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Home-Based Irrigation System

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Abstract— *Home gardening has been a livelihood, supplementary activity, and a recreation in both rural and urban areas. It has been an apparent solution to some economic and social triggers such as food security, health, starvation and rate of malnutrition. The height of the pandemic turned the interests of the public in home gardening, especially during the COVID-19 lockdown. This has opened the potential of home-based irrigation system. Home-based irrigation system uses sensor technology along with microcontroller and other electronics in order to behave like smart switching system which senses soil moisture level and irrigates the plant if necessary. Different electronic components were used to build the irrigation system. The automatic plant irrigation system used a relay module in order to give a power supply into water pump, and to control the voltage of the battery, soil moisture sensor designed based on the specially programmed Arduino board technology. Significant results in terms of avoiding dehydration and other growth deficiencies can be concluded. The system shows vast potential in measuring the level of soil moisture using the sensor technology.*

Keywords— *Irrigation system, moisture, ARDUINO, sensor technology.*

I. INTRODUCTION

The COVID-19 pandemic has affected every segment of life, including health, economy, education, and social ecologies. Quarantine measures have forced people to stay inside their homes, leading to the "new normal" of living and adaptation. One activity that has been of interests among Filipinos during the onset of the lockdown until now is the relatively increased engagement in gardening.

In the Philippines, home gardening has been a livelihood, supplementary activity, and a recreation in both rural and urban areas. It has been initiated even before the pandemic to address problems in different areas such as economics, food security, health, hunger, and malnutrition. Home gardening became a more widespread activity in rural and urban areas especially at the height of the CoViD-19 lockdown.

In the age of advanced electronics and technology, the life of human being was made simpler and even more convenient. Automated systems were introduced to reduce human efforts and to double human productivity. The proposed system supports the concept of in-house gardening made possible with homed-based irrigation system. This is a model of controlling irrigation facilities that uses sensor technology to sense soil moisture with a microcontroller in order to make a smart switching device to make plant owners worry less about their plants. This will allow plants to be irrigated when needed as detected by the installed sensor technology.

The main working principle behind this system is to connect the soil moisture sensor, which was previously embedded into the plant, to the Arduino microcontroller, which is connected to other electronic components. The sensor measures the soil moisture and transmits the results together with other data to the microcontroller, which in turn operates the pump. The microcontroller sends a signal to the relay module, which then activates a pump and delivers a specific amount of water to the plant, if the soil moisture level falls below a predetermined threshold. Once sufficient water is delivered, the pump automatically stops. The power supply powers the entire system. Since the system must be embedded in a small box, Arduino Nano is a perfect microcontroller for this purpose due to its dimension and work performance. Water pump is connected to the relay module and it works only when the relay module receives a command from the microcontroller.

Home-based irrigation system is designed and made to achieve an irrigation system that is controlled by electricity with the aid of sensor tracker. The sensor tracker is placed in the ground around the plant so that it can monitor the moisture of the soil. This will automatically transform the voltage allowing the microcontroller to function through the water pump so it can water the plants as needed. In addition, the water from the pump will run and will automatically turn off after it reaches its limit. This system aims to simplify the work, hence less hassle. Plants will be watered as needed even when left on its own.

Connecting parts of the irrigation system were subsequently subject to a series of tests. A High-side power switch, Type BTS412B, was included in the final circuit. It was used to allow the full power of the batteries to flow into the pump. The built-in voltage from the Arduino is not sufficient to power the water pump, hence the use of this switch will allow the Arduino to close a circuit in the batteries resulting to 12V and be directly connected to the water pump. The relay module is the device that opens or closes the contacts to cause the operation of the other electric control. It detects the undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area through ON and OFF. This project used an Arduino UNO, which is a board based on the ATmega328P. The microcontroller was used to regulate the moisture sensor, decides whether the irrigation is needed and generally controls the water pump. In the early phases of the project, a power bank was used and connected to the board series. A soil moisture sensor was also used to measure the moisture level in the soil. The Arduino compares the input value from the sensor to a set of predetermined values to decide if the water pump should be turned on. The sensor was placed closed to the stem of the plant and near the center of the pot. The pump used was a peristaltic 12V DC pump. It requires a current of 200-300 mA and creates a maximum flow of approximately 100 ml/min. Since the speed of the water does not change, the pump only needs to be turned on and off.

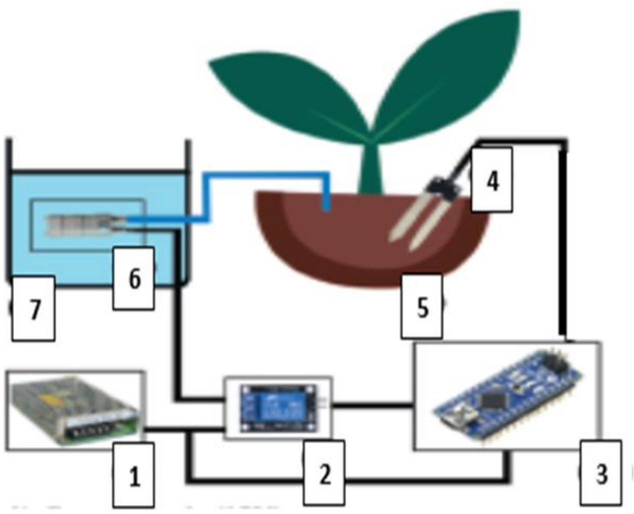

Figure 1. System Design

1.Power Supply (12V)
2.Relay Module
3.Microcontroller (Arduino)
4.Soil Moisture Probes
5.Plant
6.Water Pump
7.Water Container

The automatic plant irrigation system used a relay module in order to give power supply to the water pump, and to control the voltage of the battery, and soil moisture sensor designed based on the specially programmed Arduino board technology. The moisture sensor detects the drought level of the soil. When the moisture sensor detects that the soil is dry, it will send a signal to the Arduino, thus the Arduino will send a command to the water pump to release water, and it will be automatically stopped when the sensor sends signal to the Arduino that the soil is already moistured.

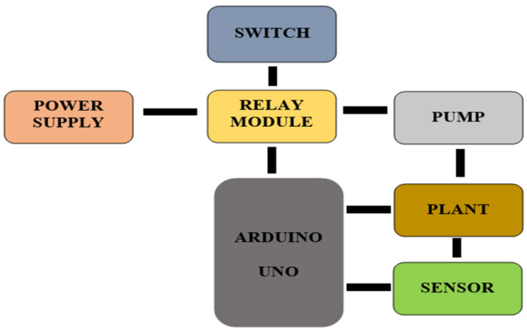

Figure 2. Development Model

Verification, Validation and Testing Plans

Below is data from the 7-day system testing.

Day	Weather	No. of Times Watered	Time Watered	Amount of Water Delivered
Day 1	Sunny	4 Times	• 7 a.m. • 12 p.m. • 5 p.m. • 11 p.m.	• 180 ml • 230 ml • 220 ml • 200 ml
Day 2	Sunny	4 Times	• 5 a.m. • 11 a.m. • 4 p.m. • 11 p.m.	• 180 ml • 250 ml • 230 ml • 220 ml
Day 3	Rainy	3 Times	• 4 a.m. • 7 p.m. • 12 a.m.	• 180 ml • 200 ml • 220 ml
Day 4	Sunny	4 Times	• 6 a.m. • 12 p.m. • 4 p.m. • 10 p.m.	• 180 ml • 240 ml • 220 ml • 220 ml
Day 5	Windy	3 Times	• 4 a.m. • 2 p.m. • 8 p.m.	• 200 ml • 200 ml • 240 ml
Day 6	Sunny	5 Times	• 4 a.m. • 10 a.m. • 2 p.m. • 6 p.m. • 12 a.m.	• 180 ml • 200 ml • 200 ml • 220 ml • 200 ml
Day 7	Rainy	2 Times	• 6 a.m. • 10 p.m.	• 220 ml • 200 ml

II. Results and Discussions

One-week test

The plant and the system were tested for one week. This was done to see whether the system functions properly, and the power bank can power the entire system sufficiently.

Energy Consumption

The power bank was enough to undertake the test. It has a capacity of 3000MAh, which was run for four days and was charged once to meet the one-week duration of the testing.

Plant health

A picture of the plant before the test is shown on the left-side of Figure 3. The right-side shows the plant after the one-week test. The leaves show the same color and texture after the test. Since the test was not done for a long period, there are no significant changes to the plant, except that the plant was still alive.

Figure 3. Plant Health

Significant results of the experiment can be concluded from the fact that the subject plant has successfully avoided dehydration and kept growing without any problems and deficiencies. This was made possible with the aid of the sensor that is embedded in the irrigation system to measure the soil moisture level and control the water pump. The system functions by using sensor technologies to measure the soil's moisture content, and a microprocessor to operate the water pump so that the plant receives the appropriate amount of water.

When someone goes on vacation and leaves a plant alone at home, the plant can be watered at home using a home-based irrigation system, which gives the plant the precise amount of water it needs and prevents irregular watering, which causes mineral loss in the soil. For the latter application, there is an example of using a home-based irrigation system to provide a wide range of applications and solutions. This method can be highly beneficial in agriculture to maintain vegetable plants irrigated for bigger harvest with low loss due to water evaporation and runoff. It is perfect for purposes of having large gardens, plantations, or individual plants with their own watering needs. The fact is that automated vertical farming uses around ten times less water and one hundred times less area than conventional farming, allowing food to be grown nearby without having to be transported over long distances, helping to address one of the world's major problems—undernourishment. Farmers from all over the world would be able to automatically and efficiently cultivate and breed the plants that are currently regarded as the most significant, desired, and used in health diets. In addition to the listed advantages and uses in agriculture, this technique has a number of applications in the realm of medicine.

It is possible to use this method as a medicinal remedy to cultivate plants that are efficient at eliminating air pollutants as well as in preventing and decreasing respiratory illnesses and lung dysfunctions, which would improve the quality of the air and living conditions. In order to reduce hazardous, toxic, and dangerous air pollutants and pesticides like CO, CO2, formaldehyde, benzene, etc., people can use this method to automatically water and grow medically significant and famous plants like medical herbs, weeping fig, ferns, etc. Also, it would save significant costs on purchasing medicine. This also prevents time-consuming processes such as manual irrigation and also the overuse of water, since oftentimes while watering plants (manually), people tend to pour more water than it actually needs, which can actually stem to various consequences.

Energy

The system requires power to function properly. It was found that the current consumption for the whole system was 5150mAH per week. A fully charged power bank was not enough to supply the system enough for the one-week test, recharging every after 3 to 4 days is a must. This solution allows the system to run for much longer. This setup could be used for the final product, but we also looked at alternative energy sources.

Powering the system with solar cells and a rechargeable battery would enable the system to run for years, without being connected to a power outlet. The system would be self-supporting, no other power supply would be needed, and the only thing to be done is to top-up the water reservoir when necessary.

System Evaluation

When studying the before and after picture of the plant, it was concluded that the system was able to keep the plant alive and healthy. The leaves did not change in color nor withered as shown in Figure 3. Therefore, it is concluded that the system is successful at its given task.

III. RECOMMENDATION

Recommendation

In this project, the choice of moisture sensor was based on what has worked for other people. A wider study and testing of different moisture sensors might improve the accuracy of the measurements. It is recommended to use two different sensors and compare their results. Another recommendation is to test multiple plants of the same sort. The plants may differ in quality and might have been exposed to for an instance in cold weather, which affects their health. Therefore, multiple plants should be tested to get a reliable result. It is also a good idea to test the system on different types of plants to see whether it works for more than one type.

A simple improvement would be to install a display board showing the current moisture level. It would make the product more interesting to some and plant owners can take track on the plant's growth. Installing a Bluetooth module would enhance the system by making it easier to control. Another improvement would be to put all electronics and the water reservoir inside a pot. One design suggestion is shown in Figure 4. The blue represents the water inside the water reservoir and the space underneath is where the electronic components would be kept. This would make the product more compact and less vulnerable. If the water reservoir is inserted in the pot, installing a water level sensor would be preferable. The water level sensor could warn the user when the water supply is running low. If a Bluetooth device and an application is used, being able to check the water level could be one feature. This might come in handy when you are away on vacation.

Figure 4. Proposed Model

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