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Development of Motorcycle Brake Oil Control System Using Arduino Uno R3 Based Pressure Sensor

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An alarm or reminder has been successfully designed to remind us when it is time to fill the brake fluid so as to avoid accidents when riding a motorbike with electronic components which are arranged, including Nex motorbike, Dot-3 brake fluid, Arduino Uno, Psi100 oil pressure sensor, red LED, Step down DC to dc, Resistor 220 0hm. The alarm was designed on the motorbike to serve as a reminder to fill the brake fluid before it decreases. In this research, calibration was carried out on the measuring instrument used so that the output produced by the sensor was the same as the digital measuring instrument, with an accuracy percentage level of 94.11%. The alarm system works when the pressure is low, the pressure sensor will read and process it on the Arduino, after processing the condition will be changed according to the pressure read by the sensor so when it is

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low the Arduino relay will provide voltage to the LED so that the LED can light up as a warning sign that the brakes are not working. good for use, and vice versa, when the brake fluid is full or meets standards, the relay will not be active and the motorbike will remain stable or can be used as usual.

Keywords: ATMega328 microcontroller; brake fluid; control system; indicators; sensors.

1. INTRODUCTION

The high number of vehicle ownership and low knowledge of safe driving will lead to a high number of accidents. Indonesian people who own vehicles, especially motorized vehicles, they do not think about the risks, motorized vehicles are one of the most dangerous land vehicles. One example is that users who use motorized vehicles often drive at high speeds on the grounds that they are running out of time because motorized vehicles are light and very easy to accelerate, especially on automatic motorbikes. The impact of users who drive at high speed when dealing with opponents on the highway, users will step on or press the brakes suddenly as a result the motorbike can fall and lose control and can lead to death [1].

Motorcycle brakes are important components that have a function to reduce speed, not to stop the vehicle. Brake failure is one of the problems that can occur if the brakes are not properly maintained. As a motorcycle user, you should perform proper vehicle maintenance such as replacing brake fluid, so as to reduce the heat arising from friction between components [2-4]. Motorcycle brake fluid has a function to lubricate the components of the braking system, so it must be maintained regularly in order to maintain safety while driving. Brake fluid needs to be replaced regularly, because its performance will continue to decline over time due to condensation or friction between components. The water content in the brake fluid will continue to increase and further reduce the level of boiling (heat), because the low boiling point indicates that the brake fluid is easy to boil and can cause brake failure [5].

An automatic brake fluid filling tool is a tool to make it easier when filling brake fluid. At present, filling the brake fluid still uses a manual method, and still shakes the brake pedal. To make it easier to fill the brake fluid, an automatic brake fluid filling tool is made to make it easier to fill the brake fluid [6].

Based on the explanation above, it can be seen that there is no report that discusses the design of an automatic brake fluid filling tool and the tool has not been applied to motorbikes so that filling the brake fluid is still done manually. Therefore, to make it easier for motorcycle users to know when it is time to fill the brake fluid, the author makes a reminder or an alarm to remind them to fill the brake fluid so that it can make the brake system always work optimally and safely for braking. Therefore, the author proposes the title "Development of Motorcycle Brake Oil Control System using Arduino Uno R3 Based Pressure Sensor". In this study, there are several things that will be analyzed, namely the brake fluid pressure bear when the volume decreases, the lowest limit of oil volume as a reference for brake fluid that has decreased, and the accuracy value of the pressure sensor used [7,8].

The main components that are indispensable in designing tools in this study are Arduino Uno and Pressure Sensors. Arduino is a single-board, open-source microcontroller derived from a wiring platform, designed to facilitate electronic use in various fields of hardware that has Atmel AVR and in the software there is its own program. The Arduino Uno is a development board based on the ATMega328 microcontroller. Arduino Uno consists of a microcontroller and a number of inputs/outputs [9].

Oil pressure sensor is a device that can detect the measured information and convert the detected information into electrical signals or other forms of information output according to certain rules, so as to meet the information transmission, processing, storage, display, record and control requirements [10,11]. The core of the oil pressure sensor is usually made of diffused silicon. Its working principle is that the oil pressure is directly applied to the diaphragm of the sensor, so that the diaphragm generates micro-displacement proportional to the oil pressure. The electrical resistance of the sensor changes, and the electronic circuit is used to detect the change, and the output of the standard measurement signal corresponding to the pressure is changed [12].

2. TOOLS AND METHODS

This research on the design of a brake fluid control system on a motorcycle using an arduino uno R3-based psi100 pressure sensor was carried out in Jimbaran, Kuta District, Badung Regency. The research time was carried out in September 2022-February 2023 around Jimbaran Hill.

2.1 Tools and Materials

The tools and materials used in research on brake fluid shortage control systems on motorcycles based on pressure sensors and Arduino Uno R3 are as follows:

a. Nex motorcycle as the placement of the tool.
b. Dot-3 Brake Fluid is the fluid used on the nex motorcycle.
c. Arduino uno to control electronic components with programs.
d. Oil pressure sensor Psi100 to detect brake fluid shortage.
e. Micro usb cable to transfer data from leptop to Arduino uno.
f. A red LED will light up to warn you that the brakes are not suitable for use.
g. Step down dc to dc to reduce the voltage from the battery by 12 volt to 5 volt so that itcan be distributed to all existing systems.
h. Resistor 220 0hm to inhibit or limit the flow of electricity flowing in a circuit.
i. Digital pressure gauge for manual pressure measurement of brake fluid.
j. Measuring cup to measure the volume of brake fluid.

2.2 Data Retrieval

A flowchart of the data collection process can be seen in Fig. 1.

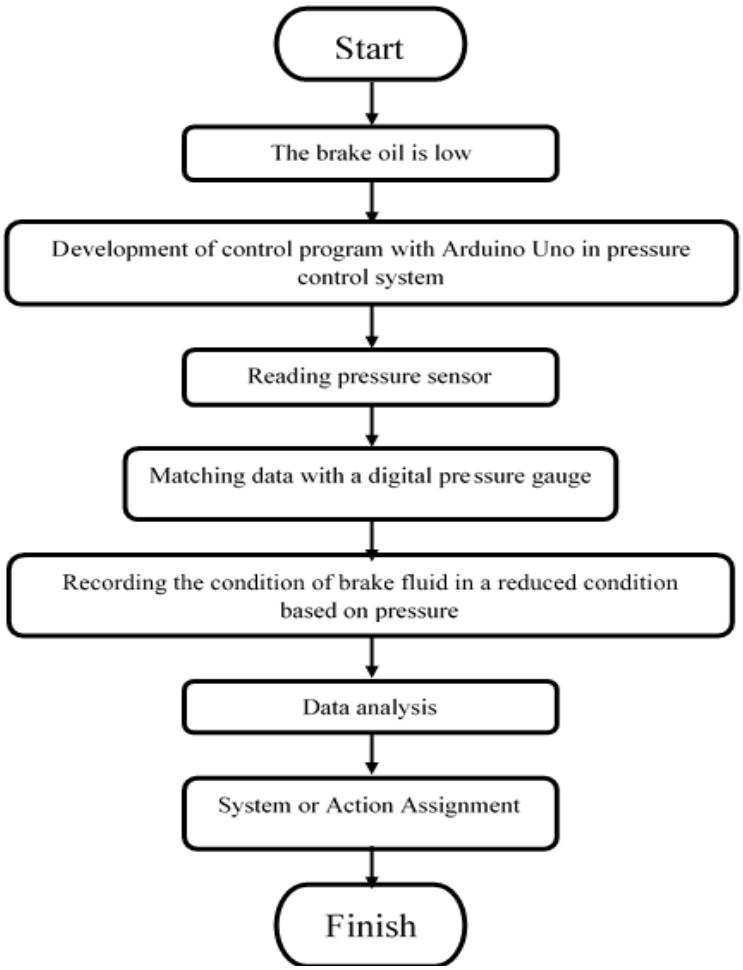

Fig. 1. Calibration data processing flow chart

2.3 Research Data Processing

The flowchart of research data processing can be seen in Fig. 2.

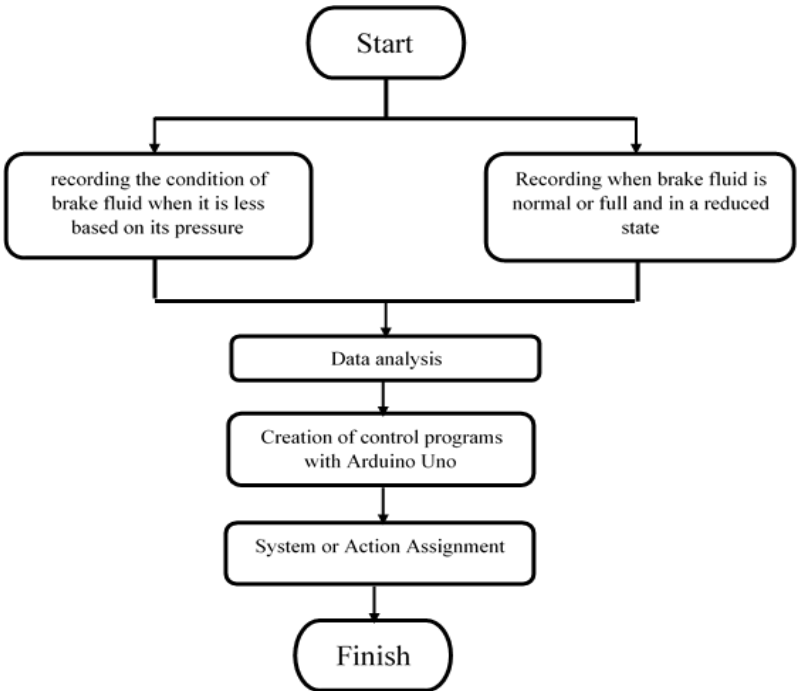

Fig. 2. Research data processing flow chart

2.4 Tool Design

Based on the program that has been made, the design of the tool can be carried out in accordance with the command program that has been given. The design of the whole tool starts from the Pressure Sensor, Arduino Uno, LED, and Relay, the pressure sensor used is the Psi100 water pressure sensor and the Arduino used is ATMega 328. The scheme of the research tool design is shown in Fig. 3.

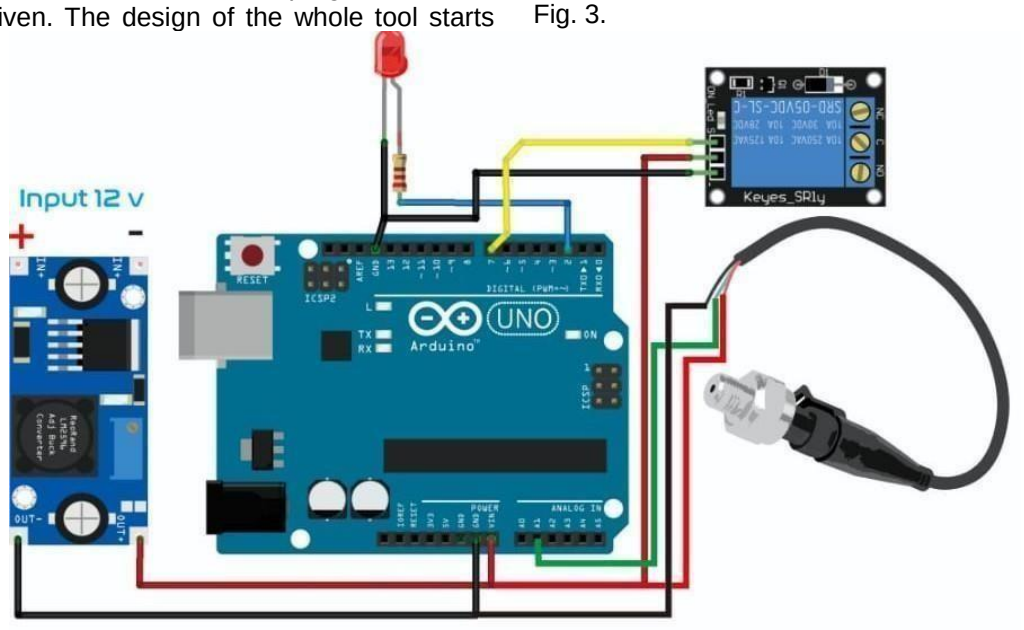

Fig. 3. Research tool design

3. RESULTS AND DISCUSSION

3.1 Research Design Tools

The following design tools used in the design of a brake fluid control system on a motorcycle using an Arduino uno R3-based psi100 pressure sensor are shown in Fig. 4.

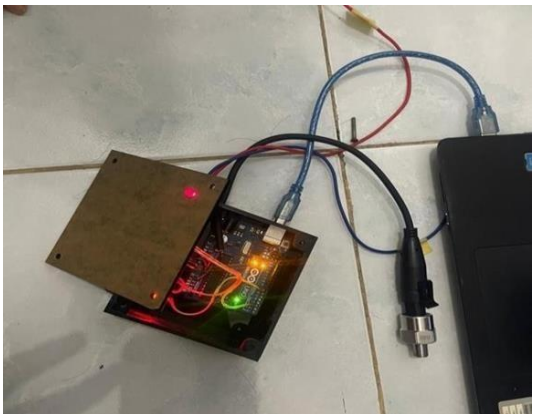

Fig. 4. Research design tools

3.2 Mechanical Pressure Gauge

The following is a manual measuring instrument used in research to measure brake fluid pressure can be seen in Fig. 5.

Fig. 5. Mechanical pressure gauge

3.3 Brake fluid volume

Before measuring the pressure in the brake fluid, there is also a measurement of the volume of brake fluid using a measuring cup.

Fig. 6. Measuring cup for brake fluid volume

The following is data on the volume of brake fluid measured using a measuring cup in the Table 1.

3.4 Data Analysis

Before conducting a study in which the measurement process relies on sensors, it is necessary to take a calibration action or match the data from the pressure sensor reading against the data from the digital pressure gauge by comparing the two data using excel so that regression and linear equations will be obtained to be entered into the Arduino program. The following calibration data can be seen in Table 2.

Table 1. Brake fluid volume data

No	Brake fluid volume (ml)
1	100
2	97
3	94
4	92
5	88
6	86
7	84
8	81
9	80
10	78

No	Brake fluid volume (ml)
11	77
12	75
13	72
14	70
15	68
16	64
17	62
18	60
19	57
20	55
21	53
22	51
23	50
24	47
25	45
26	43
27	40
28	38
29	35
30	32
31	30
32	29
33	27
34	25
35	23
36	20
37	18
38	16
39	15
40	12
41	10
42	8
43	5
44	2

Table 2. Measurement data before calibration

No	Digital MeasuringInstrument(Pa)	Pressure Sensor (Pa)
1	0	0
2	0,01	0,01
3	0,02	0,02
4	0,03	0,03
5	0,04	0,03
6	0,05	0,04
7	0,06	0,04
8	0,07	0,05
9	0,08	0,06
10	0,09	0,06
12	0,1	0,07
13	0,2	0,07
14	0,3	0,08
15	0,4	0,09
16	0,5	0,1
17	0,6	0,1
18	0,7	0,11
19	0,8	0,11

No	Digital MeasuringInstrument(Pa)	Pressure Sensor (Pa)
20	0,9	0,11
21	1	0,12
22	1,1	0,12
23	1,2	0,13
24	1,3	0,13
25	1,4	0,13
26	1,5	0,14
27	1,6	0,15
28	1,7	0,15
29	1,8	0,16
30	1,9	0,16
31	2	0,17
32	2,1	0,17
33	2,2	0,17
34	2,3	0,18
35	2,4	0,18
36	2,5	0,19
37	2,6	0,19
38	2,7	0,2
39	2,8	0,2
40	2,9	0,2
41	3	0,21
42	3,1	0,22
43	3,2	0,22
44	3,3	0,23
45	3,4	0,23
46	3,5	0,24
47	3,6	0,24
48	3,7	0,25
49	3,8	0,25
50	3,9	0,25
51	4	0,25

The calibration data retrieval process uses the Arduino program as shown in Fig. 7 below.

```
int led = 2;     // pin untuk led
int relay = 7;   // pin untuk relay
bool kondisi = false;

void setup() {
  Serial.begin(9600);
  pinMode(relay, OUTPUT);
  pinMode(led, OUTPUT);
  digitalWrite(led, LOW);
}

void loop() {
  int sensorVal = analogRead(A1);
  Serial.print("Sensor Value: ");
  Serial.print(sensorVal);

  float voltage = (sensorVal * 5.0) / 1024.0;
  Serial.print("Volts: ");
  Serial.print(voltage);

  float pressure_pascal = (3.0 * ((float)voltage - 0.47)) * 1000000.0;
  float pressure_bar = pressure_pascal / 10e5;
  Serial.print("Pressure = ");
  Serial.print(pressure_bar);
  Serial.println(" bars");
  Serial.print("Pressure = ");
```

```
while (pressure_bar >= 0.10) {  // triger tekanan agar untuk menyalakan kelistrikan pertama kai
  kondisi = !kondisi;           // jika kondisi kelistrikan sudah on (kondisi triger telah terpenuhi) ubah variable "kondisi" menjadi true

  if (kondisi == true) {  //jika variable "kondisi sudah true" lakukan ini
    Serial.println(" kondisi sama");
    digitalWrite(relay, HIGH);  // relay hidup

    int sensorVal = analogRead(A1);  // untuk membaca nilai analog dari sensor

    // dibawah ini adalah konfigurasi rumus untuk mendapatkan nilai tekanan
    float voltage = (sensorVal * 5.0) / 1024.0;
    float pressure_pascal = (3.0 * ((float)voltage - 0.47)) * 1000000.0;
    float pressure_bar = pressure_pascal / 10e5;

    //untuk menampilkan nilai pembacaan ke serial monitor
    Serial.print("Sensor Value: ");
    Serial.print(sensorVal);
    Serial.print("Pressure = ");
    Serial.print(pressure_bar);
    Serial.println(" bars");
    Serial.print("Pressure = ");

    if (pressure_bar <= 0.05) {  // jika tekanan dibawah atau sama dengan yang diatur maka:
      Serial.println("hidup led");
      digitalWrite(led, HIGH);  //hidupkan led

    } else {  //jika tekanan lebih dari yang diatur
      Serial.println("mati led");
      digitalWrite(led, LOW);   //matikan led
    }
  }
}

delay(10000);
}
```

Fig. 7. Data alalysis arduino program

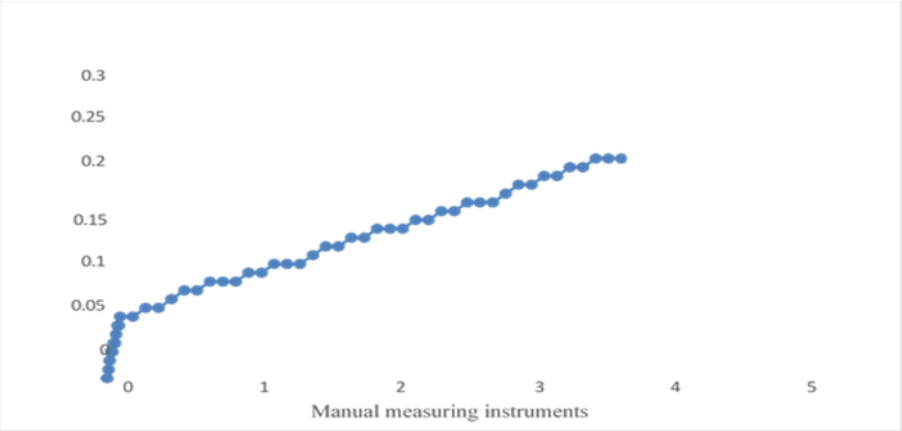

Fig. 8. Data graph before calibration

Based on Fig. 8, a linear equation is obtained:

$$(y=0.0536x - 0.0484) \text{ so that } (x= (y + 0.0484)/(0.0536) \quad (1)$$

The linear equation will be entered into the Arduino program so that the value read by the pressure sensor will be the same as the value of the manual measuring instrument

```
void loop() {
  int sensorVal = analogRead(A1);
  Serial.print("Sensor Value: ");
  Serial.print(sensorVal);

  float voltage = ((sensorVal + 0.0484)/0.0536) / 1024.0;
  Serial.print("Volts: ");
  Serial.print(voltage);

  float pressure_pascal = (3.0 * ((float)voltage - 0.47)) * 1000000.0;
  float pressure_bar = pressure_pascal / 10e5;
  Serial.print("Pressure = ");
  Serial.print(pressure_bar);
  Serial.println(" bars");
```

Fig. 9. Arduino program after calibration

3.5 Data after Calibration

Table 3. Measurement data after calibration

No.	Pressure Measuring Instrument (Pa)	Sensor Pressure (Pa)
1	0	0
2	0,01	0,01
3	0,02	0,02
4	0,03	0,03
5	0,04	0,04
6	0,05	0,05
7	0,06	0,06
8	0,07	0,07
9	0,08	0,08
10	0,09	0,09
12	0,1	0,1
13	0,2	0,2
14	0,3	0,3
15	0,4	0,4
16	0,5	0,5
17	0,6	0,6
18	0,7	0,7
19	0,8	0,8
20	0,9	0,9
21	1	1
22	1,1	1,1
23	1,2	1,2
24	1,3	1,3
25	1,4	1,4
26	1,5	1,5
27	1,6	1,6
28	1,7	1,7

No.	Pressure Measuring Instrument (Pa)	Sensor Pressure (Pa)
29	1,8	1,8
30	1,9	1,9
31	2	2
32	2,1	2,1
33	2,2	2,2
34	2,3	2,3
35	2,4	2,4
36	2,5	2,5
37	2,6	2,6
38	2,7	2,7
39	2,8	2,8
40	2,9	2,9
41	3	3
42	3,1	3,1
43	3,2	3,2
44	3,3	3,3
45	3,4	3,4
46	3,5	3,5
47	3,6	3,6
48	3,7	3,7
49	3,8	3,8
50	3,9	3,8
51	4	3,8

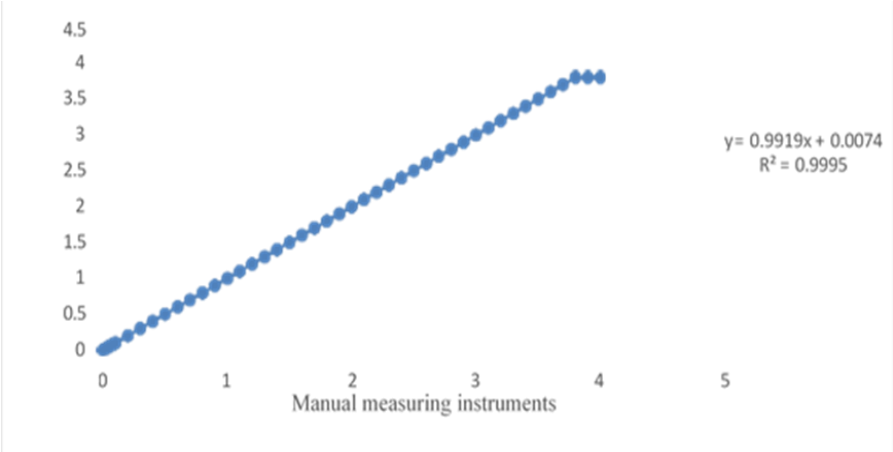

Fig. 10. Data graph after calibration

Research on the design of a brake fluid control system on a motorcycle using an Arduino uno R3-based psi100 pressure sensor aims to determine the amount of brake fluid pressure when the brakes are reduced, determine the level of brake fluid conditions that have been reduced based on oil pressure as a reference indicator of the tool being made, know the brake fluid shortage control system on a motorcycle and know the accuracy value on the pressure sensor. This research was conducted from September 2022 to February 2023. The electronic components arranged in this series of research tools include Dot-3 Brake Oil, Arduino uno, Water pressure sensor, micro usb cable, jumper cable, red LED, Step down dc to dc, Resistor 220 0hm, while the tools needed when taking data are Asus AMD A8QUAD CORE X4 leptop, Nex motorcycle, Arduino usb cable.

The research phase begins with the design of the tool, creating a program on the Arduino application to transfer to the finished tool, analyzing the calibration data that has been obtained so as to produce equation 1. Equation 1 is entered into the measuring instrument trial analysis program to produce the same pressure sensor output data as the manual measuring

instrument used. From the test data of measuring instruments, the accuracy value is also obtained with a value of 94.11%.

In this study there is an on-of switch to provide voltage to all systems and Arduino as a control system to control all components such as step down which gets a voltage from the battery of 12volt will be reduced by 5volt so that it is distributed to all existing systems, there are also relays that are controlled through Arduino. So the system is when the pressure is low then the pressure sensor will read and process it in Arduino, after the process will be changed according to the pressure read by the sensor so when the Arduino relay is low it will provide voltage to the led so that the led can light up as a warning sign that the brakes are not good to use, and vice versa when the brake fluid is full or in accordance with the standard then the relay will not be active and the motor remains stable or can be used as usual.

4. CONCLUSION

Based on the analysis that has been done, it can be concluded that:

The amount of brake fluid pressure when the brake fluid volume is reduced is 0.01Pa. The lowest limit of brake fluid volume as a benchmark for reduced brake fluid is 0.25Pa. The accuracy value of the pressure sensor is 94.11%.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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