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Desain and Construction Hybrid System of PLN-PV-Battery in the Receiver Box Package Based Internet of Things

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ABSTRACT

In previous research, if there was a power outage from PLN, the electrical system in the package receiving box experienced problems, so that the package courier could not access the package receiving box. The purpose of making this tool is to overcome electrical supply failures in IoT-based package receiving boxes. The system designed uses voltage sensors connected to each source of electrical energy from PLN, Photovoltaic (PV) and also batteries. After that, the voltage sensor gives a signal to the Arduino for the switching process to be carried out on each source of electrical energy. This system works, if there is a power outage from PLN, the electrical energy is supplied via PV. If the PV voltage is not sufficient, the electrical system will be supplied via batteries, so that the electrical energy in the package receiving box will always be available and can work even if there is a power outage from PLN. Based on the hybrid system test results, it was found that the voltage sensor works by detecting voltage from each source of electrical energy. When the voltage sensor does not detect a voltage source from PLN, the system will switch to PV, when the voltage sensor on the PV detects a voltage below 10 Volts, then the system will switch to battery.

I. Introduction

In previous research, the package receiving box was not equipped with photovoltaics or batteries [1], so that if there was a power outage from PLN, the delivery courier would not be able to access the box, so in this research a hybrid system was designed that could overcome the problem of energy availability. electricity in the box receiving the package. The benefit of this research is that electrical energy at the electrical source of the package receiving box is always available even if there is interference or blackout from PLN, so it can still be accessed by users. In this research, a DC voltage sensor was used to read current and voltage from PLN, photovoltaic and batteries. The data read by the voltage sensor will be sent to Arduino for processing and displayed on the LDC (Liquid Crystal Display) [2]. Apart from the voltage sensor, this research also uses Arduino as a controller for the switching method in the hybrid system. Arduino is a controller designed to make it easier for users to process each input voltage source and then process it to determine the desired output [3]. In this research, photovoltaics (PV) or solar panels are also used as an alternative energy source if the source from PLN experiences a blackout. Solar panels are a component that can be used to convert sunlight energy into electrical energy using a principle called the photovoltaic effect [4][5]. In this research, batteries are used as the final backup energy, if PLN or Photovoltaic cannot supply electrical energy to the electrical system in the package receiving box [6][7].

II. The Proposed Method/Algorithm

This section explains the system design which will be divided into two main parts, namely hardware (mechanical) and software (electrical) design for the PLN-PV-Battery hybrid system in an IoT-based Package Receiver Box. The electrical system in the IoT-based package receiving box as a whole uses a DC electrical system so that electrical energy from PLN must first be converted into a DC system using an AC-DC converter (Power Supply), then the electrical energy from PLN is used to turn on the electrical system in the receiving box. package, if the electrical energy from PLN goes out, the system will switch to photovoltaic, which has previously been detected by the voltage sensor. Then, if the electrical energy from PLN is also insufficient to power the system, batteries are used as the last alternative energy.

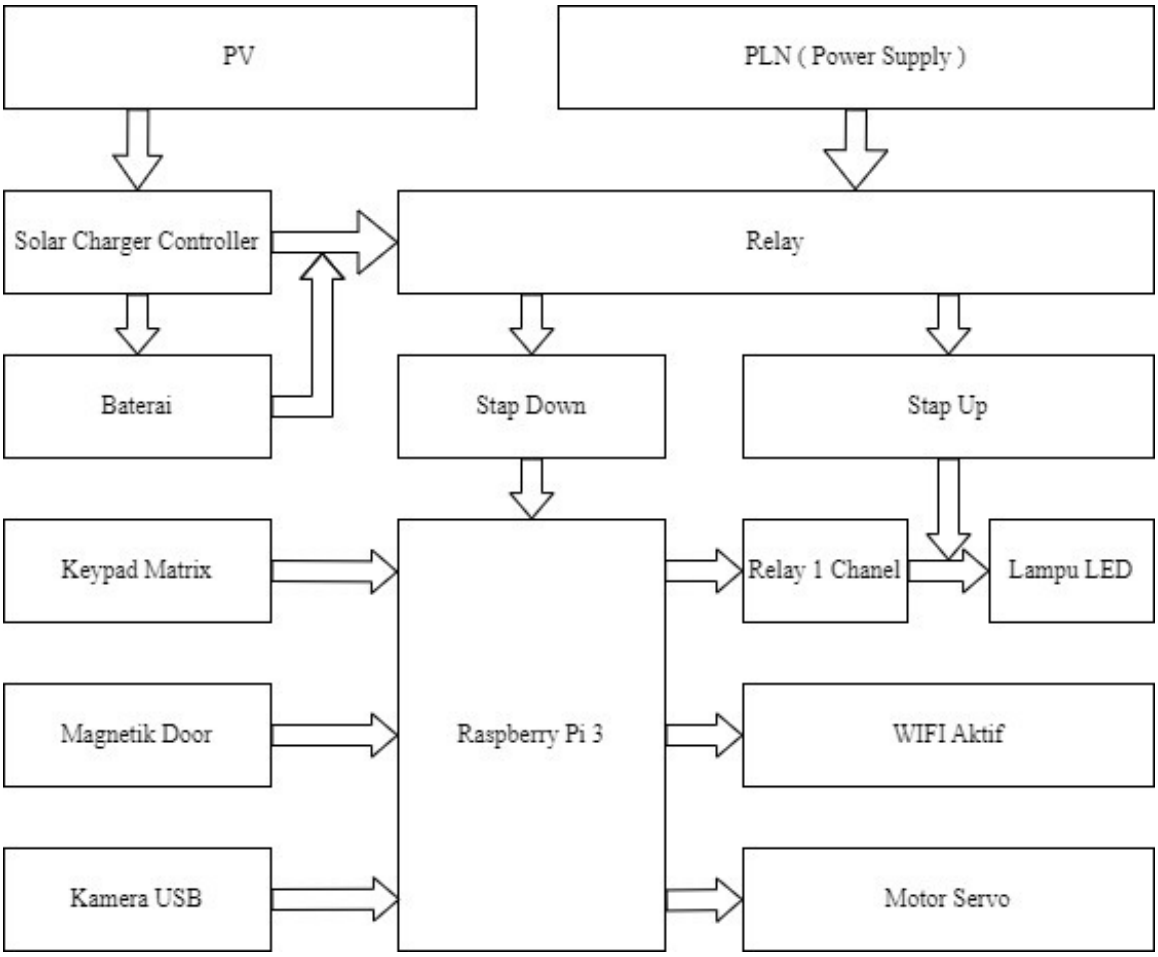

Fig. 1. Hardware System Block Diagram

- **Method**

The method used in this research is designing a hybrid system through programming on Arduino based on input from each voltage sensor placed on each electrical energy source in the form of PLN, PV and also batteries. The results of each input voltage source are processed and then used as switching electrical energy from one energy source to another. For more details, see Figure 2, namely a flowchart of the tool's working system. After the system design is carried out, the next stage is the stage of designing the mechanical system and electrical system of the tool.

- *Flowchart*

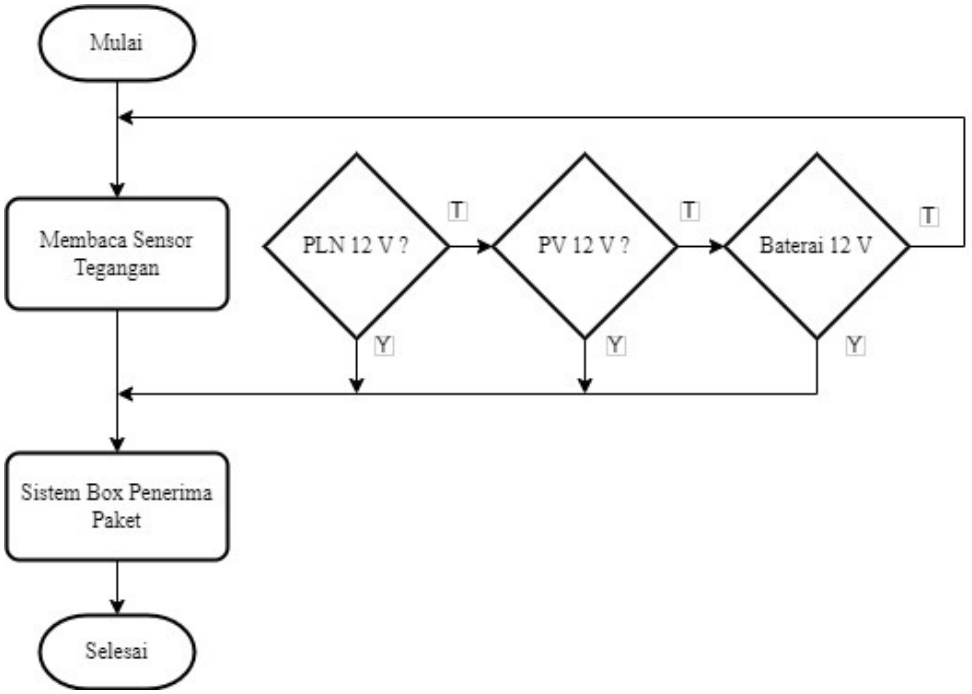

Fig. 2. Work System Flowchart

- **Electrical System Design**

This section will explain the overall electrical design in planning the creation of a PLN-PV-Battery hybrid system in an IoT-based Package Receiver Box.

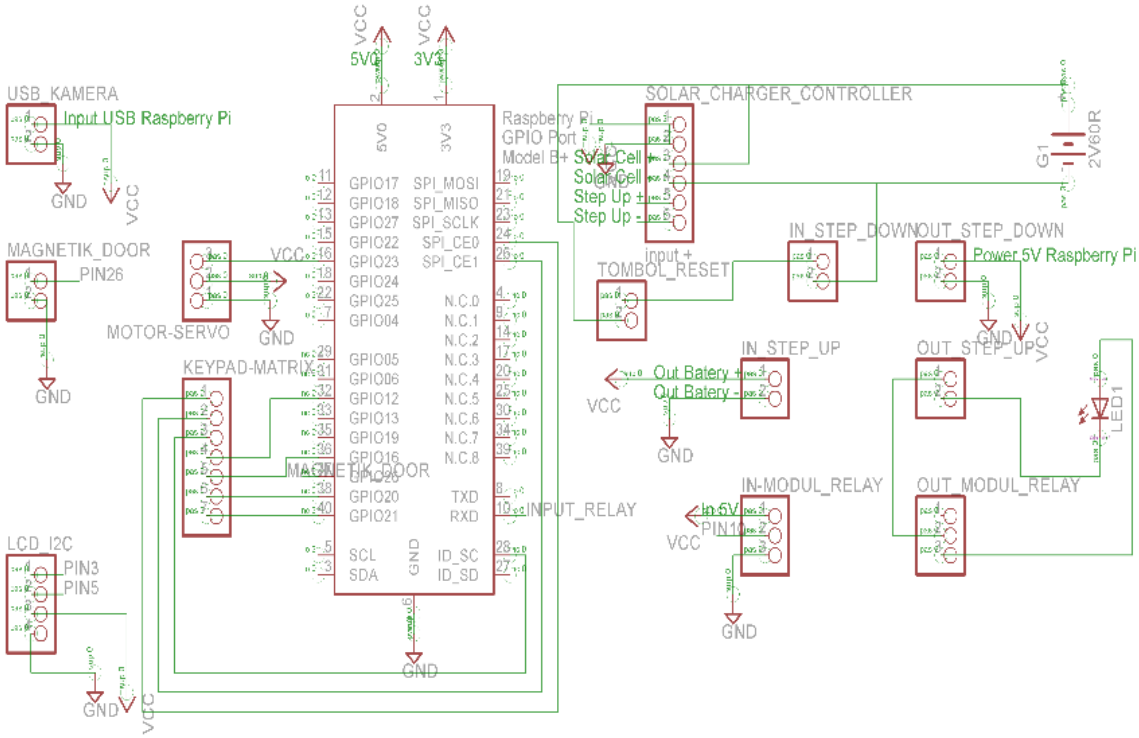

Fig. 3. Electrical System Design

- **Package Receiving Box Design**

  The design of the IoT-based Package Receiving Box system can be seen in Figure 4 below:

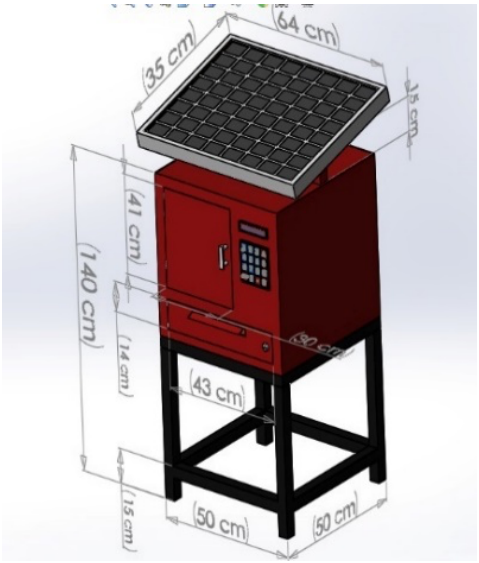

Fig. 4. Mechanical Design of Hybrid Systems in Package Receiving Boxes

- **Design System and Its Parts**

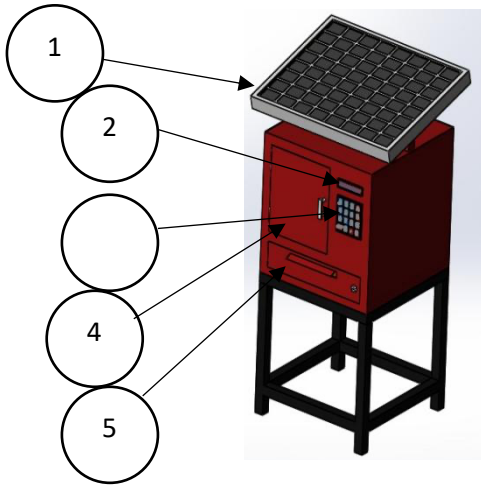

Fig. 5. Hybrid System in IoT Based Package Receiver Box

Informations:

1. Solar Panels : functions as an energy supplier to the battery to power the system.
2. LCD I2C 16x2 : functions as a display for instructions on the command to be carried out.
3. Keypad 4x4 : functions as a button to fill in the pin password to open the door on the box.
4. Main Box Door : functions as a place to enter goods or packages when they arrive.
5. Mail Door : The Mail Door is used to enter goods or packages in the form of personal files or correspondence.

III. Results and Discussion

The results of the product design for the PLN-PV-Battery hybrid system in the Internet of Things (IoT) Based Package Receiver Box can be seen in Figure 6 below.

Fig. 6. Hybrid System Product Design Results in Package Receiving Boxes

- **Solar Panel Testing**

The purpose of this test is to determine the voltage produced by the solar panel. The solar panel test results can be seen in table 1 below. This test was carried out on August 24 2023 with varying weather conditions. The solar panels used are of the Polycrystalline type.

Table 1. Solar Panel Testing

NO	Time	Voltage	Current	Power	Information
1	07.00	14,6V	1,2A	17,52W	Bright
2	08.00	14,2V	1,2A	17,04W	Bright
3	09.00	12,2V	1,1A	13,42W	Cloudy
4	10.00	12V	1,1A	13,2W	Cloudy
5	11.00	12,1V	1,1A	13,31W	Cloudy
6	12.00	12V	1,1A	13,2W	Cloudy
7	13.00	14,2V	1,1A	15,62W	Bright
8	14.00	12V	1,1A	13,42W	Cloudy
9	15.00	12V	1,2A	14,4W	Cloudy
10	16.00	14,5	1,2A	17,4W	Bright

From the solar panel test results it can be seen that the power output produced by the solar panels seems to vary with changing weather conditions, the highest power output is produced at 07.00 in the morning with an output power of 17.52 Watts, with a temperature level close to ideal, namely around 27 degrees, then the solar panels can also produce better power.

- **Battery Testing**

The results of testing the charger on the battery can be seen in table 2 below.

Table 2. Battery Charger Test Results

No	Time	Battery Current	Battery Voltage	Power
1	7.00	0,3A	9,3V	2,79W
2	8.00	0,45A	9,5V	4,275W
3	09.00	0,58A	10V	5,8W
4	10.00	0,62A	10,30V	6,386W
5	11.00	0,73A	10,70V	7,811W
6	12.00	1,25A	11V	13,75W
7	13.00	1,43A	11,30V	16,159W
8	14.00	1,84A	11,80V	21,712W
9	15.00	2,5A	11,9V	29,75W
10	16.00	2,73A	12V	32,76W

From the test results of the battery charger, there are changes in current, voltage and power where the results obtained show a linear change, where the power output produced by the battery is higher as the charging time changes.

- **Hybrid System Testing**

The results of testing the hybrid system against 3 sources can be seen in table 3 below.

Table 3. Hybrid System Process from Three Voltage Sources

NO	Source	Voltage	Condition
1	PLN	AC220-240V	PLN source ON
		-	PLN source OFF (*switch to* PV*)*
2	PV	DC 12V – 10V	PV source ON
		< 10V	PV source OFF (*switch to Battery*)
3	Battery	12V – 9V	Battery Source ON
		< 9V	System OFF

The results of testing the hybrid system for the three voltage sources, when the AC sensor reads the PLN source voltage of 220/240V then the PLN source is ON, when the AC voltage sensor does not read the PLN source voltage then the PLN source is OFF and activates the PV source, when the DC sensor reads the PV voltage from 10- 12V then the PV source is ON, when the sensor reads the PV voltage below 10V then the PV source is OFF and switches to the battery, when the DC voltage sensor reads the battery voltage below 9V then the entire system is OFF.

IV. Conclusion

Based on the results of testing and analysis of the system that has been created, several conclusions can be drawn, namely that the IoT-based package receiving box can operate even if the PLN current goes out because it gets energy sources from solar panels and batteries. The next conclusion is that the hybrid system in the package receiving box works as expected, namely the switching process on the three voltage sources works according to the hybrid system algorithm.

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