Research Article

Agrotronics Watering System

J.Ramesh A/L Jayaram[1,*]

[1] jramesh@oum.edu.my; ORCID ID (0009-0002-1876-7974)

[*] Correspondence: jramesh@oum.edu.my; +60168167481.

Abstract: *Agrotronics Watering System (AWS) is an autonomous watering system designed to work standalone in applying controlled amounts of water to the soil based on sensor's feedback. In the field of agriculture, this process is also called water irrigation. Current watering system that we have today in the market uses a Timer or manual labours to irrigate the soil. These methods have their own disadvantages. For example, by using a Timer, the soil still gets irrigated even if it is raining outside. On the other hand, employing manual labours to take care of the plants can be extremely costly as well. Therefore, AWS was built to address these problems by simply answering the questions of "When do I water?" and "How long do I water?". The best part is that AWS comes with its own Windows application which allows the users to monitor the irrigation system in real time. The sensor's data shown by this application can be exported into an excel worksheet for further analysis later on. After integrating AWS into the gardening process as in my project, I have managed to resolve my watering problems permanently. AWS has also managed to reduce my water and electricity bills drastically as well. As a conclusion, gardening has been a great amusement for me after AWS is introduced.*

Keywords: AWS; Watering System; Water Irrigation; Agriculture.

1. INTRODUCTION

According to Sambath et al. (2019), one of those activities that we normally take for granted is gardening. Unless something goes wrong, we usually don't think about it much. They also mentioned that the most fundamental resource for gardening is water. It plays a critical role in the growth, and overall health of a plant. Therefore, striking the right balance is important. Both under-watering, and over-watering can have harmful effects on plant's health (Baluprithviraj et al., 2021) . Insufficient water can lead to drought stress, causing wilting, stunted growth, and leaf discoloration. On the other hand, excessive watering can lead to root rot, nutrient leaching, and the proliferation of fungal diseases. Hence, understanding the specific water requirements of different plants is essential for their optimal growth (Hamdi, 2021).

In the field of agriculture, the watering process is also called water irrigation. Existing watering system that we have today in the market normally uses a Timer or manual labours to irrigate the soil. However, these methods have their own drawbacks. For example, by using a Timer, the soil still gets irrigated even if it is raining outside. Conversely, employing manual labours to take care of the plants can be extremely costly as well. Thus, keeping these in mind, I have proposed Agrotronics Watering System (AWS) for gardening at my home.

AWS integrates both Internet of Things (IoT) technology and innovative approach to achieve efficient water distribution and precise plants hydration. The main components of this watering system

include smart sensors, data analytics, automation, and precision irrigation techniques. These elements work in synergy to monitor soil moisture levels, climate conditions (rain or sunny), and sun light requirements in real-time.

2. METHOD & MATERIAL

Figure 1 shows a block diagram of a complete AWS process that I have used for my garden at home.

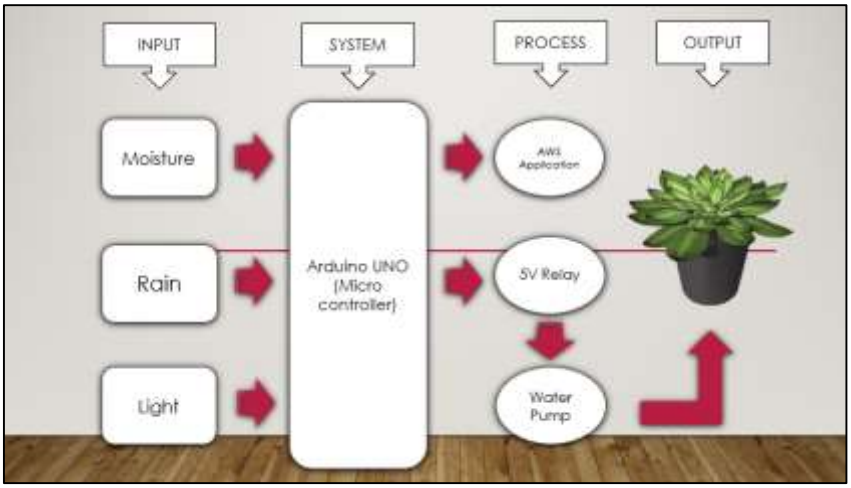

Figure 1. AWS process.

The process starts from the input part where at this stage the AWS gets feedback from the sensors used. Among the sensors used are:

2.1 Moisture Sensor

A soil moisture sensor module is utilized to determine the soil's moisture level from a scale of 0 to 100. If the soil is dry, the readings will be small, more towards 0. Equally, if the soil is wet, the readings will be high, more towards 100. These readings will then be fedback to a micro-controller for processing at later stage.

2.2 Rain Sensor

Similarly, a rain sensor is utilized to determine the climate conditions (rain or sunny) from a scale of 0 to 100 at my garden. A small reading or more towards 0 is considered as a sunny day. Likewise, a higher reading or more towards 100 is considered as a rainy day. For this project, I have set the cut-off point at level 40 before the pump starts to irrigate the soil in order to give away morning dew wetness that occurs every day in the morning.

2.3 Light Dependent Resistor (LDR)

An LDR is used to determine whether it is night or daytime. I have programmed the AWS in such a way that the pump only irrigates the soil during the daytime. Which means, no irrigation will occur at night even though the soil is dry and need to be watered immediately.

These 3 sensors will work together to continuously send feedback to the micro-controller.

Moving on to the next stages are the system and process respectively. The system incorporates an Arduino UNO micro-controller for decision making on whether to water the plants or not based on the sensor's feedback. When the conditions are right, for example, there's no rain, the soil moisture is very low and it is a daytime, then the micro-controller sends a signal to the 5V relay to switch ON the water pump. Switching of the relay to ON and OFF as well as the amount of water needed to irrigate the soil before the pump is cut off are done autonomously by the micro-controller without any human interference. In order to understand what is exactly going on in the AWS, I have also developed a Windows Application. The application runs on any 32- or 64-bit windows device and can measure the real time readings of the sensors as well as plotting them into a graph as can be seen in Figure 2.

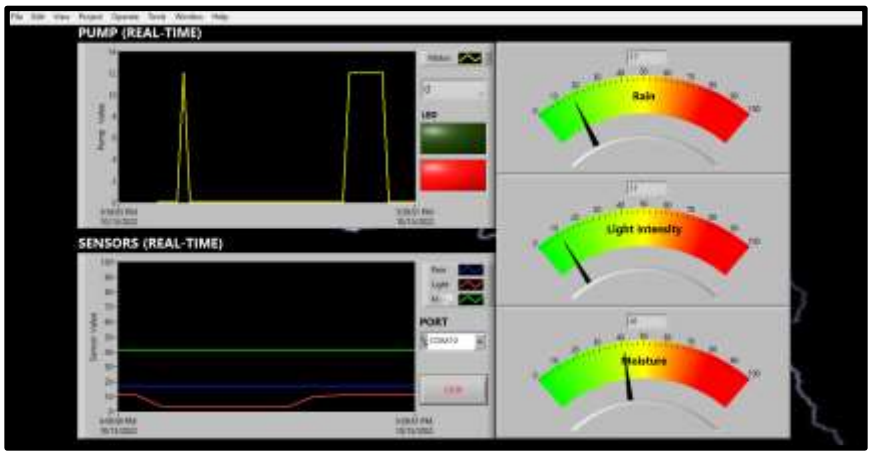

Figure 2. AWS application.

The data from AWS application can also be exported into an Excel worksheet for further analysis later on. The application comes very handy for maintenance and troubleshooting as well. Although AWS can function standalone without the Windows application, but it is highly recommended to have the application installed. At least, for monitoring purposes.

The last phase is the output stage. There's nothing much going on at this stage. Either the soil gets irrigated or not is based on the sensors feedback and the micro-controller's decision. The whole process repeats itself continuously as long as the right conditions are met.

In short, AWS works as a 3-input AND Gate system.

To determine whether the introduction of AWS into my gardening activity has really improved the water consumption or not, I had conducted an experiment with two plant Pots. The irrigation for the first Pot was done traditionally by me. I would manually pour water to the soil by using a measurement cup after getting the water measurement. The amount of water poured depended solely on my discretions that I would think was enough for the soil. Alternatively, for Pot number 2, AWS was introduced, and water irrigation was handled by the system itself. The experiment was done for a period of two weeks continuously. Water consumptions of these two Pots had been recorded into a table for analysis.

3. FINDINGS

Table 1 shows all the data recorded for water consumptions of Pot 1 and Pot 2 respectively.

Table 1. Comparison of water consumption during irrigation process.

Days	POT 1 Traditional Irrigation - Manually pouring water to the soil (mL)	POT 2 AWS Irrigation (mL)
1	180	60
2	190	20
3	150	30
4	160	10
5	0	0
6	0	0
7	180	10
8	220	20
9	185	30
10	0	0
11	0	0
12	0	0
13	160	20
14	240	10
Total	**1665**	**210**

At a glance, we can quickly come into a conclusion that Pot 1 had consumed more water than Pot 2 by looking at the total volume at the last row in the table. This was mainly because I had no control over the amount of water being poured to the soil as I couldn't justify whether the water was enough for the plant or not. On day 5 to 6 and day 10 to 12, I didn't pour any water because it was raining on those days. On average (1665÷14), I had poured roughly about 120mL of water to the soil each day.

However, when we look at the data for Pot number 2, the total amount of water distributed by AWS for irrigation was quite low, just 210mL for a course of two weeks. Not only this had proven that AWS was more efficient in irrigating the soil, but it had also saved plenty of water as well in which indirectly had saved my water bills. The amount of water consumed in Pot 2 was undeniably in control. Only on the first day AWS had used 60mL of water for irrigation. Where else, the rest of the days were quite low, only about 20mL each day. This could be primarily because of the soil being extremely dry on the first day when I had newly set up the system. Once the moisture sensor had detected enough water in the soil, the pump was cut off automatically. This mechanism had prevented additional water being consumed for irrigation. The cycle had repeated autonomously every day except on the days which were raining as mentioned earlier.

4. DISCUSSION

A complete AWS setup for the experiment can be seen as in Figure 3.

Figure 3. AWS prototype for Pot 2.

Based on the findings obtained earlier, AWS had indeed achieved the objectives of this experiment which were to achieve efficient water distribution and precise plants hydration for gardens.

As a future recommendation on the existing AWS prototype and to enhance the system design, I do have plan to equip AWS with the following items:

i). WIFI module - In order to monitor and control remotely from elsewhere by using a mobile phone;

ii). Touch LCD screen - To be able to control directly without the need of external devices;

iii). Renewable energy - For example, a backup solar power supply during a power outage; and

iv). High-pressure water pump - This is to cover a wider area of my garden.

5. CONCLUSION

Before I finish, I would like to emphasize that several limitations that existed in the traditional way of watering has been resolved by employing AWS into the gardening activity at my home. Both Timer and manual labours are no longer needed to irrigate the soil.

AWS is quite simple and has a very user-friendly interfacing system for monitoring. It is also smart enough to make decisions by itself on when and how long to water the plants. The water consumption is extremely low and cost savings as well in the long run.

To be honest, AWS can offer many benefits to the users if it is commercialized in the future. Since human intervention has been greatly reduced when it comes to water irrigation for the plants, therefore, it is hoped that one day, farmers will get benefited widely from AWS.

As for me, gardening at my home has been a great delight ever since AWS is introduced.

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