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Arduino-Based Solar Water Pump Motor Control to Adjust Water Circulation in Hydroponic Plants

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Abstract— Hydroponic plants are currently very popular because they do not require large land and land. By planting hydroponically, the harvest will be faster but it is necessary to pay attention to the air that is maintained, the purpose of distributing plant root nutrients, the use of solar power as a driving force for DC (Direct Current) water pumps in hydroponics is designed using several tools including: photovoltaic 10 Wp type polycrystalline, solar charge controller, 12v 5Ah battery, Arduino UNO, Dsi8b20 temperature sensor and 12V DC water pump. In this study, the author will make a solar pump motor drive (Solar Panel) and regulate the circulation of air volume and temperature in the hydroponic plant.

Keywords— Hydroponics, Solar Panels, Dc Water Pumps, Temperature

I. INTRODUCTION

Changes in the chemical phenomenon where sunlight can be used directly to generate electricity is called photovoltaic. Photovoltaic can be a renewable energy by utilizing solar power (sun) where sunlight can be converted into electrical energy so that it no longer uses or utilizes fuel oil which will eventually run out. Meanwhile, electricity generation can also be done in 2 (two) ways, namely directly using photovoltaics and indirectly by concentrating solar energy. With the progress of science and technology in this era of globalization, especially in the field of developing alternative energy sources combined with electronic circuits, it is expected to create new information in the field of alternative energy, especially related to photovoltaic systems.

Solar-dependent photovoltaic system performance can be affected by weather or climate. Climatic conditions have a significant effect on the amount of solar energy received by photovoltaics and can affect photovoltaic performance. The development of agricultural science and technology in the era of globalization really requires modifications to the hydroponic system so that the hydroponic system becomes even better in the future.

Because Indonesia's strategic location is known as a country with a tropical climate because it has abundant energy potential and high levels of radiation, therefore Indonesia is very well suited to using solar cells as a renewable energy source (an energy source that exists in nature). Because sunlight, waves, wind and water are renewable energy.

The hydroponic trend is very suitable to be applied in densely populated urban areas because it lacks space and does not require land. In addition to producing products for oneself (household scale), hydroponics aims to save water, more efficiency for circulation using a pump motor. Cultivating hydroponic farming without using soil but can be replaced with rockwool, cotton and other media. This hydroponic plant uses nutrients dissolved in water, you can use used bottles, PVC pipes. One method of cultivating hydroponic plants in which plant roots grow in shallow and circulated layers so that plants can obtain sufficient water, nutrients and oxygen is the Nutrifit Film Technique (NFT).

II. METHODS

In this research, there are several stages or structural designs that must be carried out before making a tool. The following is a structural design consisting of several components, namely:

a. Solar panels (Solar arrays)

Measure the value of the voltage and current that goes into the solar panel when it is pointed at the sun. Solar panels that will be applied in hydroponics as a dc motor drive.

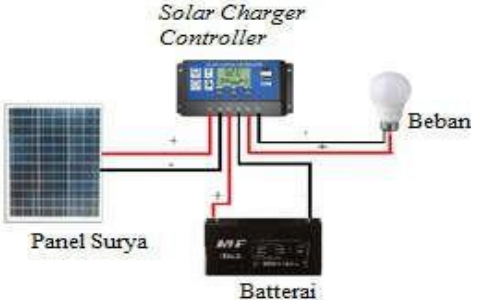

Figure 1 Schematic of testing solar panels

b. Solar panel installation

Solar charger controller installation functions to regulate the value of the voltage and current stored in the battery, so that it does not experience over charging. Therefore, using Arduino Uno to determine the volume and temperature of water in hydroponic plants.

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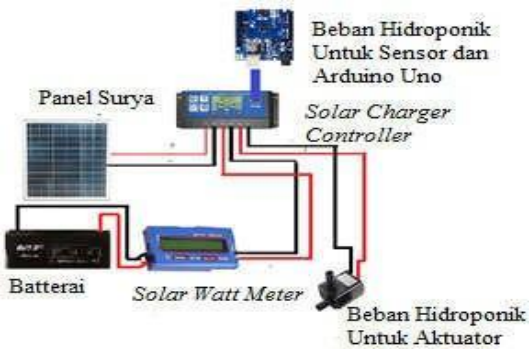

Figure 2 Solar Panel Installation

c. HC-SR04 Ultrasonic Sensor Calibration

Controlling the water level in the reservoir using the HC-SR04 ultrasonic sensor. This sensor is calibrated using a gauge block. Gauge block has a length of 10 cm - 50 cm.

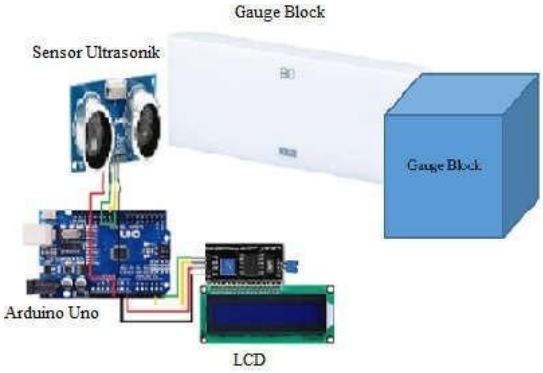

Figure 3 Ultrasonic sensor calibration series

d. Hydroponic Design

This study used the Nutrient Film Technique or (NFT) system. The plants that are the object of research are pakcoy and mustard greens with the ideal volume of water and temperature

The design scheme helps in designing the product design of the tools to be made by the researcher. The following is a schematic drawing of the design of the tools to be made in this study. In Figure 4 there are several main components such as solar panels, DC pumps that are used to pump water from the reservoir to the hydroponic pipes, the HC-SR04 ultrasonic sensor and the DS18B20 temperature sensor which are controlled by Arduino which are placed in the control *unit*.

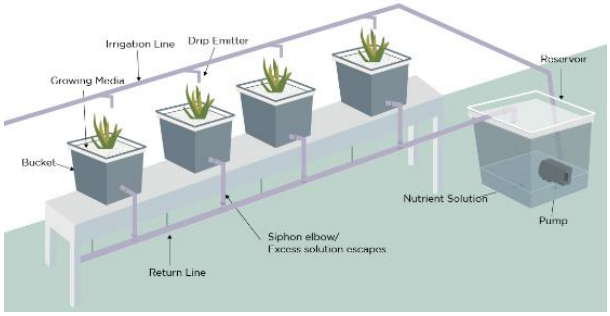

Figure 4 Hydroponic Design Scheme

How the tool works

1) Solar panels absorb sunlight and store the resulting energy into a 12v battery and control the solar charge controller (SSC).
2) The solar charge controller regulates overcharging (excess charging - because the battery is 'full') and excess voltage from the solar panel / solar cell.
3) Arduino measures the temperature and volume of water in the reservoir.
4) If the water has met the set limit then run the Dc 12v water pump.
5) The DS18B20 Temperature Sensor measures the temperature of the water in the reservoir, if the water exceeds the specified temperature limit it will adjust the speed of the pump motor to lower the water temperature and give a warning "Water Temperature Too High"
6) If the water in the reservoir decreases, the pump will automatically turn off and will work again according to the predetermined water limit.

1. Device Wiring

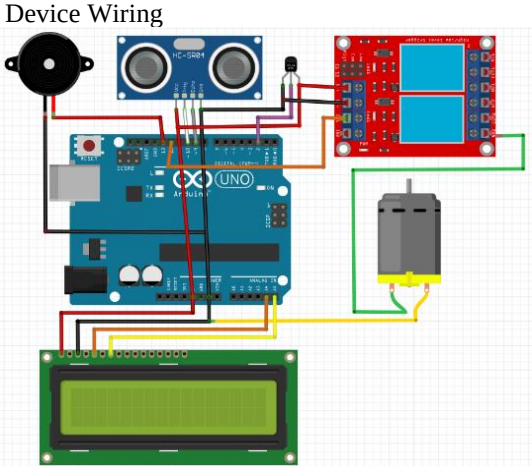
Figure 5 Wiring Diagram

The following is an explanation of Figure 5

1) At number 1, namely the buzzer as a warning / alarm sound.
2) At number 2 is the Ultrasonic sensor which functions as a measure of the volume of water from the tool that the researcher will make.
3) At number 3 there is a digital temperature sensor DS18B20 which can be connected to a microcontroller which functions as a measure of temperature in hydroponic plant water tanks.
4) At number 4 there is 2 channel relay module that functions as a time delay/pause when opening and closing a DC12v motor.
5) At number 5, namely the Arduino Uno module which functions as the brain of the program system that will be made by researchers
6) In number 6 there is a DC12v motor which functions as pumping water from the reservoir to flow through the pipes on hydroponic plants.
7) At number 7, namely the 16x2 LCD module which functions as a display of water volume and

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temperature in hydroponic plants that have been programmed by researchers

2. Tool Flowchart Diagram

The researcher made a tool flow chart or *flowchart* aimed at giving an overview of the process of the tool that the researcher will make so that it is easy to understand.

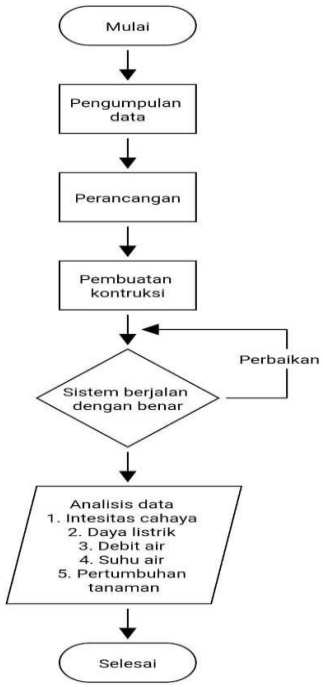

Figure 6 System Flowchart

3. Product Design

Product Design is the final description of the tools that will be made by researchers in making the tools that will be made.

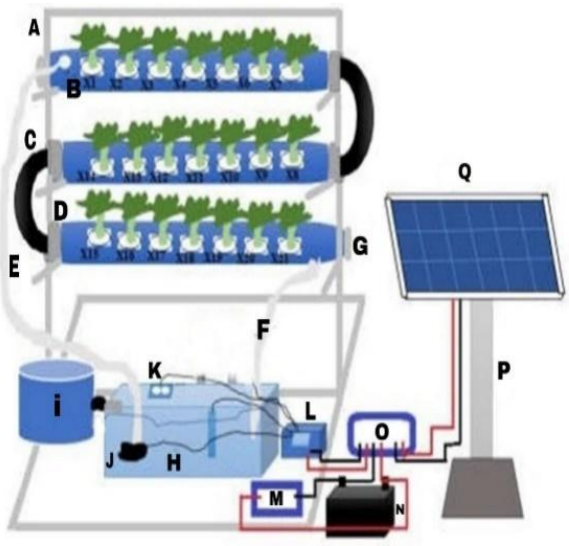

Figure 7 Hydroponic Product Design

III. Results And Discussion

This series of tools can be used by the general public, especially for people who are cultivating but do not have a large area of land, thus making hydroponic plants an alternative to farming without using large areas of land.

Figure 8 Front view

Installed components

1) LCD 16x2
2) Solar Charge Control
3) panel boxes
4) Usb Ports

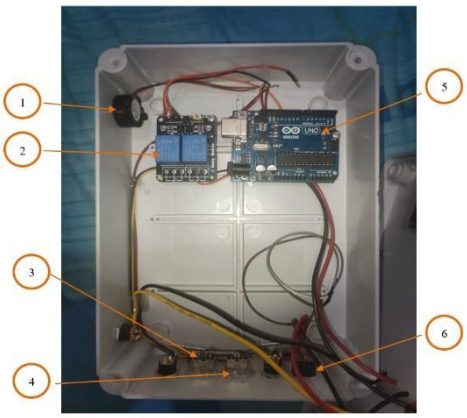

Figure 9 Inside View

Installed components

1) Buzzer
2) 2channel relay modules
3) Ultrasonic sensor USB port
4) Temperature sensor USB port
5) Arduino Uno
6) Power on/off switch

Solar Panel Testing

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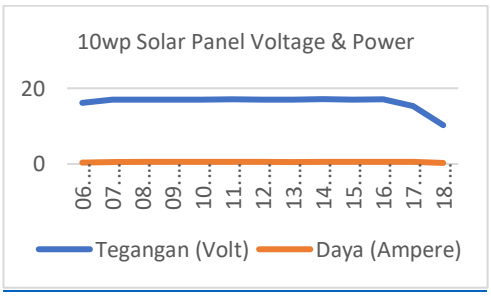
The test using a 10wp solar panel aims to find out how much power and voltage can be produced by a 10wp solar panel, as well as a comparison of this research.

Figure 10 10wp Solar Panel Data Retrieval

Table 1 10wp Solar Panel Data Retrieval

No	Time (/ hour) WIB	Voltage(V)	Power (Watts)
1.	06.00	16,10	0.40
2.	07.00	17.01	0.52
3.	08.00	17.05	0.57
4.	09.00	17.05	0.57
5.	10.00	17.04	0.57
6.	11.00	17.08	0.57
7.	12.00	17.05	0.57
8.	13.00	17.05	0.56
9.	14.00	17.07	0.57
10.	15.00	17.05	0.57
11.	16.00	17.08	0.57
12.	17.00	15,24	0.57
13.	18.00	10.25	0.28

In Table 1 the data was taken for 12 hours from 06.00 to 18.00, you can see in the table the average volts are 17Volt and the power is 0.50A. the purpose of using solar panels as a source of driving DC pump motors in hydroponic plants is as a source of renewable and environmentally friendly energy.



there is a display of data obtained from the results of testing a 10wp solar panel within 12 hours. With the voltage and power generated, a 5Ah battery can be charged by about 60%.

Water Absorption Test in Hydroponics

The test was carried out in an open room with a maximum capacity of 50 liters of water. The purpose of this test is to find out how much water volume is reduced in the absorption of hydroponic plants.

Figure 11 Water Volume Measurement

In figure 11 in the reservoir the maximum volume of water is measured from the ultrasonic sensor to the water level. It can be concluded that the further the water level is from the ultrasonic sensor, the less the volume of water in the reservoir.

Table 2 Water Absorption in Hydroponics

No	Water Level (cm)	Volume in the reservoir (liter)	Water height after absorption(cm)	Volume in the reservoir after absorption (liter)
1.	5cm	30 Liters	7.14cm	27.15 Liters
2.	7.14cm	27.15 Liters	9.30cm	24.3 Liters
3.	9.30cm	24.3 Liters	11.42cm	21.50 Liters
4.	11.42cm	21.50 Liters	13.50cm	18.05 Liters
5.	13.50cm	18.05 Liters	15.70cm	15.75 Liters
6.	15.70cm	15.75 Liters	17.80cm	12.09 Liters
7.	17.80cm	12.09 Liters	20.01cm	10.20 Liters

In table 2, tests were carried out at intervals of 1 week and obtained absorption results of 17.91 liters, the results would be different if the number of plants was greater.

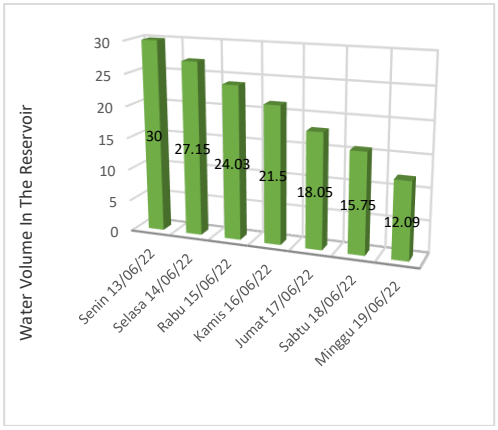


Figure 12 Data for testing the volume of water in one week

In Figure 12 there is a display of data obtained from the results of testing water absorption by hydroponic plants. The average of this test is to obtain a concentration of 3 liters of water volume reduction/day.

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Testing Using a DS18B20 Temperature Sensor

Tests using the DS18B20 temperature sensor aim to find out what the water temperature is in hydroponic plants and give a warning "WATER TEMPERATURE TOO HIGH" if the water temperature exceeds 33C.

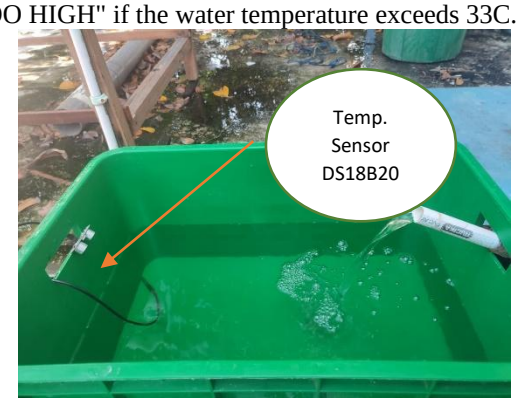

Figure 13 Temperature Sensor

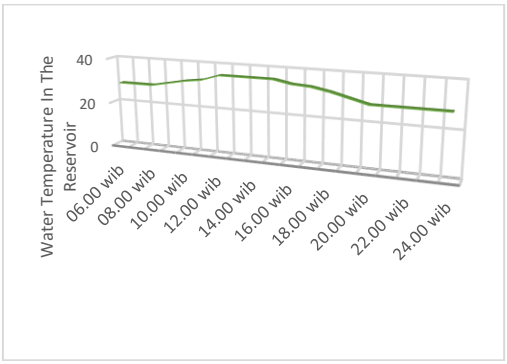

Figure 14 Testing the water temperature for 24 hours

In Figure 14 there is a display of data obtained from the results of testing the water temperature for 24 hours. For the highest water temperature concentration during the day from 11.00 – 15.00, and the lowest temperature at night.

IV. Conclusion

From the research and testing of the oxygen concentrator, it can be concluded as follows:

1. The use of a motor controller for hydroponic plants has two sensors, namely an ultrasonic sensor to measure the volume of water and a temperature sensor to set the ideal temperature for planting.
2. The control system is done digitally using ultrasonic sensors and temperature sensors and the data is displayed on the LCD.
3. From the test results of this tool the resulting solar panels can charge the battery 80%, and maintain the stability of the water at 10 liters.
4. Because it uses a solar panel with a capacity of 10wp, the battery can be charged only 80%.
5. Because it uses a motor drive, there will be a loud noise that is quite disturbing when this tool is used continuously.

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