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Prototype of Vehicle Condition Monitoring System for the Adev 01 Monalisa Electric Car

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ABSTRACT

The monitoring system used in electric cars is a vehicle condition display where the vehicle has a main drive in the form of a BLDC hub motor and a PSMS type controller. The aim of this research is to measure the temperature of the controller using a temperature sensor (DS18b20), measure battery voltage using a series of resistors, current sensor using ACS712. The input used is the sensor input which is used to detect a condition or physical change which is required in the system output. Arduino Uno R3 hardware is used to receive, manage and provide electrical signals. A user interface or user interface device is needed so that the operation of the system can be known. In this experiment, a Nextion LCD was used as a user interface. The reading tests that have been carried out produce quite varied responses, but are still within normal limits. This shows that the tests carried out have been successfully carried out well. As a result, the tool created can display data accurately, with the display data being displayed at all times as long as the power supply receives power input. The ADEV 01 Monalisa electric car vehicle condition monitoring system prototype was designed and made with smart technology which can later be developed properly and can be used to produce good and precise displays. By experimenting with the vehicle in a stationary condition, the average difference produced in the battery voltage data shows a difference of 0.284 V, in the current data using the instrument it shows a difference of 0.622 mA, in the controller temperature data it shows a difference of 1.24 ℃, with the experiment in the condition of the vehicle in speed conditions low, the average difference produced in the battery voltage data shows a difference of 0.245 V, in the current data for the instrument it shows a difference of 0.183 mA, in the controller temperature data it shows a difference of 0.074 ℃, with experimental conditions of the vehicle in high speed conditions the average difference produced in The battery voltage data shows a difference of 0.083 V, the instrument current data shows a difference of 0.79 mA, the controller temperature data shows a difference of 1.192 ℃.

1. Introduction

The monitoring system used in electric cars is a vehicle condition display where the vehicle's main energy is the battery. In this parameter display tool it can display the battery voltage where the main driver of the car uses an electric engine which is a BLDC hub motor type and a controller type with with PSMS type. The viewer is used to save time in checking the condition of each object during the competition. In a race, the condition of the vehicle is very important to be able to predict the vehicle according to the category being run. The types of categories implemented include several conditions such as speed, engine power, and energy consumption efficiency. The conditions suggested by the technician can be taken into consideration by the driver so that they can be used as a basis for being able to drive the car optimally [1]-[5].

Changes made to controller settings include several factors that can influence the characteristics of the car. In this case, there are several calculations that provide a reference for where there is a maximum value that can be used. The maximum value determined by the manufacturer can be seen in the data sheet with the controller series used, such as the al-Qorni team using the Votol EM-260s type. The peak power that can be changed in the bus bass current column. For this reason, there are several modes that can be used by implementing data transfer using a toggle switch [6]-[10].

The aim of this research is to measure the temperature of the controller using a temperature sensor (DS18b20), measure battery voltage using a series of resistors, current sensors using ACS712, these sensors above are widely available on the market at very affordable prices. Where the data from all these sensors can be displayed in real time and can be monitored at any time without using manual tools whose results do not match the original results. The Indonesian electric car competition (KMLI) has very strict regulations that must be implemented by each team. In terms of checking the condition of the vehicle, you have to go through several long stages to be able to carry it out and that can waste a lot of time [11]-[15].

Display car condition parameters in real time by implementing a system based on Arduino Uno R3. Get the value and size of car condition data accurately and be able to display car condition data. Where the results of the design and development of this tool can be used as a further stage in the development of the UAD Al-Qorni electric car. Furthermore, it is hoped that this research can help the team to provide car condition data that is very useful for drivers to reduce technician management errors regarding the condition of their vehicles. Which provides early knowledge of the condition of the car he is driving [16]-[20].

2. Methods

2.1. Software Design

The flowchart or flow diagram begins with a voltage sensor reading the voltage condition on the battery, a current sensor reading the instrument current condition, and a temperature sensor reading the temperature condition on the controller which is carried out by reading the condition of the car directly with the data taken in the form of analog voltage. After the sensor has read the sensor will send data in analog form to the Arduino Uno R3. In the condition monitoring system for the Adev 01 Monalisa electric car, the analog voltage input is converted to digital. Electric Car Voltage Monitoring System Flow Diagram. Several calibrations are carried out on each sensor, namely voltage calibration, temperature calibration, and current calibration. By setting the program code value, it will then be processed by the Arduino Uno R3. Monitoring data in the form of readings will be displayed on the Nextion LCD. The flow diagram and block diagram of the Adev 01 Monalisa vehicle condition monitoring system can be seen in Fig. 1. and Fig. 2.

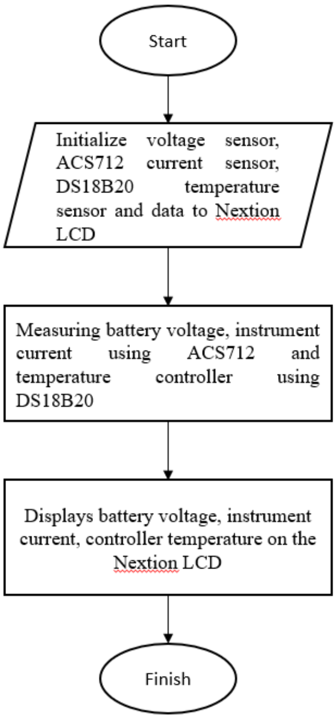

Fig. 1. Flowchart

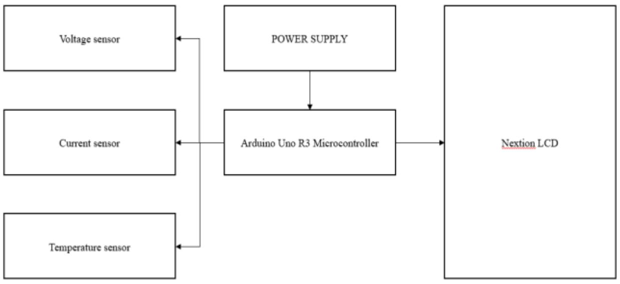

Fig. 2. Block Diagrams

2.2. Wiring Diagram

Hardware design continues by creating a wiring diagram of the components used. A wiring diagram is the process of connecting components using cables or PCB boards so that they can be connected from one component to another. All components must be connected to the Arduino UNO microcontroller. Specifications and wiring diagrams can be seen in Table 1 and Fig. 3.

Table 1. Wiring diagram specifications

No	Arduino Uno R3	Voltage Sensor	Temperature Sensor	Current Sensor	Lcd Nextion
1	TX	-	-	-	RX
2	RX	-	-	-	TX
3	A0	-	Data	-	-
4	G	G	-	-	-
5	A1	Data	-	-	-
6	G	-	Negative	Negative	-
7	A2	-	-	Data	-
8	3,3V	-	Positive	-	-
9	5V	VCC	-	Positive	Positive
10	G	-	-	-	Negative

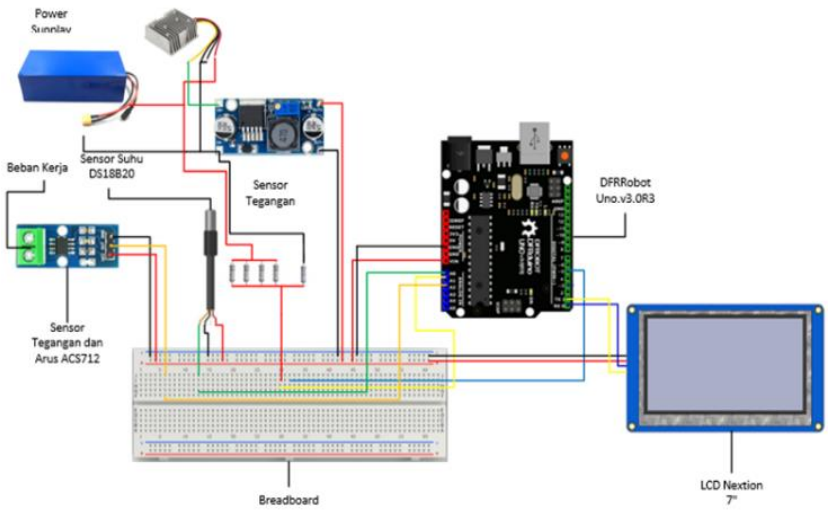

Fig. 3. Wiring diagram

3. Results and Discussion

3.1. Voltage Sensor Calibration

Sensor calibration is carried out to test the accuracy of the sensors used in the system. This is done to reduce errors that occur when the system is used. The calibration process is carried out using the help of a multimeter. Calibration is carried out by comparing the values read by the sensor with a multimeter. Then the two values obtained are compared to find the difference value. The data obtained is displayed in Table 2.

Voltage sensor calibration produces good data with minimal differences. 20 calibration data were collected. With an interval of 30 second. The average difference produced is 0.23 Volts. This shows that the calibration carried out has been successful as desired. The data obtained from the calibration results are made in the form of a graph shown in Fig. 4

Table 2. Voltage sensor calibration results

No	Voltage on the Sensor (V)	Voltage on the Multimeter (V)	Difference(V)
1	46.52	46.75	0.23
2	46.52	46.75	0.23
3	46.52	46.75	0.23
4	46.52	46.75	0.23
5	46.52	46.75	0.23
6	46.52	46.75	0.23
7	46.52	46.75	0.23
8	46.52	46.75	0.23
9	46.52	46.75	0.23
10	46.52	46.75	0.23
11	46.52	46.75	0.23
12	46.52	46.75	0.23
13	46.52	46.75	0.23
14	46.52	46.75	0.23
15	46.52	46.75	0.23
16	46.52	46.75	0.23
17	46.52	46.75	0.23
18	46.52	46.75	0.23
19	46.52	46.75	0.23
20	46.52	46.75	0.23
Average	**46.52**	**46.75**	**0.23**

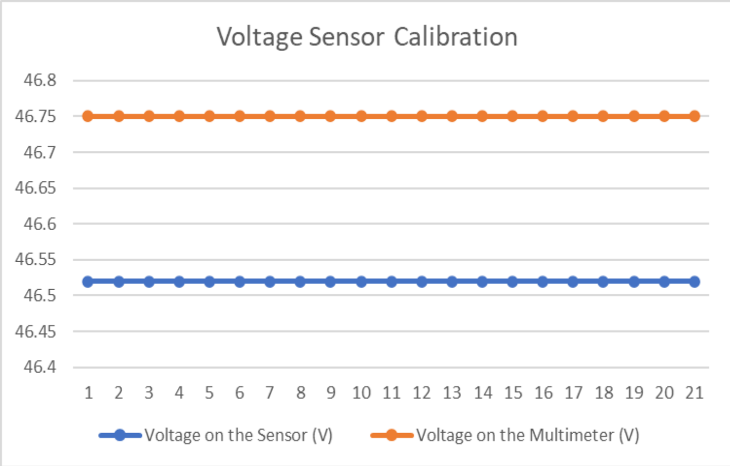

Fig. 4. Voltage sensor calibration graph

3.2. Current Sensor Calibration

Sensor calibration is carried out to test the accuracy of the sensors used in the system. This is done to reduce errors that occur when the system is used. The calibration process is carried out using ampere pliers. Calibration is carried out by comparing the values read by the sensor with the amperage. Then the two values obtained are compared to find the difference value. The data obtained is displayed in Table 3.

Current sensor calibration produces good data with minimal differences. 20 calibration data were collected. With an interval of 30 second. The average difference produced is 0.39 mA. This shows that the calibration carried out has been successful as desired. The data obtained from the calibration results are made in the form of a graph shown in Fig. 5.

Table 3. Current sensor calibration results

No	Current on the sensor (mA)	Current on the ampere pliers (mA)	Difference (mA)
1	20.39	20	0.39
2	20.39	20	0.39
3	20.39	20	0.39
4	20.39	20	0.39
5	20.39	20	0.39
6	20.39	20	0.39
7	20.39	20	0.39
8	20.39	20	0.39
9	20.39	20	0.39
10	20.39	20	0.39
11	20.39	20	0.39
12	20.39	20	0.39
13	20.39	20	0.39
14	20.39	20	0.39
15	20.39	20	0.39
16	20.39	20	0.39
17	20.39	20	0.39
18	20.39	20	0.39
19	20.39	20	0.39
20	20.39	20	0.39
Average	**20.39**	**20**	**0.39**

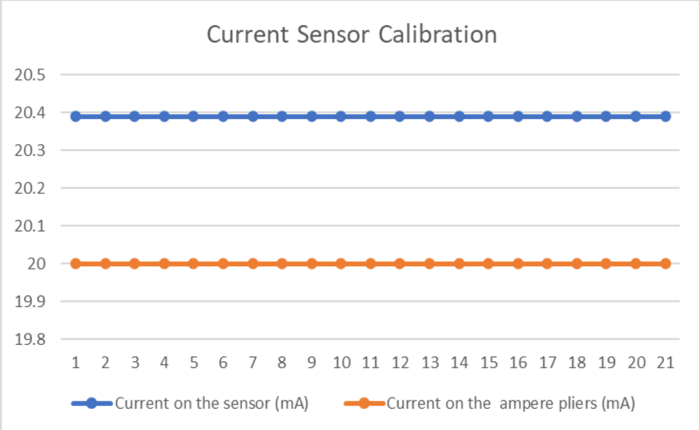

Fig. 5. Current sensor calibration graph

3.3. Temperature Sensor Calibration

Sensor calibration is done using data that has been taken from previous measurements, the calibration method used in this study is linear regression in equation (1). Fig. 5 (a) displays the calibration results of the LDR sensor, Fig. 5 (b) displays the calibration results of the Photodiode sensor, and Fig. 5 (c) displays the calibration results of the BH1750 sensor.

3.4. Sensor Experiments After Calibration

Sensor calibration is carried out to test the accuracy of the sensors used in the system. This is done to reduce errors that occur when the system is used. The calibration process is carried out using a thermometer. Calibration is carried out by comparing the values read by the sensor with the thermometer. Then the two values obtained are compared to find the difference value. The data obtained is displayed in Table 4.

DS18b20 temperature sensor calibration produces good data with minimal differences. 20 calibration data were collected. With an interval of 30 second. The average difference produced is 0.7 °C. This shows that the calibration carried out has been successful as desired. The data obtained from the calibration results are made in the form of a graph shown in Fig. 6.

Table 4. Temperature sensor calibration results

No	Temperature on the sensor (°C)	Temperature on the Thermometer (°C)	Different (°C)
1	33.4	34.1	0.7
2	33.4	34.1	0.7
3	33.4	34.1	0.7
4	33.4	34.1	0.7
5	33.4	34.1	0.7
6	33.4	34.1	0.7
7	33.4	34.1	0.7
8	33.4	34.1	0.7
9	33.4	34.1	0.7
10	33.4	34.1	0.7
11	33.4	34.1	0.7
12	33.4	34.1	0.7
13	33.4	34.1	0.7
14	33.4	34.1	0.7
15	33.4	34.1	0.7
16	33.4	34.1	0.7
17	33.4	34.1	0.7
18	33.4	34.1	0.7
19	33.4	34.1	0.7
20	33.4	34.1	0.7
Average	**33.4**	**34.1**	**0.7**

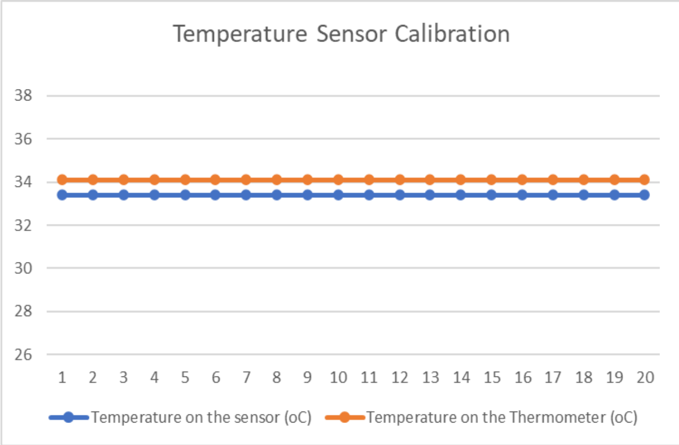

Fig. 6. Temperature sensor calibration graph

3.5. Car Testing in Idle Conditions

Car testing in stationary conditions is carried out to see the response of the car when the car is turned on. However, the car is not in running condition. The parameters observed are the voltage on the battery, current on the instrument and temperature on the controller. The voltage on the battery is observed using a multimeter, the current on the instrument is observed using ampere pliers, the temperature on the controller is observed using a thermometer. The results of testing the car in stationary conditions can be seen in Table 5.

Testing data on battery voltage, instrument current and temperature on the controller produced good data with 10 data tests carried out in the car's stationary condition. With an interval of 30 seconds.

The average difference produced in the battery voltage data shows a difference of 0.284 V, in the instrument current data it shows a difference of 1.222 mA, in the controller temperature data it shows a difference of 1.24 °C. This shows that the data testing carried out has been successful as desired. The data obtained from the test results are made in graphic form which is displayed in Fig. 7.

Table 5. Test results of the voltage sensor when the car is stationary

No	Voltage on the Sensor (V)	Voltage on the Multimeter (V)	Different (V)
1	46.52	46.75	0.23
2	46.52	46.75	0.23
3	46.52	46.75	0.23
4	46.52	46.75	0.23
5	46.52	46.75	0.23
6	46.52	46.75	0.23
7	46.52	46.75	0.23
8	45.09	45.5	0.41
9	45.09	45.5	0.41
10	45.09	45.5	0.41
Average	**46.091**	**46.375**	**0.284**

Table 6. Test results of the current sensor when the car is stationary

No	Current on the Sensor(mA)	Current on the Ampere Pliers (mA)	Different (mA)
1	20.9	21	0.1
2	20.9	21	0.1
3	20.3	20	-0.3
4	20.3	21	0.7
5	21.5	30	8.5
6	20.1	20	-0.1
7	20.8	20	-0.8
8	22.3	22	-0.3
9	20.34	20	-0.34
10	20.34	19	-1.34
Average	**20.778**	**21.4**	**0.622**

Table 7. Test results of the temperature sensor when the car is stationary

No	Temperature on the Sensor (ºC)	Temperature on the Thermometer (ºC)	Different (ºC)
1	35.6	36.8	1.2
2	35.6	36.8	1.2
3	35.6	36.8	1.2
4	35.6	36.8	1.2
5	35.6	36.8	1.2
6	35.6	36.8	1.2
7	38.2	39.5	1.3
8	38.2	39.5	1.3
9	38.2	39.5	1.3
10	38.2	39.5	1.3
Average	**36.64**	**37.88**	**1.24**

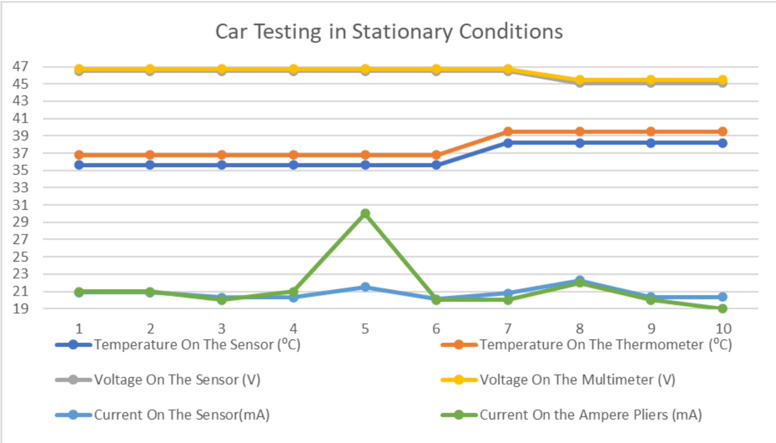

Fig. 7. Graph of car data testing at rest

3.6. Car Testing in Low Speed Conditions

Testing the car in low speed conditions was carried out to see the response of the car when the car was started. However, it is running at low speed which is displayed on the speedometer showing 5 km/hour. The parameters observed are the voltage on the battery, current on the instrument and temperature on the controller. The voltage on the battery is observed using a multimeter, the current on the instrument is observed using ampere pliers, the temperature on the controller is observed using a thermometer. The results of testing the car in stationary conditions can be seen in Table 6.

Testing data on battery voltage, instrument current and temperature on the controller produced good data with 10 data tests carried out in the car's stationary condition. With an interval of 30 seconds.

The average difference produced in the battery voltage data shows a difference of 0.245 V, in the instrument current data it shows a difference of 0.683 mA, in the controller temperature data it shows a difference of 0.083 oC. This shows that the data testing carried out has been successful as desired. The data obtained from the test results is made in graphic form which is displayed in Figure. 8.

Table 8. Results of testing the voltage sensor on the car at low speed

No	Voltage on the Sensor (V)	Voltage on the Multimeter (V)	Different (V)
1	41.02	41.1	0.08
2	41.52	42	0.48
3	41.8	41.5	-0.3
4	43.8	44	0.2
5	43.99	43.99	0
6	44.3	44.25	-0.05
7	44.2	45.3	1.1
8	44.49	44.93	0.44
9	46.3	46.3	0
10	46.3	46.8	0.5
Average	**43.772**	**44.017**	**0.245**

Table 9. Results of testing the current sensor on the car at low speed

No	Current on the Sensor(mA)	Current on the Ampere Pliers (mA)	Different (mA)
1	20.01	20	-0.01
2	20.63	21	0.37
3	20.85	21	0.15
4	20.2	19	-1.2
5	21	20	-1
6	20.8	21	0.2
7	20.1	20	-0.1
8	22.4	22	-0.4
9	20.56	21	0.44
10	20.28	20	-0.28
Average	**20.683**	**20.5**	**0.183**

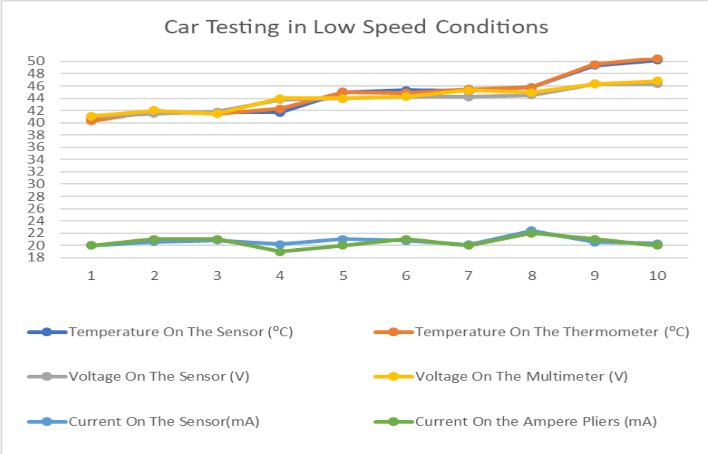

Fig. 8. Graph of test data in low speed conditions

3.7. Car Testing in High Speed Conditions

Car testing in high speed conditions is carried out to see the response of the car when the car is turned on. However, it is running at low speed which is displayed on the speedometer showing 30 km/hour. The parameters observed are the voltage on the battery, current on the instrument and temperature on the controller. The voltage on the battery is observed using a multimeter, the current on the instrument is observed using ampere pliers, the temperature on the controller is observed using a thermometer. The results of testing the car in stationary conditions can be seen in Table 7.

Testing data on battery voltage, instrument current and temperature on the controller produced good data with 10 data tests carried out in the car's stationary condition. With an interval of 30 seconds.

The average difference produced in the battery voltage data shows a difference of 0.083 V, in the current data for the instrument it shows a difference of 0.6231 mA, in the controller temperature data it shows a difference of 1.205 °C. This shows that the data testing carried out has been successful as desired. The data obtained from the test results are made in graphic form which is displayed in Fig. 9.

Table 10. Test results for voltage sensors on cars in high speed conditions

No	Voltage on the Sensor (V)	Voltage on the Multimeter (V)	Different (V)
1	39.63	39.06	-0.57
2	40	40.23	0.23
3	40.8	40.5	-0.3
4	42.8	43	0.2
5	42.99	43.99	1
6	43.3	43.12	-0.18
7	43.2	43.53	0.33
8	43.49	43.49	0
9	44.3	44.2	-0.1
10	44.99	45.21	0.22
Average	**42.55**	**42.633**	**0.083**

Table 11. Test results for current sensors on cars in high speed conditions

No	Current on the Sensor(mA)	Current on the Ampere Pliers (mA)	Different (mA)
1	21.51	20	-1.51
2	20.42	20	-0.42
3	20.95	20	-0.95
4	20.20	20	-0.20
5	20.25	20	-0.25
6	20.42	20	-0.42
7	21.30	20	-1.30
8	20.22	20	-0.22
9	21.26	20	-1.26
10	21.37	20	-1.37
Average	**20.79**	**20**	**0.79**

Table 12. Test results for temperature sensors on cars in high speed conditions

No	Temperature on the Sensor (ºC)	Temperature on the Thermometer (ºC)	Different (ºC)
1	50.9	47.5	-3.4
2	53.12	51.9	-1.22
3	53.7	54	0.3
4	56.11	58.3	2.19
5	56.96	58.7	1.74
6	59.9	60.1	0.2
7	61.2	63.5	2.3
8	62.31	63.8	1.49
9	65.56	69.8	4.24
10	70.42	74.5	4.08
Average	**59.018**	**60.21**	**1.192**

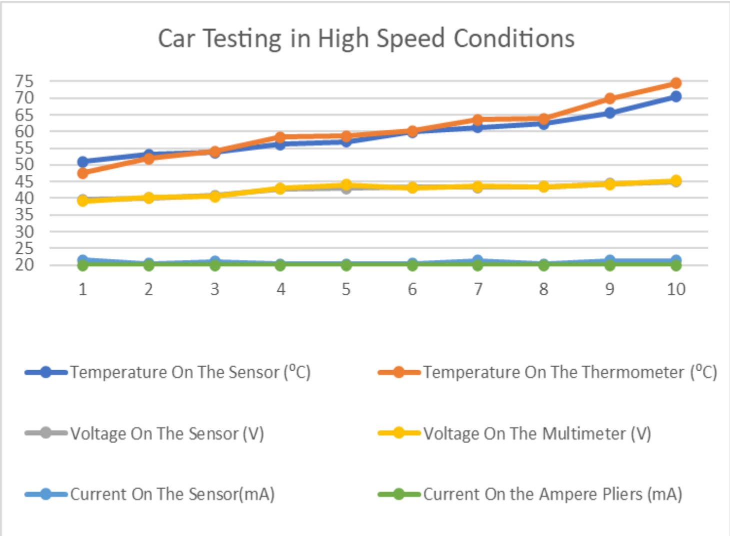

Fig. 9. Graph of test data in high speed conditions

The reading tests that have been carried out produce quite varied responses, but are still within normal limits. This shows that the tests carried out have been successfully carried out well. The conclusion is that the prototype system for monitoring the condition of the ADEV 01 Monalisa electric car can function well and can display several component data in the form of battery voltage, usage current on the instrument and temperature differences on the Votol Em-260s controller.

The ADEV 01 Monalisa electric vehicle condition monitoring system prototype implements real time data display using the Arduino Uno R3 microcontroller and Nextion LCD as data display devices. As a result, the tool created can display data accurately, with the display data being displayed at all times as long as the power supply receives power input. The ADEV 01 Monalisa electric car vehicle condition monitoring system prototype was designed and made at a low price with smart technology which can later be developed well and can be used to produce good and precise displays.

4. Conclusions

Based on the research that has been carried out, several conclusions can be drawn, namely, The prototype vehicle condition monitoring system for the ADEV 01 Monalisa electric car has succeeded in reading real-time changes in vehicle condition displayed on the Nextion LCD. The accuracy value produced by the sensor is displayed on the LCD in each trial. The difference in value when the car is running faster, the difference value becomes smaller under high speed conditions. The values displayed are voltage with a difference of 0.083 V, current with a difference of 0.79 mA, temperature. with a difference of 1.192 ℃. This tool has succeeded in shortening the time to check the condition of the car after competing at KMLI activities.

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