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Energy Management on Electric Vehicles Using Fast Charging Banking Capacitor using Internet of Things (IoT) System

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ABSTRACT
Electric vehicles are one of the vehicles without emissions which is an alternative to reduce air pollution. One of the things to be outlined is the limitations of fossil fuels that are getting run out. Due to the higher world oil prices, many people are looking for alternatives to car fuel, one of which is electric motor technology which is applied to electric car vehicles. However, there are problems related to energy, charging, battery which can be monitored by the use of electric vehicles. The development of electric cars in Indonesia was emphasized on a real-time energy monitoring system, the rate of battery life, and the type of charging that will be used for a long time to charge the battery. In this research, we proposed a system for handling the problem of fast charging electric car energy monitors. The monitor is equipped with features such as a battery energy monitor (voltage, current, battery temperature). Finally, the measurements at the test points of voltage, current and battery temperature have been carried out and it is known that the circuit is working properly.

Keywords: *Electric Vehicle, Fast Charging, Battery, Energy*

1. INTRODUCTION

The car is one of the transportations that is often used in everyday life. Its practical and convenient use makes the car an option. One of the things that triggers the manufacture of electric cars is that they are environmentally friendly and do not cause pollution in the open environment and can reduce the use of fuel oil which is getting less and less.

In previous research, the development of electric cars in Indonesia was emphasized on a real-time energy monitoring system, the rate of battery life, and the type of charging that will be used for a long time to charge the battery. The acceleration to overcome these problems is by conducting research every year.

In this study, electric cars are equipped with an indicator panel that serves as important information to determine the condition of the car directly while driving so that the driver feels comfortable and safe and can take action quickly and precisely when something happens, for example to find out, the battery capacity indicator when it is running. operated, when parked, and when charging.

Then it is also equipped with safe distance data for users to find out the distance of the remaining energy in the battery with the distance to be travelled, the speed of the vehicle, and the temperature of the battery. This research also aims to assist industry, government and society in overcoming the development of electric cars in Indonesia.

The specific objectives of this research are;
1. Make an electric car prototype.
2. Create fast charging system for the battery of electric vehicle car
3. Create an Internet of Thing (IoT) monitoring system on Electric Car Energy Management that can be monitored

The battery energy management monitoring system in electric cars is currently being built where vehicle users can find out what percentage of the remaining energy is stored in the battery.

2. LITERATURE REVIEW

2.1. Battery Charger

Battery charger is a device that serves to charge the battery with a constant voltage until it reaches the specified voltage. When the specified voltage level has been reached, the charging current will decrease automatically according to the settings and hold the charging current until it becomes slower so that the indicator lights up indicating the battery is fully charged.

2.2. Deep Cycle Battery Lead Acid

Deep cycle batteries are designed to produce energy (electric current) that is stable (not as stable as the starting battery) but for a long time. This type of battery is resistant to repeated charging - discharging cycles (deep cycle) therefore its construction uses thicker plates as shown in the picture.

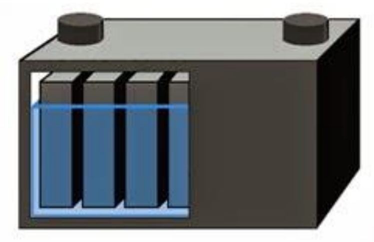

Figure 1 Deep Cycle Battery Lead Acid.

Deep cycle batteries are widely used in equipment that uses electric motors such as fork lifts, electric cars, electric bicycles. This type is also widely used in alternative energy projects to store electric current.

Table 1. Specification of Types of Battery

Types of Battery	Volt (V)	Curret (I)	Resistance (R)
Alkaline	1,5	900-1155	±0,00166
Lithium	3	1600	0,0018
Ni-Cd	1,2	900-1155	±0,00133
Ni-Mh	1,2-1,45	900-1155	±0,00133
Li-Po	7,4-8,4		
Lead Acid	12	210	0,057

2.3. Single Phase Charger Rectifier and Capacitor Charger Banking

Single phase rectifier is a rectifier whose input circuit uses single phase AC supply. Through the MCB, the 220 V single-phase AC supply enters the primary side of the 1-phase main transformer and then the secondary side of the transformer is converted to a DC voltage of 110 V. This output still contains high enough ripple so that a filter circuit is still needed to minimize the output voltage ripple.

Fast charging system that will be used by using a large current to flow to the capacitor and battery. For banking capacitors that will be used as energy storage into a capacitor, with a large current stored in the battery it will be able to push the speed of the current that will enter the battery.

2.4. System Internet of Things (SIoT)

System Internet of Things (SIoT) is a global infrastructure that functions as an information society by enabling services that connect physical and virtual objects based on information technology. In addition, the definition of the Internet of things (IoT) is a technology that allows objects (things) in the form of physical devices (embedded systems) to exchange information with each other.

The embedded system in the IoT infrastructure is hardware that is embedded with electronics, software, sensors and connectivity. Embedded system devices process data from sensor inputs and operate within the internet infrastructure. IoT is also often associated with machine-to-machine (M2M) communications in industry. M2M products are usually called smart systems or, smart as well-known examples are smart cities and smart homes.

3. RESEARCH METHOD

Currently, the research team is developing a smarter fast charging and monitoring system design. has advantages including:

1. With the system that will be built at this time in the future, the energy that will be used in electric cars can be saved and can be used efficiently by adjusting the speed of the electric car. Then the energy obtained is not only by using charging from 220 V AC electricity, but also by adding solar cells that are attached to the entire body of the electric car.
2. Electric cars using fast charging capacitor banking system will make charging faster.
3. Monitoring system equipped with features (voltage, current, motor temperature, battery temperature, motor

speed regulation, motor braking, battery efficiency adjustment).
4. Monitoring system equipped with auto and manual settings, with two-way communication, using a Web Server.
5. By using the Internet of Things (IoT) system in electric cars, it can make success in the smart city system.

The final result of this research is expected to be able to contribute to hygiene technology that can be felt by many people, at all levels of society.

3.1. Mechanical Design

In designing the chassis and body mechanical system, the design is sketched on paper and then simulated in 3D using Auto Cad software and Autodesk Inventor Software. The next stage is making real mechanics as shown picture below:

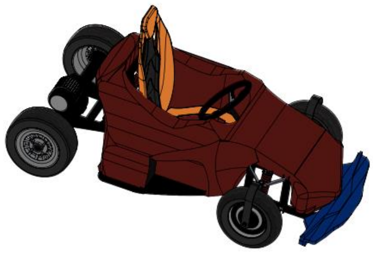

Figure 2 Mechanical Design of Electric Vehicle

3.2. Electrical Design

The design of electronic devices begins with a simulation and then continues to be made using the PCB Wizard. After checking each path on the PCB, it is then processed using NaCL to dissolve the copper on the PCB board. The printed PCB board is then assembled and tested.

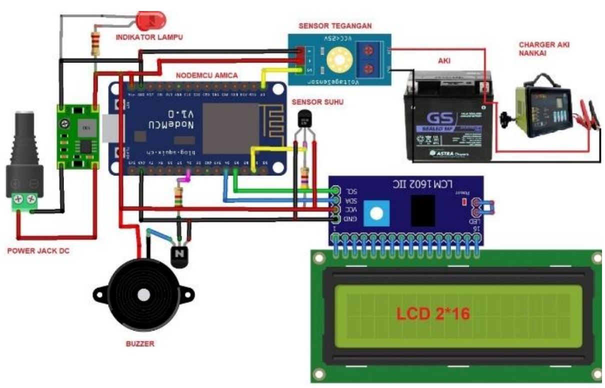

Figure 3 Electrical Design of Electric Vehicle

3.3. IoT System Design

The design of the IoT system begins with the design of an electric car energy management monitoring system. Then the design of a one-way robotic communication system to the web interface. The design of the monitoring system is carried out to determine what data will be sent from the electric car to the web to be monitored.

The following stages are the development and refinement of an IoT communication system that only uses a one-way communication system, so at this stage it will be developed using a two-way communication system so it will allow users to be able to monitor the state of the energy in electric cars, and also be able to control it.

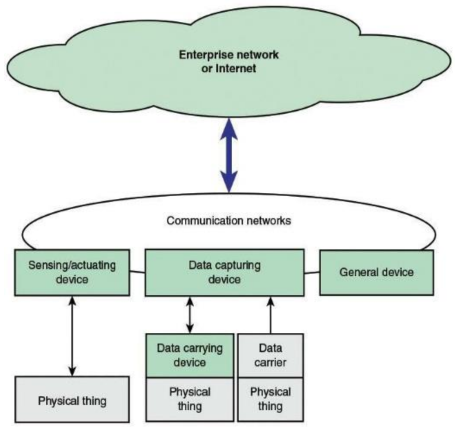

Figure 4 Internet of Things Network

4. DISCUSSION

The research being developed is to make fast charging banking capacitors for monitoring. This system is expected to provide a faster time to charge the batteries used in every electric vehicle, especially electric vehicles using lead acid batteries with the appropriate battery voltage and current capacity. Furthermore, the energy information stored and used in the battery will be sent to the monitor on the electric vehicle.

In this testing stage, we perform some result of voltage, current and temperature sensors. Testing is carried out in 2 ways, non-charging and charging. The data taken is data from reading the voltage sensor seen on the HMI display, and reading data voltmeter. Data is taken every minute when doing the test.

4.1. Voltage Sensor Testing

The voltage sensor in the battery charger monitoring design with an HMI display works to detect the output voltage to the battery. The result is shown below:

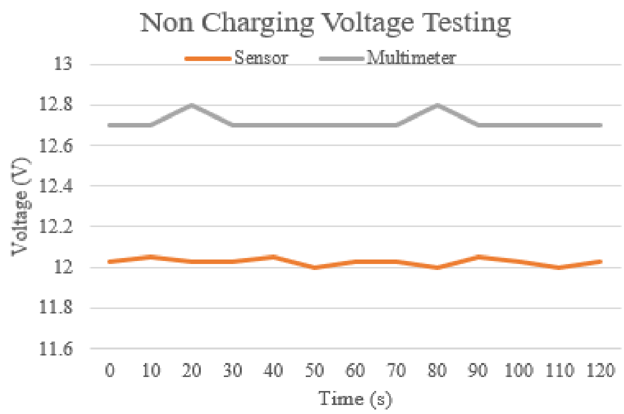

Figure 5 Non-Charging Voltage Sensor Testing

From the data above, it can be seen that there is an average difference of 0.7 V and the average error is 5.72. The data from the sensor readings are also visualized in a non-constant graph. This happens because the sensor used includes sending a signal with a voltage (usually 0-10V), the weakness of this sensor is interference in the form of noise around it that affects the value of analog sensor.

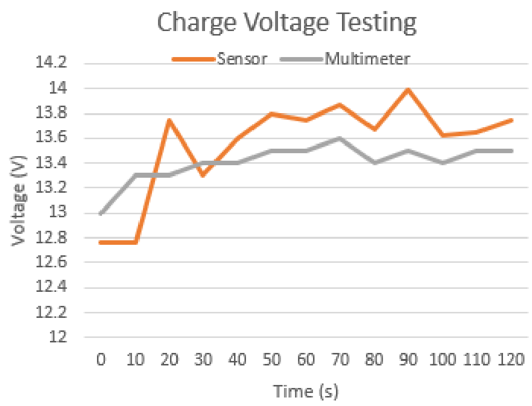

Figure 6 Charging Voltage Sensor Testing.

From the data above, it can be seen that there is an average difference of 0.5 V and an average error of 1.05. Data from sensor readings are also visualized in a graph that is not constant up and down. This happens because the sensors used include those that send signals with a voltage (usually 0-10V), the weakness of this sensor is that it has interference in the form of noise around it that affects the sensor's analog value. Because it is in a state of charge, the voltage will continue to increase because the battery will get a supply from the charger until it is full.

4.2. Current Sensor Testing

The current sensor in the battery charger monitoring design with an HMI display functions to detect the current flowing from the charger output to the charging object, namely the electric car battery.

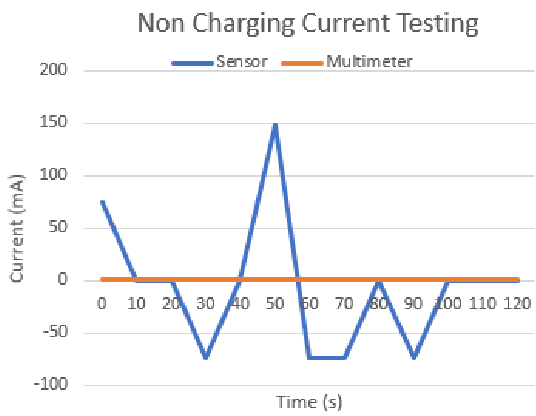

Figure 7 Charging Current Sensor Testing.

The data above is irregular in shape because the sensor readings and multimeter measurements do not get current values. This is because the battery does not have a load so that the current does not flow. According to Ohm's law, current is directly proportional to voltage and inversely proportional to load. Since the load is assumed to be 0, the current is not read. Sensor readings that do not detect the current value will have an error so that it shows a value of -78mA, 0 mA, and 148.

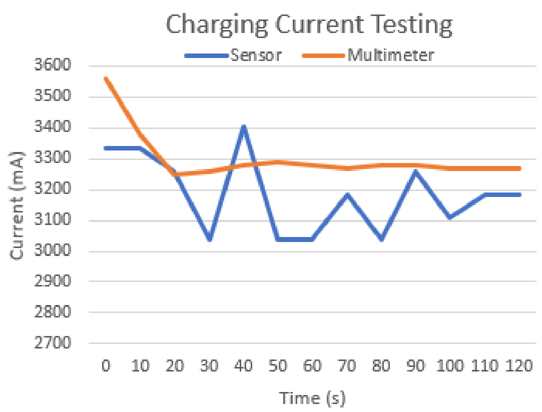

Figure 8 Non-Charging Current Sensor Testing.

From the data above, the sensor readings have a fairly large spike while the multi meter looks a little stable. The average reading error for the charge current test is 3.85 and the difference is 119.08 mA. The reading of the current value will decrease if the battery process will be full. When the battery is full, the current will have a value of 0 so the charging process stops because the current does not flow.

4.3. Temperature Sensor Testing

The temperature sensor in the battery charger monitoring design with an HMI display functions to detect the battery body temperature when charging.

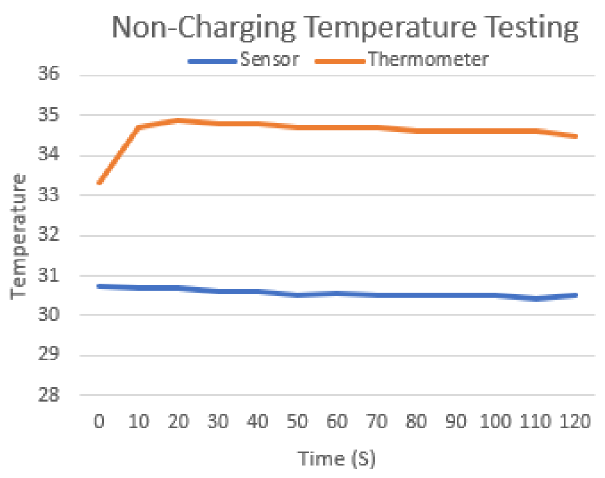

Figure 9 Non-Charging Sensor Testing.

From the data above, the sensor and thermometer readings have a significant difference, this happens because the sensor used is not suitable for reading solid objects. This sensor can function properly, when measuring liquids. The difference between the two measuring instruments is 4.01 degrees and the error is 13.12. This error value is high enough that it cannot be used as a measuring tool.

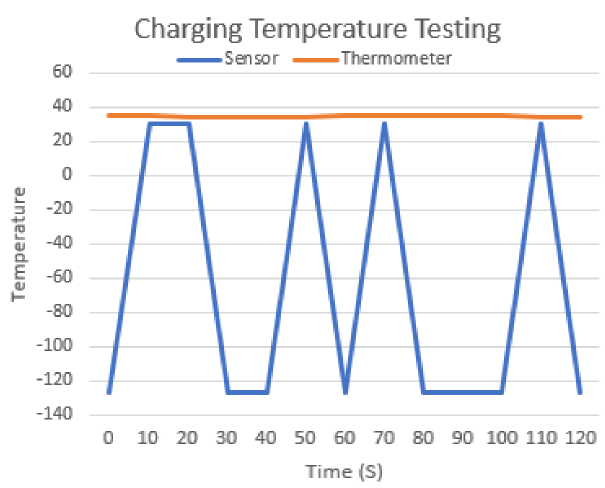

Figure 10 Charging Sensor Testing.

From the data above, the sensor and thermometer readings have a significant difference, this happens because the sensor used is not suitable for reading solid objects. This sensor can function properly, when measuring liquids. An error or temperature sensor reading is not detected if the reading is -127. The difference between the two measuring instruments is 101.12 degrees and the error has a value of 72.97. The error value is quite high, so it cannot be used as a measuring tool.

5. CONCLUSIONS

Finally, testing have been made at each test point so that it can be seen that the circuit is working properly. This test point is carried out on the sensor used. The measurement values obtained on each sensor that will be a reference point that the circuit has been running well and if there are errors in the circuit, identification and troubleshooting can be carried out appropriately.

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