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ESP 8266-based Car Battery Current and Voltage Monitoring Design

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ABSTRACT

Fluctuations in engine speed make motorists unaware of the actual battery voltage and current, as the permissible battery voltage should be above 85% of the maximum voltage. Generally, the battery voltage for gasoline engines is about 12.5 volts in order to function normally. Therefore, regular battery checks and optimal battery recharging are required. This study aims to calculate how much the current and voltage changes at each load when the engine rotation is 1000, 1500, 2500, 3000, 3500, 4000 RPM using the ESP8266 microcontroller and compare it with measurements using a multimeter. The method of data collection is done experimentally by comparing the results of current and voltage measurements of the battery when the engine is loaded. The test results show that the voltage sensor on the battery measured by a multimeter tends to increase from 1000 RPM to 2000 RPM, which is caused by alternator efficiency and changes in electrical load. The voltage increase occurs again at 4000 RPM, indicating the alternator works harder at high revolutions. Current measurements based on the load show that the current in AC loads tends to be higher compared to audio and lighting loads. The effectiveness of the current and voltage sensor readings of the battery output was declared successful, because the entire process, from reading to sending data via smartphone, ran well without a hitch..

Keywords: Mickconroller, Battery, Voltage, Current, ESP8266, Multimeter

1. INTRODUCTION

The need for electrical energy sources is increasing, one of the alternatives to providing electrical energy sources is batteries [1]. Batteries are a very important part of everyday life, especially in vehicles, batteries have a function to supply electrical energy to the starter system, ignition system, lights and electrical components [2][3]. The electrical system on the vehicle is connected to one component with another, each component has a different way of working and function but has the aim of supporting the system as a whole [4][5]. When the car engine is turned on, the electrical components of the vehicle are driven by electricity from the alternator and battery (battery), but when the car engine is off, the electricity from the alternator is no longer used, and only comes from the battery [6][7]. When a battery is used, there is a chemical reaction process inside. Over time, the chemicals degrade without you realising it [8][9]. This causes the battery to be damaged and inhibits the battery charging process in the car [10][11]. The use of batteries in vehicles is designed for SLI (Starting Light Ignition), and must be used under high current and voltage conditions [12][13]. If the vehicle is driven for a short distance with a large load, the battery charging process is not optimal, because the battery can be drained quickly. As well as the battery charging process takes place not optimally and the vehicle battery is easily damaged. The allowed battery voltage must be at least 85% of the maximum voltage, because the operating range of battery voltage so that a 12.5 Volt petrol engine can be used under normal conditions [14] [15].

Another problem is the battery charging system process. There are several components that are directly connected to the battery [16]. Namely the altenator and regulator, the function of the altenator to supply electric power to the battery is called the battery charging process, while the function of the regulator is to regulate the amount of electric current flowing into the batter[17][18]. The use of batteries in cars over time without realising components such as altenators and regulators are damaged and hinder the charging process in car batteries[19] [20].

Vehicle batteries are of two types, namely, primary and secondary batteries. Primary batteries are known as disposable batteries that cannot be recharged. Secondary batteries are batteries that can be recharged by an electric charge (rechargeable) when the battery condition is exhausted, one example of the type of secuder battery in a vehicle is a lead acid battery [21][22].

Based on tests conducted by Jeferi Lianda on the current and voltage capacity of solar panel batteries, an average error value of 0.97% was found. In testing a 12 V / 7 Ah battery using solar panels with a capacity of 50 WP, it takes 4.5 hours to charge the battery with an average current of 1.74 Amperes. Battery charging can also be controlled via smartphone by pressing the OFF button on the Blynk application[23].

G. Kalyani also conducted monitoring tests on the batteries of IoT-based electric vehicles that use lithium-ion batteries.

The use of lithium-ion batteries can lead to overcharging, which significantly reduces battery life and increases the risk of dangerous fires. The system informs users about the battery condition in real-time [24].

Based on tests conducted by Hala Jarallah El-Khozondar using an ESP32 microcontroller, it was found that energy consumption can be monitored based on the pulses received. Each pulse is equivalent to one kilowatt-hour and is calculated to determine daily and monthly energy usage, according to user-defined limits. If the usage exceeds the limit, an alarm will sound and the electricity supply to the house will be automatically cut off [25].

Checking the battery regularly and recharging the battery is optimally done by the car owner, therefore a tool is needed to monitor the battery [26]**.** Easy to use and can find out the condition of the battery without the need to disassemble the battery compartment, so that the car driver does not need to worry about the condition of the battery because the measurement results of the voltage and current of the stored battery are displayed back through the smartphone in realtime using the ESP 8266 microcontroller [27][28].

The purpose of the ESP 8266-based Car Battery Current and Voltage Monitoring Design research is to get the results of the current and voltage readings of the car battery in real time using the ESP 8266 microcontroller and analyse the performance of esp8266 in monitoring the current and voltage of the car battery accurately[29][30].

2. RESEARCH SIGNIFICANCE

The importance of ESP 8266-based car current and voltage design research is that it helps in efficient energy management, this technology reduces maintenance costs by detecting problems earlier and allows remote data access for better battery management. In addition, this system allows real-time monitoring of battery current and voltage, so users can know the battery condition at any time by using a Smartphone.

3. RESEARCH METHODS

In this research two stages are carried out, the first stage is the hardware design stage and the second stage is the software design stage. To implement the design is done well the need for sufficient information and collection of theories related to the research planning process, can see in **Fig.1.**

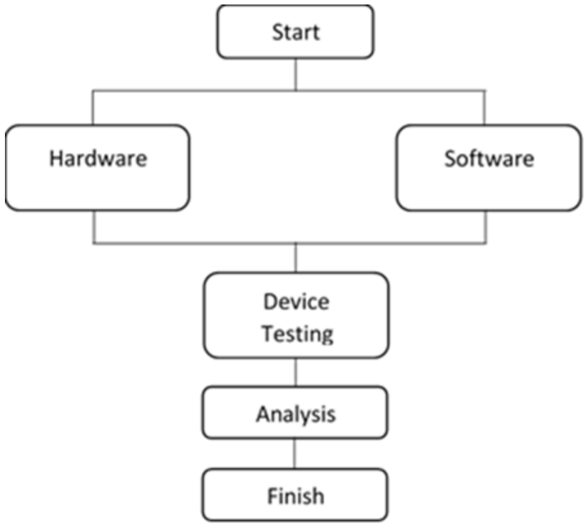

Fig 1 . Follwchat system

Fig 1. This flowchart shows the process that starts from designing the hardware and software. Once both are ready, the next step is testing the tools to make sure everything is working properly. Furthermore, the data and test results are analysed to ensure all objectives have been achieved. Testing the current sensor is done by connecting the circuit in series to the positive wires of the AC, Audio and Light loads to the hardware. When testing the car in a state of engine rotation 1000, 1500 2000, 2500, 3500, and 4000 rpm, then the measurement results are compared with the measurement results using ampere pliers. Voltage sensor testing is assembled in parallel with the negative pole of the battery and the positive pole of the test to calculate the performance of the battery voltage when the car is driven. Then the test results are compared with the multimeter measurement results to find out how big the difference between the hardware test value and the multimeter value.

3.1 Hardware Design

In this research two stages are carried out, the first stage is the hardware design stage (Hardware) and the second stage is the software design stage (software). To implement the design is done well the need for sufficient information and collection of theories related to the research planning process**.**

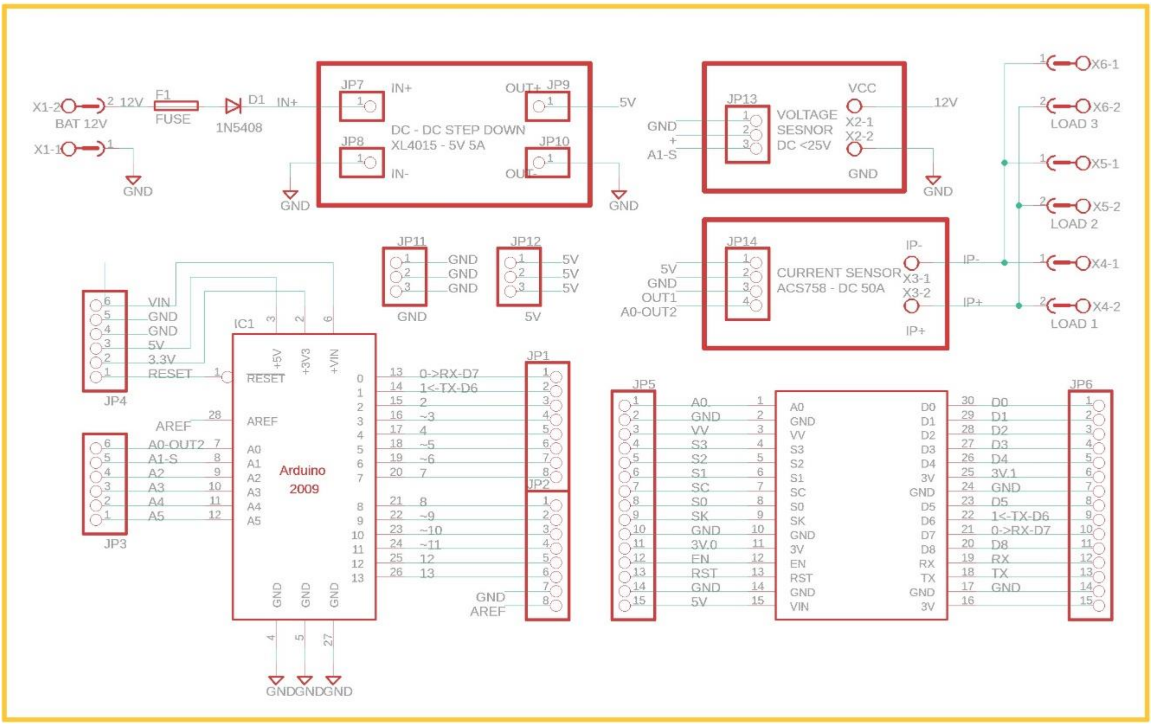

Fig 2. Wiring Diagram Design

Fig 2. shows the design of the wiring diagram of the battery current and voltage monitoring system in the car, using EAGLE (Easily Applicable Graphical Layout Editor) Software is a software used to design and create electronic schematics and printed circuit boards (PCB).

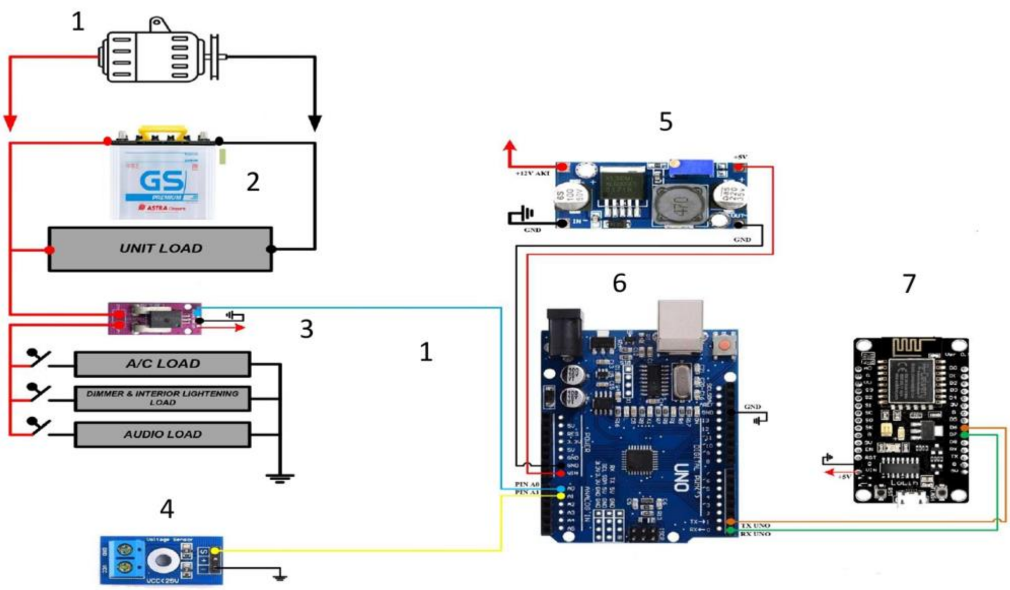

Fig 3. Hardware Design

Fig. 3 Shows a Control System Consisting Of Various Electronic Components That Are Connected To Each Other 1. Altenator 2. Batttery 3.Curret Sensor 4. 4. DC Voltage Sensor 5. DC-DC Step Down Converter 6. Arduiuno Uno 7. ESP 8266.

This circuit is used to monitor the current and voltage in the car's electrical system in real-time, enabling early detection of electrical problems and ensuring the car's electrical system is functioning optimally. With the Wi-Fi module (ESP8266), data can be monitored remotely, providing convenience and efficiency in the management and maintenance of the car's electrical system. how the circuit works The alternator (1) charges the car battery (2) while the engine is running, supplying power to the entire car electrical system. The load (3) uses power from the battery, and the current flowing through this load is measured by the current sensor (4). the DC-DC Step Down Converter (5) converts the 12V voltage from the battery to 5V to provide stable power to the Arduino Uno (6). The Arduino Uno (6) collects data from the current and voltage sensors, processes it, and then transmits it to the ESP8266 module (7). The ESP8266 (7) transmits the collected data wirelessly to a server or application for further monitoring and analysis.

3.1 Software Design

Software design is carried out to provide instructions in the form of a program to the arduiuno boar so that the hardware (hardware) can carry out its duties as a current and voltage monitoring system on a vehicle battery that can be displayed via a smartphone screen using an IoT system.
The IoT system is useful for extending the benefits of a continuous internet connection that allows us to connect machines, equipment, sensors using the internet network to obtain data in real time. The programme is created using the arduiuno IDE software and then uploaded via the arduiuno bord. The C language is used as the language of the programme that is made about the programme running the current sensor and voltage sensor on the car in order to take measurements and then send the data or results into the Thinger IoT server database**.**

```
#include <SoftwareSerial.h>
#include <ESP8266WiFi.h>
#include <ThingerESP8266.h>

SoftwareSerial DataSerial(12, 13);

unsigned long previousMillis = 0;
const long interval = 1000;

String arrData[3];

#define USERNAME "Reynaldo"
#define DEVICE_ID "MONITORING_VIP"

#define DEVICE_CREDENTIAL "yb_W9K+51X2?F!V!"

 const char* ssid = "IVENTORY02";
 const char* password = "876545678";

ThingerESP8266 thing(USERNAME, DEVICE_ID,
DEVICE_CREDENTIAL);
void loop() {
  thing.handle();
  unsigned long currentMillis = millis();
  if(currentMillis - previousMillis >= interval){
      previousMillis = currentMillis;

      //BACA DATA SERIAL DARI NODEMCU
      String data = "";
      while(DataSerial.available()>0){
        data += char(DataSerial.read());

    data.trim();
if(data != ""){
      //parsing dulu atau pecah data
      int index = 0;
      for(int i=0; i<= data.length(); i++){

    DataSerial.println("Ya");
    // Serial.println("Ya");
```

4. RESULTS AND DISCUSSION

The device testing includes overall performance testing to determine whether the system works properly and as expected in **Fig.4**

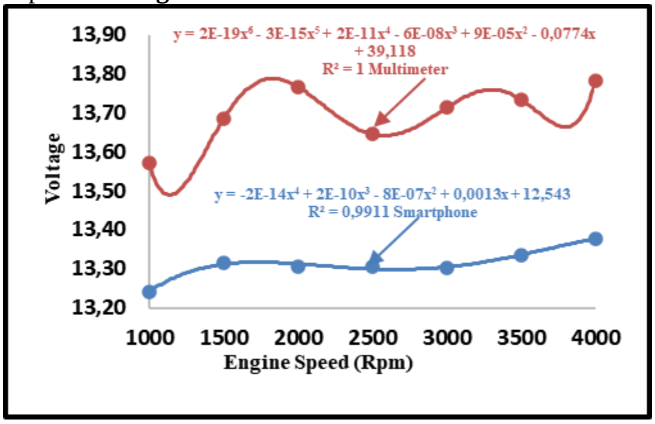

Fig 4. Comparison Of Smartphone And Multimeter Voltage

Fig 4. shows the test results, the voltage measured using a multimeter tends to be higher than that using a smartphone. The voltage measured with the multimeter tends to increase from 1000 RPM to 2000 RPM, which is caused by factors such as alternator efficiency, changes in electrical load, or electrical system dynamics. The increase again at 4000 RPM indicates that the alternator is working harder at high revolutions to meet the increased electrical demand.
When using a smartphone, the voltage tends to stabilise at 1500 to 3000 RPM due to the limitations of the sensor which cannot capture small fluctuations. The voltage starts to increase again at RPM 3500 and 4000. The charging system shows an increase in electricity demand which is met at high revs. In general, the voltage measured using the multimeter varied more compared to the smartphone. This difference in measurement results is due to the different sensitivity of the sensors.

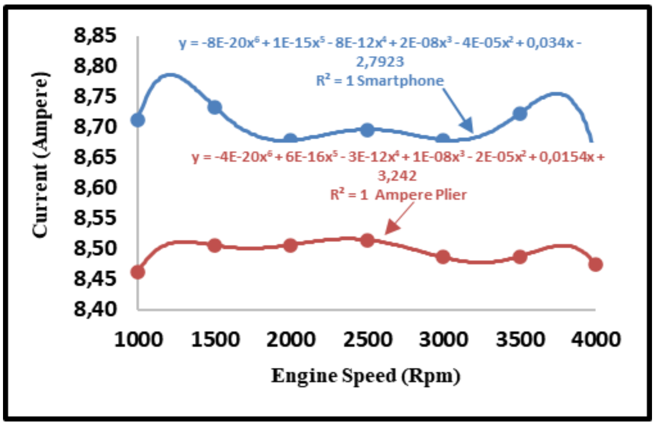

Fig 5 . Comparison of Smartphone Current and Ampere Plier

Fig 5. shows the graphical results of current measurements with pliers ampere and smartphone results obtained using pliers ampere tool tends to increase from 1000 RPM to 2500 RPM. This happens because the alternator produces more power as the RPM increases, meeting the higher electrical demand at higher engine speeds. The decrease in current at 3000 RPM and 4000 RPM may be due to changes in electrical load or alternator efficiency changing at higher engine speeds.

The current measured using a smartphone tends to be higher than with an ampere-tip tool. The increase in current at 1500 RPM and decrease at 2000 RPM shows that the smartphone can detect some changes in current, although it is not as accurate as an ampere-tool. The increase in current at 3500 RPM and decrease at 4000 RPM show a similar pattern to that of a pair of pliers, although the measurement results may not be as detailed as those of a pair of pliers.

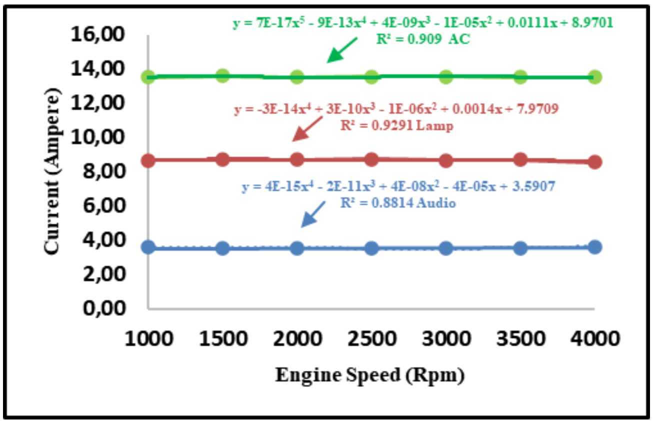

Fig 6. Current Measurement Graph Based on Load

Fig 6. shows the results of current testing on various loads (AC, audio, and lights), the current generated when using AC loads tends to be higher than the lights or audio loads. This is because AC loads require more power to operate than other loads. The current generated in audio, AC, and lighting loads experienced a not too significant increase and decrease because these loads consume relatively stable power during operation.

The higher current demand on the AC load indicates that the car charging system must be able to handle large power demands. At engine speeds of 1000 RPM to 2500 RPM, the current tends to increase as the car's electrical system starts to work more intensively to supply power to components such as lights, air conditioning, and audio that are starting to activate. The increase in current again occurs at 3500 RPM, indicating that at higher engine speeds, the car's electrical system needs to provide more power to compensate for the increased load. The drop in current at 4000 RPM is due to changes in alternator efficiency or electrical load adjustments that occur at very high engine speeds. Overall, these results show how a car's charging and electrical systems must work to meet various power requirements at various engine speeds.

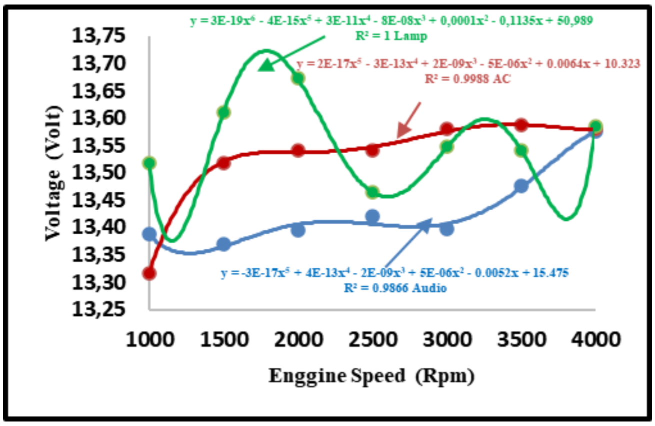

Fig. 7 . Voltage measurement graph based on load

Fig 7. shows that the voltage generated when using lamp loads tends to be higher than that of AC or audio loads at engine speeds of 1000 to 2000 RPM. At these revolutions, the alternator works more efficiently to meet the power requirements of the lamp. However, as the engine speed rises to 2500 RPM, the alternator efficiency changes and the power demand from AC and audio loads increases. This causes the voltage at the lamp load to decrease as more power is diverted to the AC and audio loads. At higher engine speeds (above 2500 RPM), the charging system adjusts the power distribution to ensure all loads get enough voltage. This explains why the voltage on the AC and audio loads increases slightly while the voltage on the lamp load decreases at 2500 RPM.

5. CONCLUSIONS

Based on the test results and data analysis, it can be concluded that the voltage sensor on the battery measured by a multimeter tends to increase from 1000 RPM to 2000 RPM, caused by alternator efficiency, changes in electrical load, or electrical system dynamics. The voltage increase again occurs at 4000 RPM, indicating the alternator is working harder at high revolutions to meet the increased electricity demand. Current measurements show that the current in AC loads tends to be higher compared to audio and lighting loads. The current measured using a smartphone also tends to be higher than that of an ampere meter. The increase in current at 1500 RPM and the decrease at 2000 RPM show that the smartphone can detect some changes in current. Overall, the current and voltage sensors worked very well, with no obstacles affecting the voltage and current readings, and the data transmission via smartphone went smoothly.

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7. AUTHOR CONTRIBUTIONS

Conception and design: Reynaldo
Methodology: Reynaldo
Data acquisition: Reynaldo
Analysis and interpretation of data: Yuniarto Agus Winoko, Reynaldo
Writing publication: Yunirto Agus Winoko
Resources, technical and material supports: Yunirto Agus Winoko
Supervision: Yunairto Agus Winoko

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