient analysis" of the shaking of the rotor disc with actual heat management effect is obtainable.

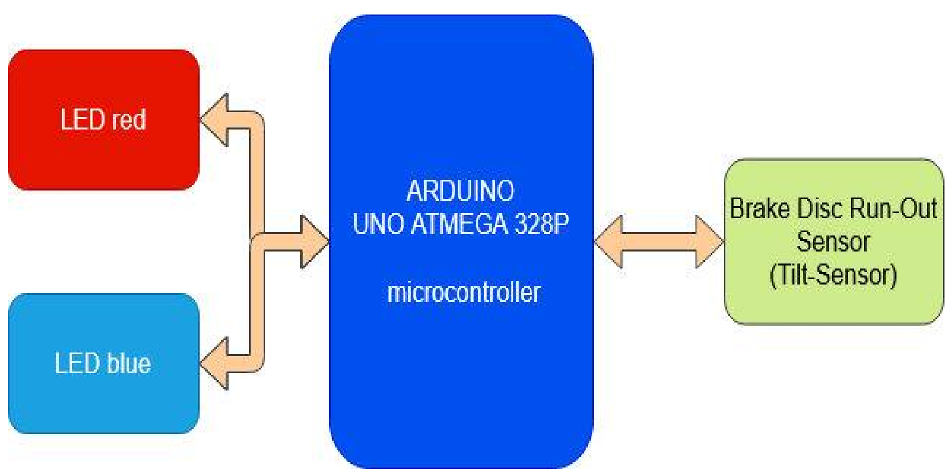
III. AIM AND OBJECTIVE

1) To identify the driver about the brake wobble.
2) To reduce vehicle brake service.
3) To save the car from losing its braking power.
4) To maintain a noise-free environment from disc wobble noise.

IV. METHODOLOGY

A. Hardware Design

1) Block Diagram



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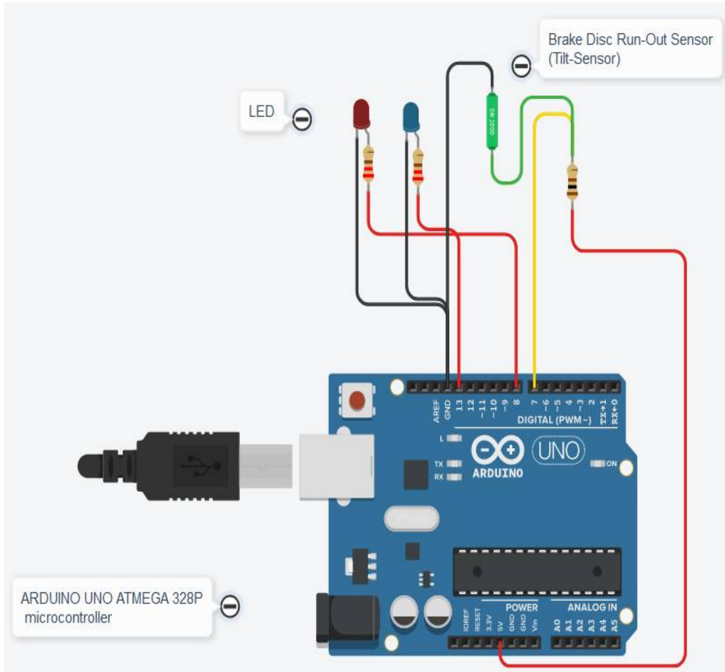
2) Interfacing Circuit Diagram



V. TECHNICAL SPECIFICATION

A. AT mega 328p micro-Controller

1) Operating temperature – 55+125°C
2) Storage temperature – 65+150°C
3) The voltage on any pin except RESET for the ground – 0.5 V
4) Maximum operating voltage – 6.0 V

B. Tilt Sensor SW 200D

1) Type: Bi rolling sphere
2) Material: metal
3) Shape- Round, Cylindrical
4) Colour- black/white
5) Life span- per 10,0000 cycles
6) Contact Rating- 5V and 10Ma
7) Contact Resistance- 10ohm
8) Insulation Resistance- >10M ohm min. at 24VDC
9) Capacitance- 5 pF

C. LCD 16 x 2 display ADM1602K-NSW-FBS/3.3V

1) Operating temperature – 0°C to 50 °C
2) Storage temperature – (-10 °C to 60 °C)
3) Supply voltage for LCD – 3.0 VDC
4) Input voltage – 3.3 VDC
5) Supply current – 2.5 Ma

D. (LED) T-1 3/4 (5mm) SOLID STATE LAMP

1) Power dissipation - 75 mW

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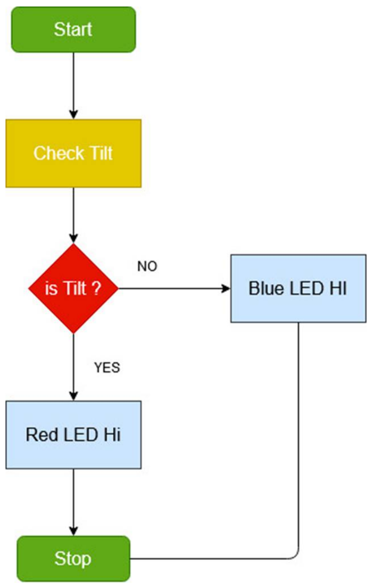
2) DC Onward Current - 30 mA
3) Top Forward Current - 155 mA
4) Inverse Voltage - 5 V
5) Operating as well as Storage Temperature – (-40°C To +85°C)
6) Lead Solder Temperature - 260°C

VI. SOFTWARE DESIGN

A. Program Flow Chart



B. Coding

Below is the coding of the proposed circuit along with comments.

```
int tilt = 7; //global declaration of tilt sensor at pin 7

// setup initializes serial and the button pin
void setup()
{
  Serial.begin(9600); //baudrate set to 9600
  pinMode(8, OUTPUT); //RED LED attached at pin 8
  pinMode(13, OUTPUT); //BLUE LED attached at pin 8
  pinMode(tilt, INPUT); //TILt sensor attached at pin 7
}

//loop checks the button pin each time,and will send serial if it is pressed
void loop()
{
  // setting global variable declaration
  float reading;
  reading = digitalRead(tilt); //read ultrasonic sensor
  Serial.println(reading); //print value on serial monitor

  if(reading==0) // tilt value is one
  {
    digitalWrite(8, HIGH); // if tilted, turn the red LED ON
    digitalWrite(13,LOW); // if no tilted, turn the red LED OFF
  }

  else // tilt value is zero
  {
    digitalWrite(8, LOW); // tilted, turn the red LED OFF
    digitalWrite(8, LOW); // tilted, turn the red LED OFF
    digitalWrite(13,HIGH); // if no tilted, turn the red LED ON
  }
  delay(200); // delay of 200 milliseconds
}
```

C. Condition

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1) If the tilt sensor tilts the displacement value is 0.08mm and returns to its original position (concerning wobble in disc rotor), giving the driver an early warning light.
2) If the tilt sensor does not tilt the displacement value is 0.00mm and returns to its original position (for wobble in disc rotor), giving the driver no warning light.

The above methodology states that the tilt sensor is used instead of a deformation sensor. Due to a lack of software and sensor support a tilt sensor is finalized. It gives a specific value of 1 and 0, due to such reading it was not possible to display the values on LCD.

VII. CONCLUSION AND RESULT

After creating and testing the circuit on software, it was concluded that the above circuit was successful in doing its job as it detected the wobble in the disc rotors and warned the driver with the help of Noise and LEDs. This system has never been introduced to the production model of the automobile market. With the help of research, it was decided and from public demand for brake wear, a prototype of this system was developed. The above circuit had a specific job that was planned to be implemented on high-end vehicles and luxury vehicles. The vehicles with brake pad wear sensors assure a good compatibility with the disc run-out sensor.

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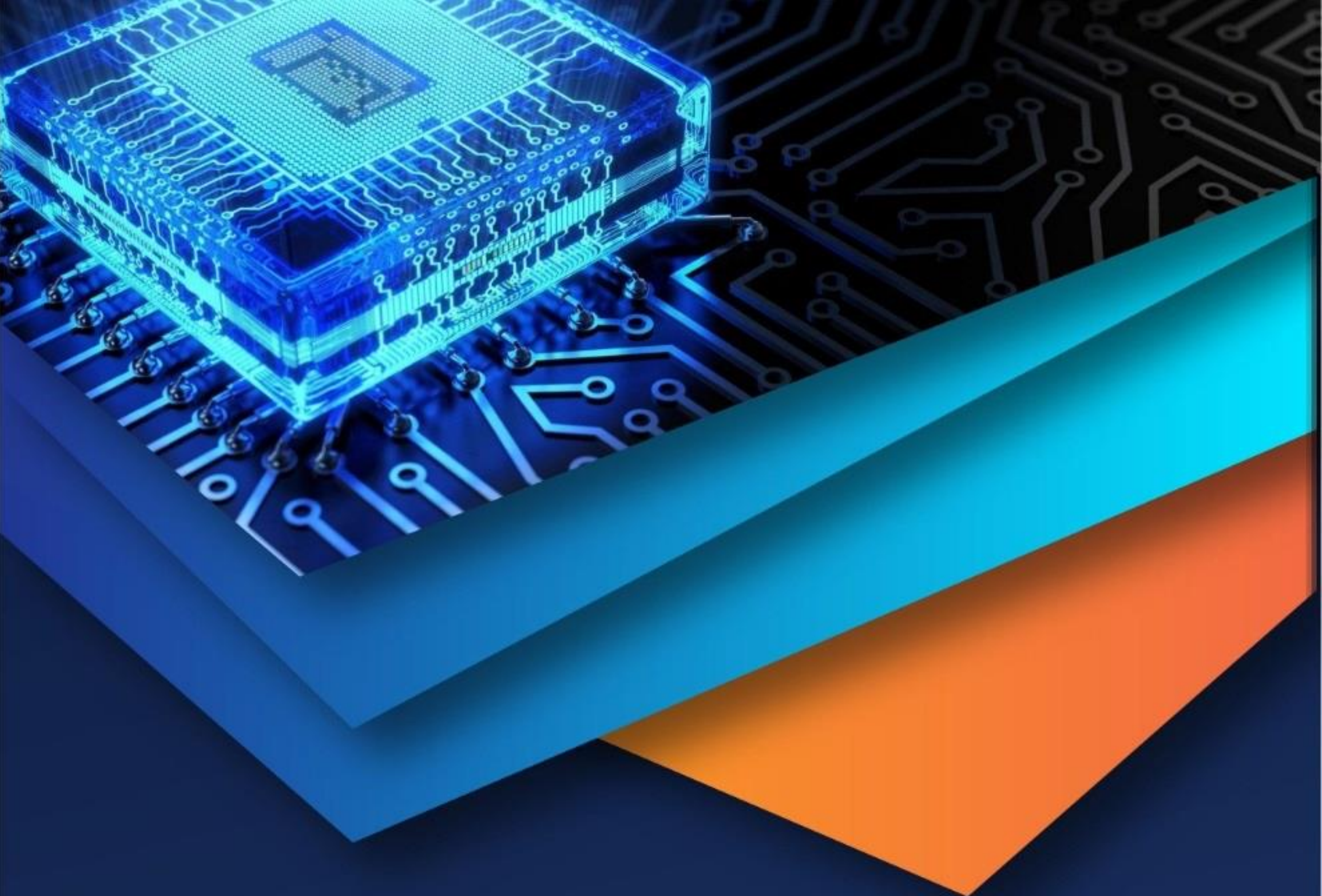

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