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Implementation of Solar Cells for Energy Sources in Hydroponic Automation Systems

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ABSTRACT
The hydroponic plant management automation system uses electronic devices that require electrical energy for these devices to work. The supply of electrical energy will be a problem in a power outage or the location of plants far from the power source. In addition, the continuous use of electricity will also increase the operational costs of plant maintenance. This research implements solar cells for electric power generation to activate sensor devices in hydroponic plant automation systems. The main device is a 60-watt solar panel with 5A battery storage to activate sensors in the hydroponic automation system. The study results can be concluded that this equipment can help source energy in hydroponic automation systems. The battery charging process takes an average of 100 minutes (without using a load) and takes an average of 155 minutes (with a load).

***Keywords**: Solar panels; Batteries; hydroponic automation; electricity.*

INTRODUCTION

Hydroponics is a way of growing crops without using soil media but using water or porous materials (Juanda, 2020). Planting with hydroponic techniques is a pattern of farming using media other than soil, with attention to meeting the plant's nutritional needs concerned or, in other terms, farming using water media (Nuswantara et al., n.d.); (Sujono & Kafi, 2020). Along with the development of science and technology, the hydroponic system needs to be modified to make it better. For example, regulating the provision of nutrients according to plant needs is to design an automatic tidal hydroponic system using an Arduino Uno microcontroller-based device to control the watering system according to the needs of the plant so that it does not waste electricity because the water circulation control system uses a motor (Setyohadi et al., 2020); (Sifaunajah, 2020). The automatic water circulation regulator hydroponic planting method in its manufacture requires a system design with a motor as a driving force for water flow, controlled artificial heaters, and solar panels as a power generator (Gozali, 2016); (Widya & Airlangga, 2020).

Planting with hydroponics requires the proper nutrients that are channeled by water to the plant roots. In this study, the author will provide a solution, namely designing a solar power plant (solar panels) for hydroponic plants. Solar panels' performance in certain environmental conditions can be determined by directly monitoring the output parameters such as current, power, and voltage. From the results of this monitoring can obtain information on whether a solar panel installation is appropriate and produces the desired output power (Setiawan et al., 2020).

METHOD

This research took place at the University of KH. A. Wahab Hasbullah, which is located on Jl. Garuda No. 9, Tambakberas, Tambak Rejo, Jombang District, Jombang Regency. The tools used in this research are solar panels, Arduino, accumulator, solar charger controller, voltage sensor, current sensor, ESP8266 module, smartphone. The method used is the Waterfall method. This method was first introduced by Winston Royce around 1970. This method consists of 5 iterative stages: the literature study analysis stage, the system design/design stage, the hardware assembly stage, the coding stage, and the testing stage. This method is carried out from top to bottom sequentially, as shown in Figure 1.

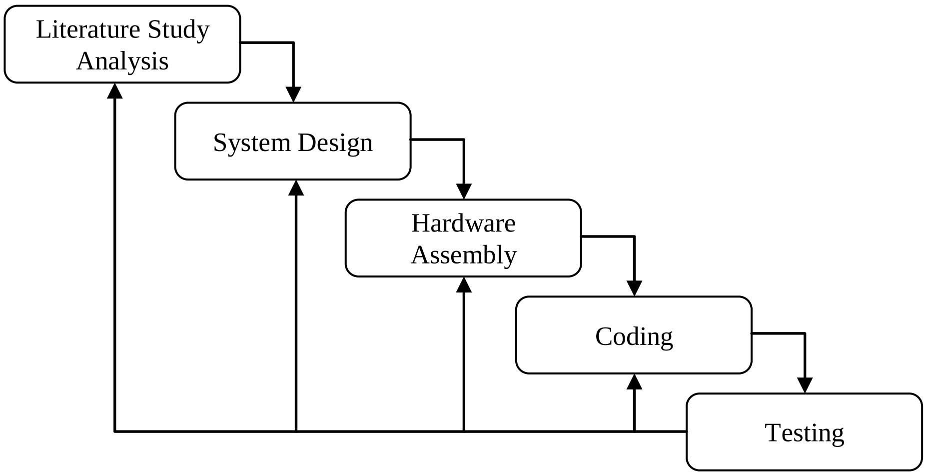

Figure 1. Stages in the waterfall method

The flow of this method starts from the system analysis stage. This stage aims to analyze the system requirements; in this case, the researcher conducts a literature study, interviews, and observations of the existing system. Next is the System Design Phase, namely, by designing the flow and setting the required components. The next stage is Hardware Assembly; this stage combines the Arduino Uno with several sensors and other electronic components and ESP8266 as a data sender to the server. Furthermore, the coding stage is carried out. The Arduino and ESP 8266 coding systems use Arduino ide with the C++ programming language. The website coding system is built with CodeIgniter, which uses JavaScript, PHP, and HTML programming languages, for code implementation and editing using the Sublime Text editor tools. Finally, through the testing phase. At this stage, testing the system's compatibility and functionality is carried out to review whether the system is running according to the concept and plan.

System planning

The design of the tool system is made to simplify and assist in the process of creating tools. The design of the device can be seen in Figure 2.

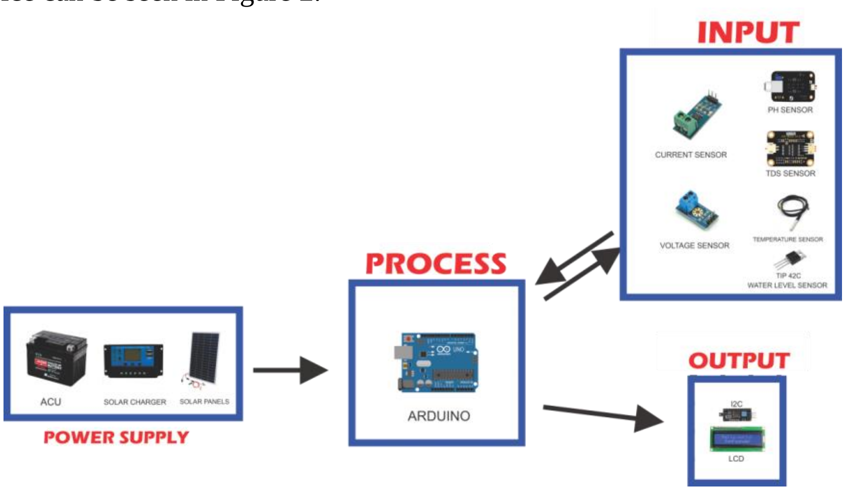

Figure 2. System Flow Sketch.

After the system design has been completed, the next step is hardware design. The hardware design includes inputs, processes, and outputs into a unit arranged into an energy source tool for the "smart hydroponic" component. The hardware design uses Arduino Uno as a sensor reader, ESP8266 wifi module as a sender of sensor data to the web server, solar panels as a converter of sunlight into electrical energy, solar charger controller as a regulator of electrical power from the Suya panel to charge the battery, and regulate the power that comes out to supply sensors/components in smart hydroponics. The website software uses the Codeigniter framework as a monitoring application as well as controlling sensor data.

RESULT AND DISCUSSION

Tool Assembly Results (Hardware)

The assembly of this tool is done by combining sensors and other components so that they are integrated, as shown in Figure 3.

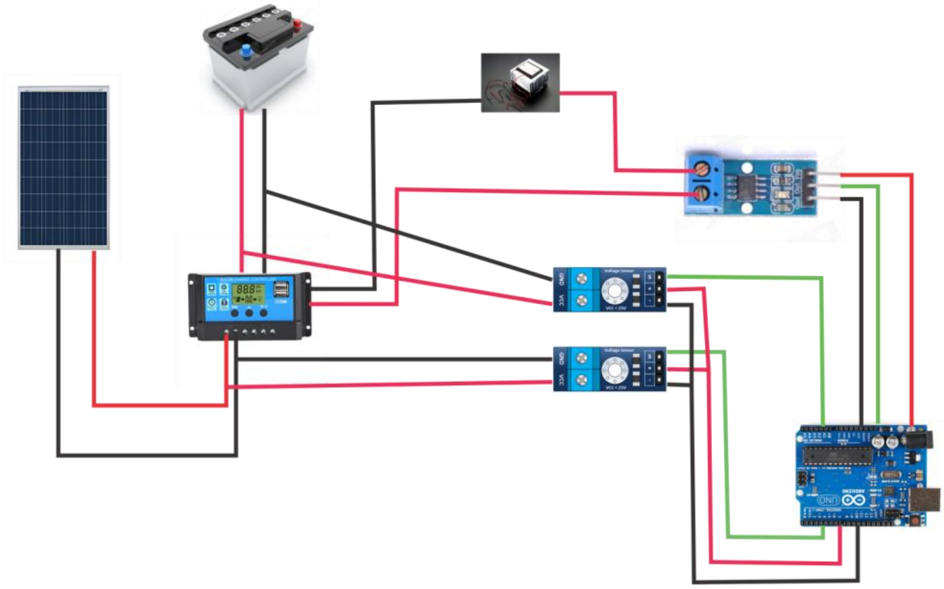

Figure 3. Schematic of sensor and component combination

In the Current Sensor, as shown in Figure 3, you can see how to connect the current sensor pin from the solar panel to the Arduino Uno A2 pin. The current sensor from the battery is connected to the Arduino Uno A3 pin. The Voltage Sensor is in charge of detecting the mains voltage value and producing a comparable signal. The resulting signal can be analog voltage or current, or even digital; figure 3 explains how to connect the sensor from the output of the solar charger controller to the Arduino Uno. By joining the production of the solar charger controller to pin A1 Arduino Uno. To measure AC voltage, the voltage must be converted to DC voltage. (Junaldy et al., 2019). Solar panels are solar cells that can convert solar energy into electricity. From Figure 3, it is explained that the solar panels directly charge the solar charger controller to charge the battery. The electrical power generated by the solar module depends on the size of the light intensity obtained by the solar module. To anticipate when the solar module produces a small amount of power, a battery with a larger capacity is required. The battery charging system is regulated by charge control, preventing the battery from being damaged due to overcharge (Rahmad & Rangkuti, 2018). The results of assembling the tool along with the hydroponic automation system can be seen in Figure 4.

Figure 4. Solar Panel Implementation

Result

Solar Panel Testing With Solar Charge Controller Module. This test is carried out to determine the input voltage of the solar panel that enters the 12 VDC accumulator. The purpose of installing this module is so that the voltage from the solar panel can be adequately controlled during the charging and discharging process so that the condition of the accumulator remains prime (Suprayitno et al., 2018). Panel Flow control testing is carried out in 2 stages. The first test was carried out without using a load on the battery, and the second test was carried out using a load on the battery. The test results are as follows:

Table 1 Test results of no-load battery charging with solar panels

No	Time	Battery level	Panel Voltage
1	10:08:45	10 %	13,05Volt
2	10:21:35	20 %	13,39Volt
3	10:28:12	30 %	13,05Volt
4	10:37:50	40 %	13,39Volt
5	10:44:09	50 %	13,39Volt
6	10:59:54	60 %	13,05Volt
7	11:10:23	70 %	13,39Volt
8	11:16:09	80 %	13,44Volt
9	11:23:06	90 %	13,39Volt
10	11:29:43	100 %	13,05Volt

The results of the battery charging test without using a load obtained that the average time required to charge the battery entirely is 100 minutes. This test was carried out during the day, starting at 10.08 to 11.30 WIB with sunny weather.

Table 2 Test results for charging batteries using solar panel loads

No	Time	Battery level	Panel Voltage
1	12:00:12	10 %	13,44Volt
2	12:29:43	20 %	13,44Volt
3	12:42:09	30 %	13,44Volt
4	12:59:47	40 %	13,05Volt
5	01:31:11	50 %	13,39Volt
6	01:51:42	60 %	13,05Volt
7	02:08:33	70 %	13,39Volt
8	02:19:12	80 %	13,39Volt
9	02:25:56	90 %	13,05Volt
10	02:35:17	100 %	13,39Volt

The results of the battery charging test using a load obtained that the average time required to charge the battery fully in 155 minutes. This test was carried out during the day, starting at 12.00 WIB with sunny weather.

CONCLUSIONS

In this final study, the author concludes based on this research that several conclusions can be drawn, namely that a Current and Voltage Monitoring device has been made in the Solar Panel. The implementation of solar cells for energy sources in the hydroponic automation system for measuring parameters from solar panels has been successfully carried out. The data collection results provide the results of charging batteries with solar panels without using a load; the time needed is 1 hour 39 minutes 43 seconds. The data collection results give the results of charging batteries with solar panels using a load of 2 hours 35 minutes 17 seconds.

The results of this study may have many shortcomings. Therefore, we provide suggestions including this tool only using a 60-watt solar panel, 5-ampere battery battery, and the load used is limited to sensors and micro-controllers with relatively small power so that it does not cover all hydroponic automation equipment. This tool only reads DC and voltage, so it is recommended to replace the sensor with reading AC if you want to read AC and voltage for subsequent development. In the future, it is hoped that there will be better development.

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