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A NEW DESIGN OF AUTOMATIC PLANTING AND MONITORING SYSTEMS

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ABSTRACT

To address the need for efficient plant watering and maintenance, the author proposes the development of an automated plant watering system. This system incorporates advanced features to save time and simplify human efforts. It comprises three soil moisture sensors, enabling the detection of soil moisture levels, and three mini water pumps for watering purposes. Leveraging the capabilities of the Internet of Things (IoT) service, the system can send notifications to users, allowing them to monitor soil moisture values and pump statuses remotely. This IoT-based approach not only eases the user's workload but also enhances time efficiency by enabling plant monitoring from any location with internet access. Moreover, the system design emphasizes the utilization of renewable energy sources, specifically solar energy, to generate electricity for powering the system. By incorporating soil moisture sensors, water pumps, and IoT connectivity, users can effortlessly monitor and manage their plants' watering needs. The adoption of renewable energy sources ensures sustainable operation and reduced reliance on traditional power sources. Ultimately, this innovative system aims to enhance convenience, optimize time management, and promote environmental sustainability in plant care.

Keywords: Watering Plants, Internet of Things (IoT), New and Renewable Energy

I. INTRODUCTION

Watering the plants is done manually, but sometimes we don't have enough time to water the plants. Higher lifestyles that lead to higher living costs also therefore require people to work even harder so they don't have time to water their plants. Watering plants is an activity that needs to be considered in carrying out plant maintenance, therefore, the author has an idea to create a plant watering system and can monitor it automatically to save time and make human work easier.

Watering the plants used by the author is with a soil moisture sensor and arduino mega 2560 as control and control of copper plates. According to (Gunawan, & Sari, 2018) A copper plate sensor which functions as an electrode to measure soil resistance and is converted into an analog voltage will then be converted into digital data so that it can be processed by the Arduino Microcontroller. Soil humidity that has been set according to plant needs, this tool is also equipped with a Linquid Cristal Display (LCD) which can display the condition of the soil whether it is moist or dry according to the reading from the soil moisture sensor in the form of a value on the LCD. This tool is also equipped with a water pump for watering. According to (Calsum, 2020) If the soil moisture sensor is on detect soil moisture and dryness which can later drive the motor plant and then sprinkle water, if the dry soil has received intake sufficient water, the motor and faucet will automatically stop working.

The design of watering this plant uses energy utilization. Energy is a form of power that is produced or possessediby something. Energy is an important component for human survival

because almost all activities of human life are highly dependent on the availability of sufficient energy. To avoid an energy crisis due to limited energy in nature, renewable energy is needed. Renewable energy is energy that comes from sustainable natural processes, such as solar power, wind power, biological process water currents, and geothermal energy. With the existence of renewable energy, it is hoped that human need for energy sources will not decrease (Kurnianto, F., et al, 2015). The design of this tool the author uses Renewable Energy which utilizes energy from sunlight to become electricity as a source of electrical energy generation.

A tool for converting sunlight using solar cells that can convert sunlight into electrical energy. Solar cells or solar cells are devices that can convert sunlight energy into electrical energy using the principle of the photovoltaic effect.The sunlight on the semiconductor (photovoltaic) medium, causing electrons in the medium to be released from their bonds and flow/move, resulting in backflow activity. This transfer is known as photovoltaic. When a photovoltaic cell is exposed to sunlight, the electron charge will flow to a high potential charge. The junction between the two layers causes electricity to flow, generating a DC current.

The stronger the light received, the stronger the electricity obtained (Tharo, Z., et al, 2022).

Watering these plants using IoT services. In addition to facilitating the work of system users using the IoT concept, it can increase user time efficiency in doing other work, because they can water and monitor plants through internet access wherever they are. With this background, a plant sprinkler will be designed using a soil moisture sensor which will then be processed by Arduino Mega 2560 and instructed to the LCD to display soil moisture values and pump status.

II. LITERATURE REVIEW.

2.1. Literature Review

This study has several relevant studies, including:

According to research from (Gunawan, & Merliana, S., 2018) entitled "Design and Build Automatic Plant Sprinklers Using Soil Moisture Sensors", in his research the plant sprinklers use soil moisture sensors where the system created is by using Arduino Microcontroller Chip technology which specially programmed. The working principle of this tool is that when the soil moisture sensor detects the soil moisture level in dry conditions, the microcontroller will activate the relay driver so that the solenoid valve gets an electric current to open the faucet so that water from the pipe can flow to water the plants. Vice versa if the soil is wet, the microcontroller will deactivate the relay driver and the solenoid valve will close and the water will stop flowing.

Research (Hidayat, H., & Suwandi, 2020) conducted at the Agricultural Training Center (BBPP) Lembang entitled "Design and Analysis of an Arduino Uno Microcontroller-based Plant Watering System using an SMS Gateway". This study uses the Arduino Uno Microcontroller as the control center which is equipped with SIM800l which is used to process sending and receiving messages. If the microcontroller gets information from moisture sensor that soil moisture is less than the minimum limit, sensor humidity will send information in the form of SMS to the user that humidity soil is less than the minimum limit then watering the plants, microcontroller will process to water the plants for 1 minute.

Research from (Pratama, 2019) entitled "Design of an Internet of Things (IoT)-based Automatic Plant Watering System", in his research which used an Arduino Uno and then connected to NodeMCU by conducting serial communication so that it can connect to the web, if the soil moisture sensor detecting soil moisture or dryness which can later move the motor to the plants and then sprinkle water, if the dry

soil has received sufficient water intake, the motor and pump will automatically stop working. As long as the system is connected to the internet network, the system can be monitored anytime and anywhere.

2.2. Solar Power Plant (PLTS)

Solar Power Plant (PLTS) is a renewable energy that is commonly used by utilizing sunlight which is converted into electrical energy. According to (Anisah, S., et al, 2022 (in Herki Desrizal, 2018)) that the conversion of solar panels consists of photovoltaic solar cells. This cell is a layer of pure silicon (Si) or other semiconductor material which is processed in such a way that when the material gets photon energy it will generate electrons from their atomic bonds to become electrons that move freely, and will produce a direct voltage (DC) electric current.

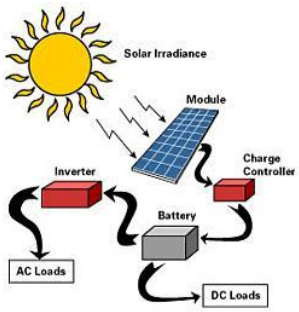

Figure 1. The working concept of PLTS

A solar panel is a tool that consists of several solar cells converts light into electricity. Basically a solar cell is a photo diode which has a very wide surface so it is more sensitive to incoming light and produce strong voltages and currents than a typical photo diode.

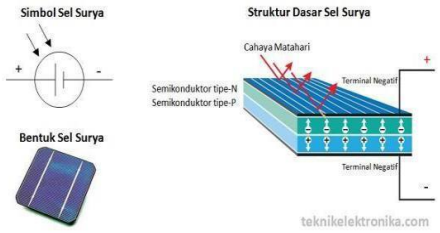

Figure 2. Solar Cell Structure and Symbols

A solar cell or solar cell is a device or component that can convert sunlight energy into electrical energy using the principle of the photovoltaic effect. What is meant by the Photovoltaic Effect is a phenomenon in which an electric voltage appears due to the connection or contact of two electrodes that are connected to a solid or liquid system when they receive light energy. Therefore, solar cells or solar cells are often referred to as photovoltaic (PV) cells. A solar cell or photovoltaic cell, is a semiconductor device consisting of a large-area PN junction diode, which, in the presence of sunlight, creates useful electrical energy. This change is called the photovoltaic effect.

Table 1. Arduino Mega 2560 Specifications

Microcontroller Type	Atmega 2560
Operating Voltage	5V
Voltage	7-12V
Voltage Limit	6-20V
Digital Input/Output pins	54
PWM pins	15
Analog Input Pins	16
Current for Digital Pins	40 Ma
Current for the 3.3 V pin	50 mA
Flash Memory	256 KB (8 KB for bootloader)
SRAM	8KB
EEPROM	4KB
Clock Speed	16MHz
Long	10.1cm
Wide	5.3cm
Heavy	37 grams

Source: Aldy, 2021

2.3 .Soil Moisture Sensor

Soil moisture is the amount of water held in the soil. The mass of the soil granules is obtained by weighing the dry soil. Meanwhile, the mass of water is the difference between the mass of the soil grains that have been given water and the mass of the soil grains. One way to determine the water content in the soil (soil moisture) is to use a Soil Moisture Sensor.

Figure 2.4 Physical form of the Soil Moisture Sensor

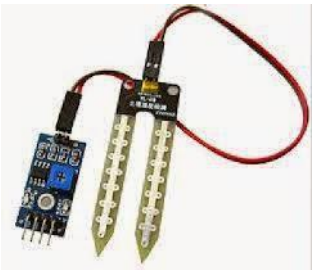

Figure 3. Physical Form of the Soil Moisture Sensor

Soil moisture sensor is a humidity sensor that can detect moisture in the soil. This sensor consists of two probes to pass current through the ground, then read the resistance to get the value of the humidity level. More water makes it easier for the soil to conduct electricity (small resistance), while dry soil is very difficult to conduct electricity (large resistance). The author uses a soil moisture sensor with type Yl-69 because this module can use a power supply between 3.3 volts to 5 volts making it flexible for use on various types of microcontrollers. The specifications of the sensor are:

Table 2. Soil Moisture Sensor Specifications

Input Voltage	3.3 Volts / 5 Volts
Output Voltage	0 – 4.2 Volts
Current	35 mA

III. METHOD.

In the design of a Plant Sprinkler there are two types of supporting devices, namely hardware and software. The hardware consists of a soil moisture detection circuit and an Arduino Mega 2560 system circuit. The device needed to connect the communication is NodeMCU ESP8266. The block diagram of the plant sprinkler system is shown in the following figure.

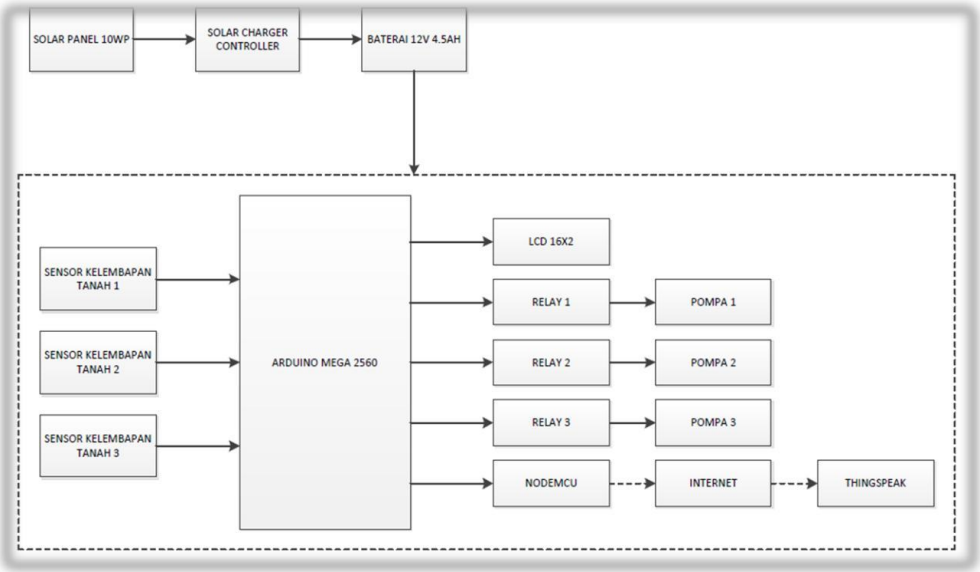

Figure 4. Block Diagram of a Plant Sprinkler

Explanation of the Block Diagram:

1) ARDUINO
   Arduino is the control center for all programmed system work processes.
2) Soil Moisture Sensor
   The Soil Moisture Sensor is used to detect soil moisture values.
3) LCD
   The LCD is used to display soil moisture information at that time.
4) Relays
   The relay is used as a switch to turn on and turn off the water pump.
5) MCU nodes
   MCU nodes are used to process sending and receiving messages connected to the Internet.

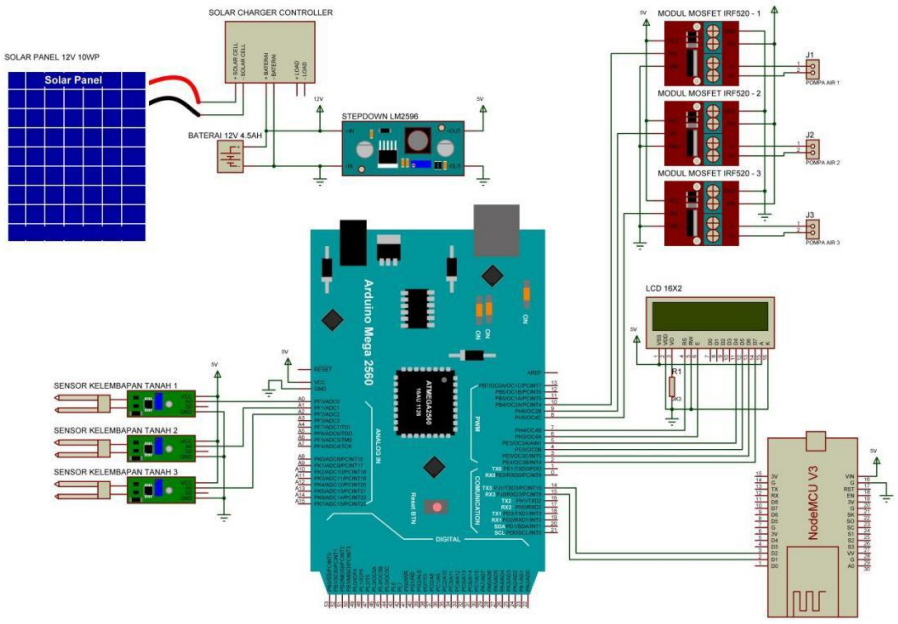

Figure 5. Overall Network

This circuit uses LM2596 as a component that lowers the 12V voltage to 5V to be given to circuits that require a working voltage of 5V. Next Arduino is connected to one LCD 16X2 which is used to display the humidity value and pump status. Also connected to three Soil Moisture Sensors and three water pumps, then using the MOSFET module as a switch to turn on and turn off the water pump. This circuit uses the Arduino Mega2560 as the center control which is also connected to the MCU Node to connect the circuit with internet.

This circuit consists of one 12V 10WP Solar Panel which is connected to one Solar Charger Controller (SCC), then SCC is also connected to one 12V 4.5AH Battery. In this circuit the Solar Panel functions as a source of energy to be used, the energy obtained from the Solar Panel is forwarded to the Solar Charger Controller (SCC) which functions as a regulator of the voltage from the current of the solar panels to the battery so that the battery is not easily damaged due to over-charging and also the instability of the voltage. The final path in this series is the battery which is used as a place to store the electric current generated by the solar panel before it will be forwarded to the load to operate the load later.

IV. RESULT

4.1.Measurements on Solar Panels

The purpose of measuring the Solar Panel is to find out how much the Output Voltage is obtained from the Solar Panel. The measurement method is by using a Digital Multimeter. The multimeter is set in the 20V DC range. Negative (-) multimeter is connected to the Negative (-) output of the Solar Panel and so is the Positive (+) multimeter connected to the Positive (+) output of the Solar Panel. Measurements were carried out 1 week with a measurement scale of 5 times per 2 hours once in 1 day, starting at 08.00-16.00 WIB. The measurement results are obtained as shown in the table below:

a) Measurement day-1 in cloudy weather conditions, obtained measurement results as shown in the table below:

Table 3. Measurement Results on Solar Panels day-1

O'clock	Illumination (Lux)	Voltage (V)
08.00	1830	10.86V
10.00	4250	10.10V
12.00	4150	10.16V
14.00	3130	10.06V
16.00	2510	10.08V

b) Day-2 measurements in sunny weather conditions, obtained measurement results as shown in the table below:

Table 4. Measurement Results on Solar Panels day-2

O'clock	Illumination (Lux)	Voltage (V)
08.00	17650	9.92V
10.00	52960	12.49V
12.00	24400	12.12V
14.00	22170	12.10V
16.00	18400	12.08V

c) Measurement day-3 in cloudy weather conditions, obtained measurement results as shown in the table below:

Table 5. Measurement Results on Solar Panels on day-3

O'clock	Illumination (Lux)	Voltage (V)
08.00	2240	11.7V
10.00	3990	12.05V
12.00	16079	12.44V
14.00	7740	12.09V
16.00	1860	12.05V

d) 4th day measurement in sunny weather conditions, obtained measurement results as shown in the table below:

Table 6. Measurement Results on Solar Panel day-4

O'clock	Illumination (Lux)	Voltage (V)
08.00	1360	11.97V
10.00	13300	12.08V
12.00	13582	12.30V
14.00	12700	12.25V
16.00	11743	12.05V

e) Measurement day-6 in sunny weather conditions, obtained measurement results as shown in the table below:

Table 7. Measurement Results on Solar Panels day-5

O'clock	Illumination (Lux)	Voltage (V)
08.00	2330	11.58V
10.00	43300	12.20V
12.00	13500	12.07V
14.00	23300	12.06V
16.00	14600	12.02V

V. CONCLUSION.

1) This system is designed using Renewable Energy (EBT) by using Solar Panels which work by absorbing sunlight and then converting it into electrical energy. Thus it can save electrical energy for its users.

2) The system will automatically water the plants when the soil moisture sensor detects soil moisture below normal limits and watering will stop when the sensor detects that the humidity is normal. The humidity value limit can be adjusted according to the type of plant used.

3) As long as the system is connected to the internet network, the system can be monitored using thingspeak with an average delay of 20 seconds. The available data contains information on soil moisture and pump status.

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