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Smart Watering Plant Using Solar

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Abstract: This project intends to solve many problems like reducing wastage of water, harnessing natural energy, and helping humans do work more efficiently. As a result, it has taken the initiative to prevent water waste by developing a smart watering system prototype. The smart irrigation system was powered by a solar panel, and the Arduino Uno controller connected the input (soil moisture sensor) to the output (water pump). The project also produced a working prototype of an automated plant watering system and the system operations performed by Arduino Integrated Development Environment (IDE) software. The solar-powered Smart Watering Plant is controlled by an Arduino Uno. The controller will send a signal to the motor to pump water into the soil when the soil moisture sensor determines that the soil is dry. It is powered by a solar panel with a 5W output, a 3W, 0.18A motor for the water pump, and a soil moisture sensor for the irrigation system's input. As a result, the project is a success, as the plant receives enough water. It is possible to reduce water waste and energy use. The project is environmentally beneficial because it employs renewable energy.

Keywords: Smart watering system, Solar panel, Arduino IDE

1. Introduction

Plants, as we all know, are extremely beneficial to all humans in a variety of ways. Plants help to keep the environment healthy by naturally cleansing the air and generating oxygen. To sustain this environment we need to make sure that the plant is healthy and get enough water, but as humans, we can not decide when or how to know that we have given enough water to plant or not. This has led to water waste problems, therefore with this powered-solar Smart Watering Plant, it can reduce water waste and save water bill cost. The main objective of this project is divided into four parts which are to powered the Smart Watering Plant system using solar power, using Arduino Maker Uno as a controller that will be connected with soil moisture sensor as an input and water pump as an output, the third one is to create a working prototype of an automated plant watering system, and lastly, the operations are working by using Arduino Integrated Development Environment (IDE) software. Besides, this project is created based on a project scope that becomes a guide to create the prototype. The project is powered by a solar panel with a 5W output, a 3W, 0.18A motor for the water pump, and a soil moisture sensor

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for the irrigation system's input, lastly, the Arduino platform is used for the controller in this system. As a result, the project is a success, as the plant receives enough water. It is possible to reduce water waste and energy use. The project is environmentally beneficial because it employs renewable energy.

1.1 Brief history of the irrigation system.

Based on the description of our project, this irrigation system became an important point in our project.The artificial application of regulated quantities of water to land is an irrigation method that improves crop production. Irrigation contributes to agricultural products' production and landscape conservation and the recovery of damaged soils in dryland and less than normal precipitation seasons. Rainfall is also used to protect crops, such as frost protection, reduce grain field weed development and soil consolidation. Irrigation has a variety of other uses. Rain-fed agriculture, on the other hand, is an agriculture that is solely reliant on direct rainfall. Cattle cooling, dust removal, sewage removal and mining are all done with irrigation systems.

In other countries, irrigation, which is the removal of surface water from a specific location, is sometimes compared to drainage [1]. Surface irrigation is even used to water landscapes in certain areas, for example, in and around Phoenix, Arizona. The irrigated area is surrounded by a berm and the water is delivered according to a schedule set by a local irrigation district. This can be a good example and information for this project. It shows that this project seeks to tackle several problems such as water waste reduction, the exploitation of natural energy and the efficiency of labour for humans. The initiative has thus been made to reduce wasting water through the development of a prototype smart watering system.

1.2 Solar for alternative power for smart watering plants.

Apart from the irrigation system, alternative power using solar makes this project more efficient. Solar power is a free renewable energy source that may be utilised to create electricity conveniently and without pollution. In the solar-powered Smart Watering Plant, solar cells or photovoltaic cells are the means to convert solar energy into electricity. The solar panels can be stored in batteries and can be instantly employed as a power supply to the Smart Watering Plant system.

2. Materials and Methods

2.1 Materials

There are six main sets of components that need to be considered (refer to **Figure 1**).

- Solar panel. For solar panels, collects clean renewable energy in the form of sunlight and converts that light into electricity which can then be used to provide energy for electrical loads [2]. So, the energy generated will be channelled into our project. Solar panels use sunlight as an energy source to produce direct current electricity. A group of PV modules is called a PV panel, and a panel system is an array. So, this makes our project more effective and efficient.
- Solar charge controller. In this project we will use Pulse Width Modulation (PWM) solar charge controllers. PWM solar charge controllers are the standard type of charge controller. They are simpler than MPPT controllers, and thus generally less expensive. PWM controllers work by slowly reducing the amount of power going into your battery as it approaches capacity. When your battery is full, PWM controllers maintain a state of “trickle”, which means they supply a tiny amount of power constantly to keep the battery topped off. Besides, we used the PWM controller because it is typically recommended for use in smaller systems where MPPT benefits

are minimal, while MPPT is recommended for 150W-200W or higher sized systems to take advantage of its benefits [3].

- Lead-acid Battery. Our group uses this battery pack because this battery uses a lead sponge and lead peroxide to convert chemical energy into electrical energy. This type of battery is called a lead-acid battery. Lead-acid batteries are most often used in power stations and substations because they have higher cell voltages and lower costs. Therefore, these batteries are ideal for storing the excess solar energy generated in our projects. It also serves as backup energy in case solar energy is not working [4].
- Arduino Maker Uno. The Maker Uno differs from other Arduino-compatible development boards, mainly, because of its additional on-board hardware and how the hardware on this board is placed, strategically. Compared to the generic Arduino Uno, this board looks slightly different as its placement of components is altered and the board's appearance is vastly divergent. But Maker Uno is fully compatible with Arduino. We can share the same library and code [5]. We put in 12x LEDs, 1x piezo buzzer and 1x programmable button on the Maker UNO. We can see that Maker Uno does not have the DC jack power input socket as most of the boards used in classes are powered using USB. It also replaced the ATmega16u2 with CH340 to bring down the cost.
- Motor. For this project we will use a micro submersible water pump DC 3V-5V as a water pump to run the water through the tube to the plant when the sensor detects the resistance of the soil is high (soil is not moist).
- Sensor. Soil Moisture Sensor really suitable for our project, which is used to measure the volumetric water content of the soil [6]. This makes it ideal for conducting experiments in courses such as soil science, agricultural science, environmental science, horticulture, botany, and biology. Our project also focuses on the aspects listed.

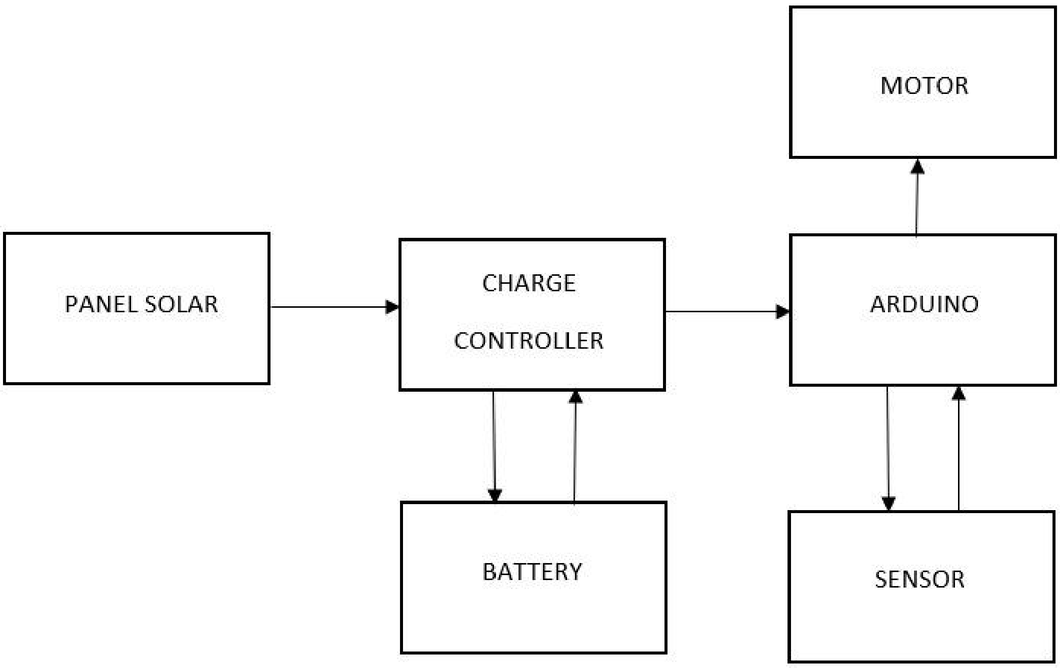


Figure 1: Specific of block diagram of project

2.2 Modelling Process

Based on the requirement, the design is divided into two major developments (as shown in **Figure 2**); software development and hardware development. To confirm the system is working, the programs need to be done correctly. With the intention of the project working, the whole circuitry needs to be constructed correctly and the functionality is checked.

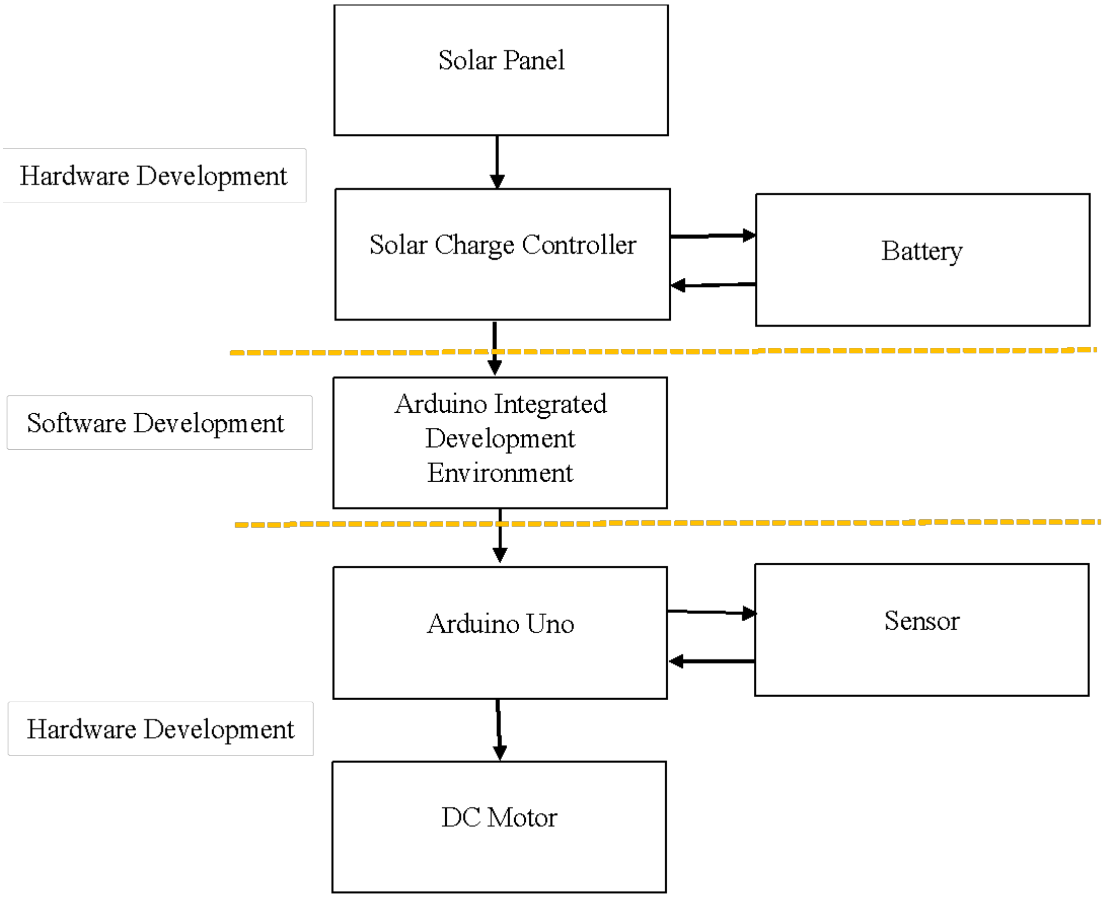


Figure 2: Modelling process

2.3 Configuration of project

Solar panels capture sunlight rays and convert them to electric power to give supply to the system. Operate by making a connection directly from the solar array to the battery bank. During bulk charging, when there is a continuous connection from the array to the battery bank, the array output voltage is 'pulled down to the battery voltage. In this project, it will. slowly reducing the amount of power going into your battery as it approaches capacity. When the battery is full, PWM controllers maintain a state of "trickle", which means they supply a tiny amount of power constantly to keep the battery topped off. The battery will be a backup source in this project system, as we know that panel solar cant work at night because there is no sunlight, so with the battery, the system still has a power supply.

After the Pulse Width Modulation controller reduces the power from panel solar it the supply will flow to electrical equipment which is Arduino, sensor, relay, and motor. By using Arduino IDE software we will program Maker Uno so when the sensor detects the resistance of the soil is high which means the soil is less moist, Maker Uno will read it and run the motor so it will flow the water from the tank to the soil.

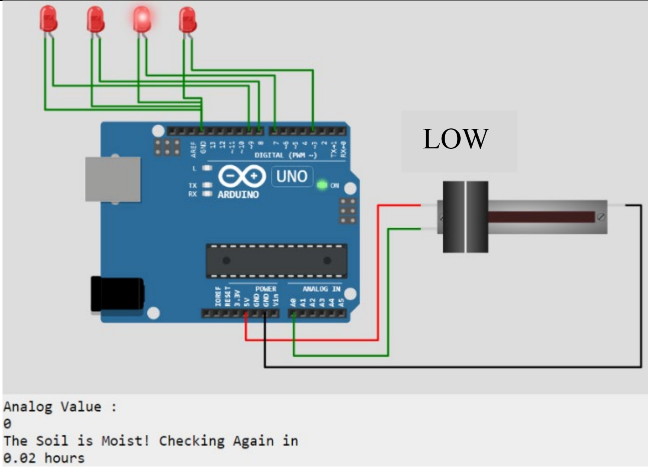
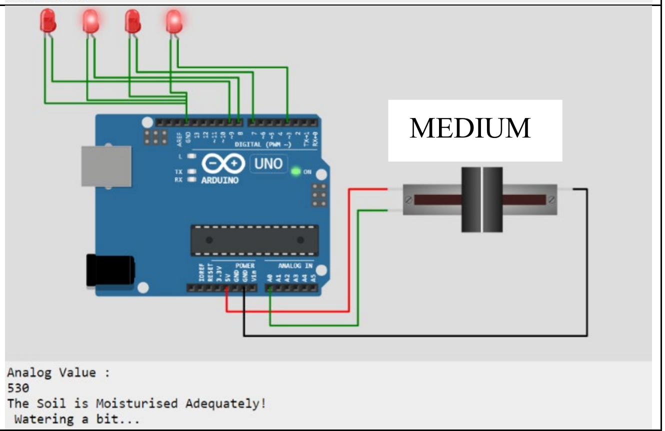
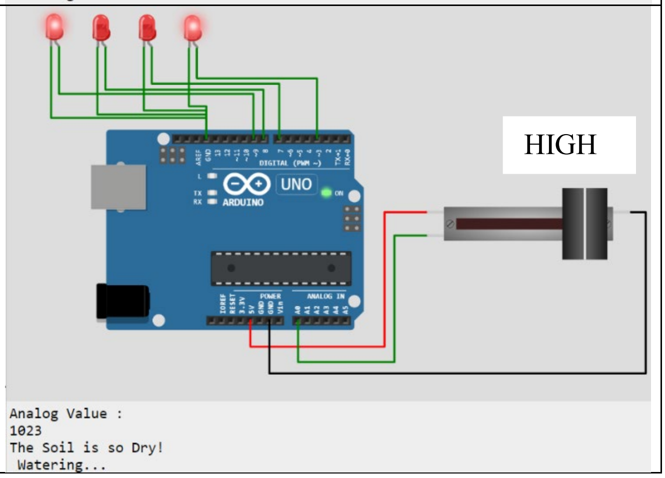
3. Results and Discussion

The result was divided into two categories which included the software analysis result and hardware analysis result.

3.1 Results from simulation

Table 1 shows the characteristics of the simulation circuits under certain conditions.

Table 1: Simulation circuit of Smart Watering Plant System

Condition	Simulation Circuit
Slide potentiometer will act as a soil moisture sensor. When the sensor detect value is low then 512 led at pin 7 (green) will turn on, indicating that the soil is moisture.	
When sensor detect value is medium between 513 to 768, LED at pin 8 (yellow) will turn on along with micro submersible water pump that is represented by LED at pin 3 to flow the water through the tube to the soil that is dry.	
When sensor detect value is high in range of 769 to 1023, LED at pin 9 (red) will turn on, along with LED at pin 3 that represent a micro submersible water pump.	

3.2 Hardware result analysis

i. Solar Panel

An experiment was done on a solar panel to collect the voltage that was able to be absorbed by the solar panel. This experiment was done for 3 days with 6 hours and 29 minutes duration (9.01am-3.30pm). Solar panel was put under the hot sun to absorb sunlight and its open-circuit voltage was tested as shown in **Figure 3** and recorded every 9 minutes. The average open circuit voltage of a solar panel is around 16V to 20V. The lowest voltage is 16.93V while the highest voltage is 19.45V. Table 2 shows the data of average open circuit voltage with time.

ii. Soil Moisture Sensor

For the soil moisture sensor an experiment was conducted by placing the sensor in a pot at different depths of soil, the first one is 1cm, then 2cm, 3cm, 4cm and lastly 5cm. The reading of the resistance was recorded and we can see the difference of the resistance value which represents if the soil is moisture the resistance is low and if not it's wise. **Table 2** shows the result of this testing.

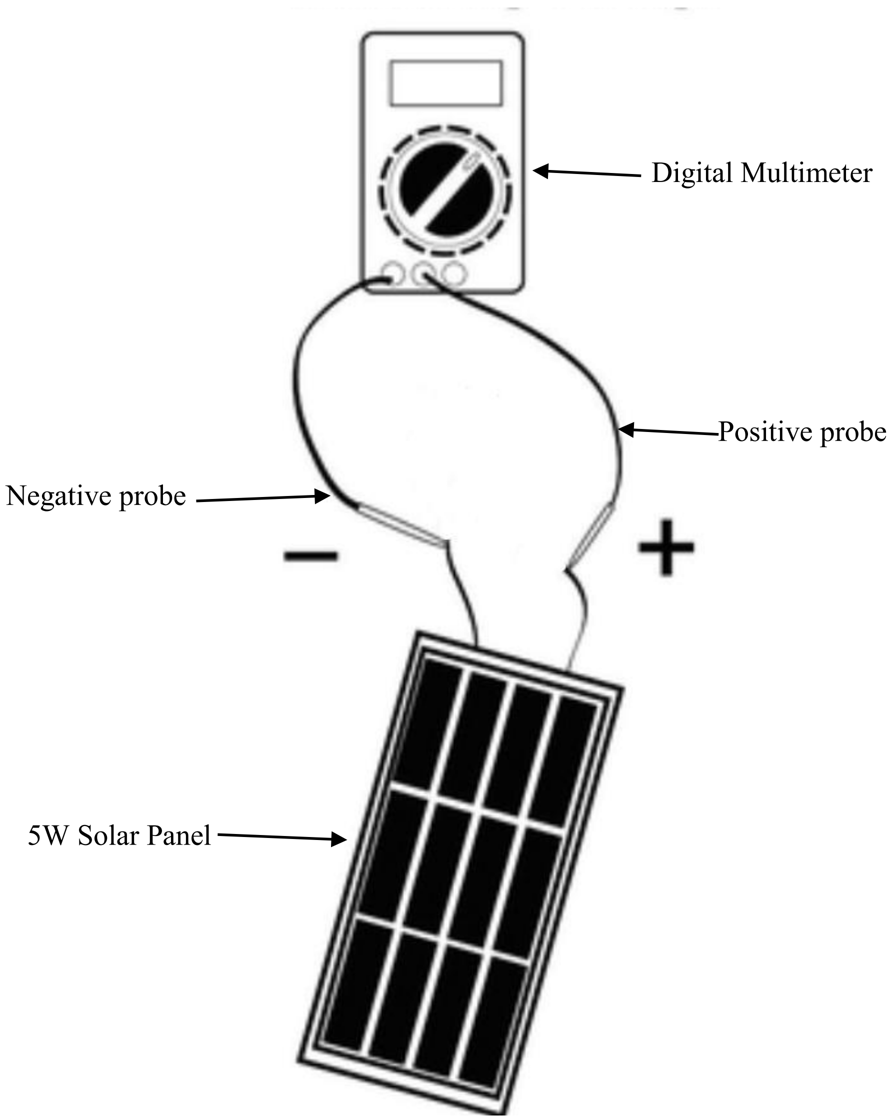


Figure 3: Measurement of solar panel voltage

Table 2: Voltage reading of solar panel.

Days / Times	Day 1	Day 2	Day 3	Average voltage value of solar panel
9.01 am – 9.10 am	19.45 V	18.51 V	18.93 V	18.62 V
9.11 am – 9.20 am	18.68 V	18.47 V	18.01 V	
9.21 am – 9.30 am	18.91 V	18.49 V	18.10 V	
12.01 pm – 12.10pm	18.18 V	18.38 V	18.42 V	18.03 V
12.11pm – 12.20 pm	17.95 V	17.88 V	17.88 V	
12.21 pm – 12.30 pm	18.36 V	17.75 V	17.50 V	
3.01 pm – 3.10 pm	18.34 V	18.74 V	17.85 V	18.16 V
3.11 pm – 3.20 pm	16.93 V	17.52 V	18.69 V	
3.21 pm – 3.30 pm	18.50 V	18.69 V	18.15 V	

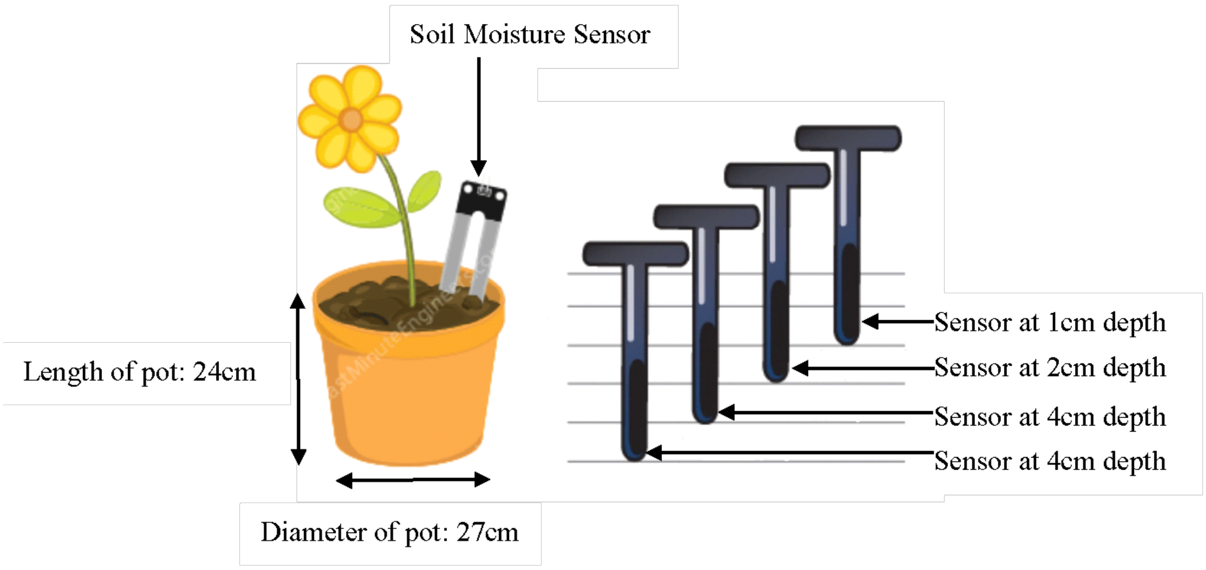


Figure 4: Measurement of soil moisture sensor at different depth

Table 3: Resistance reading of soil moisture sensor

Depth in soil (cm)	1 cm	2 cm	3 cm	4 cm
Resistance reading (kΩ)	280 kΩ	69.1 kΩ	33.6 kΩ	23.77 kΩ

3.3 Discussion

As we can see from the solar panel experiment, we can say that the voltage captured by the solar panel from the sunlight is dependent on the weather, if the weather is cloudy the voltage that is measured is low. For example, as listed in **Table 2**, the lowest value is 16.93 V at 3.11 pm – 3.20 pm. In addition, from the values that have been recorded we can see the average of the voltage from 3 days we conducted the experiment, which is 18.62 V for day 1, 18.03 V for day 2, and 18.16 V for day 3. Next, we conducted an experiment to see the reading of soil moisture sensors at different depths. We can see that if the sensor is placed at the surface the reading of resistance is high, because soil at the surface is easily dry. Meanwhile if we placed the sensor at the bottom (4 cm) the value of resistance is going to drop because the level of soil is more moisture than the surface. We can conclude here that if the resistance is high the soil is dry and if the value of resistance is low the soil is moisture. Lastly, from this test we know that the depth of the soil moisture going to be placed is going to affect the reading of the resistance (soil moisture level).

4. Conclusion

With proven results, it is no surprise that this intelligent watering system aims to use a solar panel to provide the electricity supply for the system. Use an Arduino Maker Uno controller to integrate the soil moisture sensor input into the water pump output, design a system prototype, and ultimately the Arduino IDE software system operations. This project benefits from using a renewable sunlight power source that is environmentally friendly, secondly by using this system to water the plant when necessary since we use a soil moisture sensor to detect the moisture in the soil and transfer the data to the Arduino to activate the pump so that water can flow from tank to plant and stop when the soil humidity is low.

Acknowledgement

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