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Automatic Plant Watering System

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Abstract: This paper presents an automatic plant watering system based on ESP-WROOM-32 module with ESP32-D0WDQ6 chip or it is called ESP32 for home, office, and small uses. This system is easy to control than manual in the watering plant's process. In daily operations related to farming or gardening watering are the most important cultural practice and the most labour-intensive task. Growing a plant has always been a favorite activity for people around the globe but taking care of it is a different story to unfold. The lack of essential things for plants such as water, fertilizer, and sunlight can fail the process of growth of a plant. Most people forget about this when they have a busy schedule for the entire week, or they are not home. This device should be capable to water the plant automatically at a specified time, used ESP-WROOM-32 module with ESP32-D0WDQ6 chip to operate the whole system. This system is targeted at people who have a tight daily schedule. It is completely practical for home-usage. An automatic plant watering system is the solution to replace manual activities in the watering plant. For the application of an automatic plant watering system, it used combinations of water pumps, filters, nozzles, and pipes. This project uses the ESP32 microcontroller which the Arduino control system coding of this device was developed through C ++ programming to sense the moisture content is less than the limit predefined. Then, it will start supplying the desired amount of water until it reaches the limit. When the soil is dry, the pump will automatically be watering the fields and when the soil is wet the pump will automatically switch off, thereby eradicate the need for manpower and conserve time.

Keywords: Automatic, Watering, System, ESP32, Small, Plants

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1. Introduction

Growing a plant has always been a favorite activity for people in this world. A plant can give a lot of benefits in many aspects. the impact of indoor and outdoor plants on their emotional welfare considering behavioural, social, and demographic variables. The emotional state was neutral and a significant proportion expressed positive emotions. Having indoor plants was correlated with more positive emotions, and confined inhabitants allocated more time for plant maintenance [2]. It also teaches people to be disciplined in taking care of the plant. Lack of water, fertilizers, and sunlight for the plant [1] can fail the process of growth of a plant. People should not forget that plants and trees give them green and fresh enviroment [3]. Even though thoughts on having beautiful plants inside their places are beautiful, there are some responsibilities that one must fulfill to let the plants live for a long period and being great prosperous. Watering the plant is one of the responsibilities when one is planning to grow a plant or a tree. People may not have the time to constantly take care of a plant to let it live in a great condition. Even if a person wants to grow plants, they still have jobs to attend to or are far away from home for a long period that can drain out their energy and time hence incapable of taking care of their plants.

This is where the Automatic Plant Watering System [4] comes into play. It provides a system where it helps the people that could not give the attention needed for a plant to grow. Automatic Plant Watering System able to identify the plants' conditions and provide the plants' needs automatically. The product aims to give users the best assistance on giving the best care for people's plants without having to be present near their plants. The principle of this invention is to create and design an ergonomic device [5] for small uses such as an office and in a room. This device should be powered with ESP-WROOM-32 module with ESP32-D0WDQ6 chip [6]. This system will have a wireless network or timer to water the plan according to time and with the exact amount of water that the plants needed. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm will be developed with the threshold amount of water that plants needed and timer to water accordingly. All of the algorithms will be programmed into a micro-controller based on the motor that will be operated with the help of ESP32 [7] and the sensor involved. After making initial proposals for the design concept, the design details are developed virtual by generating part drawings and assemblies using SolidWorks software 2019 [8]. Finally the fabrication process is carried out based on the design results and material selection [9].

2. Materials and Method

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study. In this paper, the methods only presenting for virtual design and suggestion material for fabrication.

2.1 Suggestion of materials

Table 2: The suggested material for the system part

Item	Materials	System Parts	Characteristic & Function
1.	Hardwood	Frames	Low maintenance and high resistant
2.	Poly Methyl methacrylate	Acrylic panel	Lightweight and optical clarity as a shield for plants
3.	Silicone	Tube	Low odour and appropriate as transferring tube
4,	Thermoformed Plastic	Arduino Bank, water tank	Low cost, high durability, and lightweight
5.	Stainless Steel	Hinge and Pin, Net	Corrosion-resistant.

Table 2 shows the suggested material for incoming fabrication for the Automatic Plant Watering System. These materials were selected referring to their ability and suitability to each machine part in terms of character and function

2.2 Housing designed by using SolidWorks 2019 Software.

The housing of Automatic Plant Watering System are designed using SolidWorks 2019. **Figure 1** below shows some of the parts was illustrated by this software. **Figure 1 (a)** shows a hinged door for our automatic watering system. This is the entrance for the plant inside the chamber. This part design starts with a sketch of a 2 cm × 4 cm square and extrudes it for 0.3 cm depth using a mid-lane direction. Next, create a 0.5 cm diameter circle that is attached with extruded part and extrude it for 1 cm depth and linear pattern it for 2 with 2 cm spacing. Then, draw 3 0.3 cm diameter circles on the extruded part and extrude cut all the way. **Figure 1 (b)** shows the hinge door pin used to assemble the complete hinge door. **Figure 1 (c)** shows a wood liner part that has been designed to sketch a 50 cm × 30 cm square and extruded it for 5.20 cm depth and then sketch 46 cm × 26 cm square on the top of it and extrude cut it. At the front, create a 4.20 cm ×46 cm and extrude cut it all the way. At the sides, create a 4.20 cm × 26 cm square and extrude cut it all the way. **Figure 1 (d)**, net was created with sketch a 50 cm × 30 cm square and extrude it for 1.0 cm depth. Next, draw a 0.20 diameter circle and extrude it for 50 cm depth. After that, linear pattern it for 0.9 cm spacing and 54 instances. Next, create a 0.20 cm diameter circle and extrude it for 30 cm depth. And then repeat the same step as mentioned before. Last, create a 2.0 cm × 2.0 cm square at each corner and extrude cut it all the way.

Figure 1 (e) shows a silicone tube that was designed to sketch a 0.5 cm diameter circle and extrude it for 10 cm depth. Next use flex 2.0 from the end of both sides. Next, **Figure 1 (f)** is a water tray that has been created with sketch 45 cm × 25 cm square and extrude for 5 cm depth and then create another square that is smaller than the first square and extrude cut it to create a container-shaped like. For the sides, it is 1 cm. All of the fillets on the tray are 1 cm radius. Next, **Figure 1 (g)** is a water pump. To create this part, draw a circle with a diameter of 2.3 cm and extrude it until it reaches 4.5 cm in length. then cut-extrude a 0.5 cm hole at the center of the circle. Then draw a circle with a diameter of 0.75 cm at the side of the part and extrude until it reaches 2cm. then make a 0.3 cm shell at the circle. last make a fillet at each side of the part to get a better result.

Figure 1 (h) is the main part of the wood is attached to the Perspex. This part was designed to sketch a 30 cm X 30 cm square and extrude it for 50 cm depth. For the triangle, 16 cm height and 30 cm width. So, the 50 cm end lines were connected to the height and then extrude for 50 cm. Next, 2 cm from each side of each shape are sketch (square) and extruded cut to create the extrude cut for each part. **Figure (j)** is triangle roof Perspex with the height of 13.40 cm and width 28 cm and the extrude for 0.2 cm depth. **Figure 1 (k)** is the front Perspex part with 28 cm × 28 cm square and extrude for 0.2 cm depth. Furthermore, in **Figure 1 (l)**, the rectangle roof Perspex was designed to draw a 19.21 cm × 48 cm square and extrude it for 0.2 cm depth. Last but not least is an Arduino bank to keep all of the electronics inside it as shown in **Figure 1 (m)**. This part was sketched with a 10 cm × 10 cm square and extrude for 10 cm depth and use a shell of 0.1 cm. For the airflow, extruded cut 1 cm × 0.5 cm square and make a linear pattern for 0.4 spacing and 4 instances.

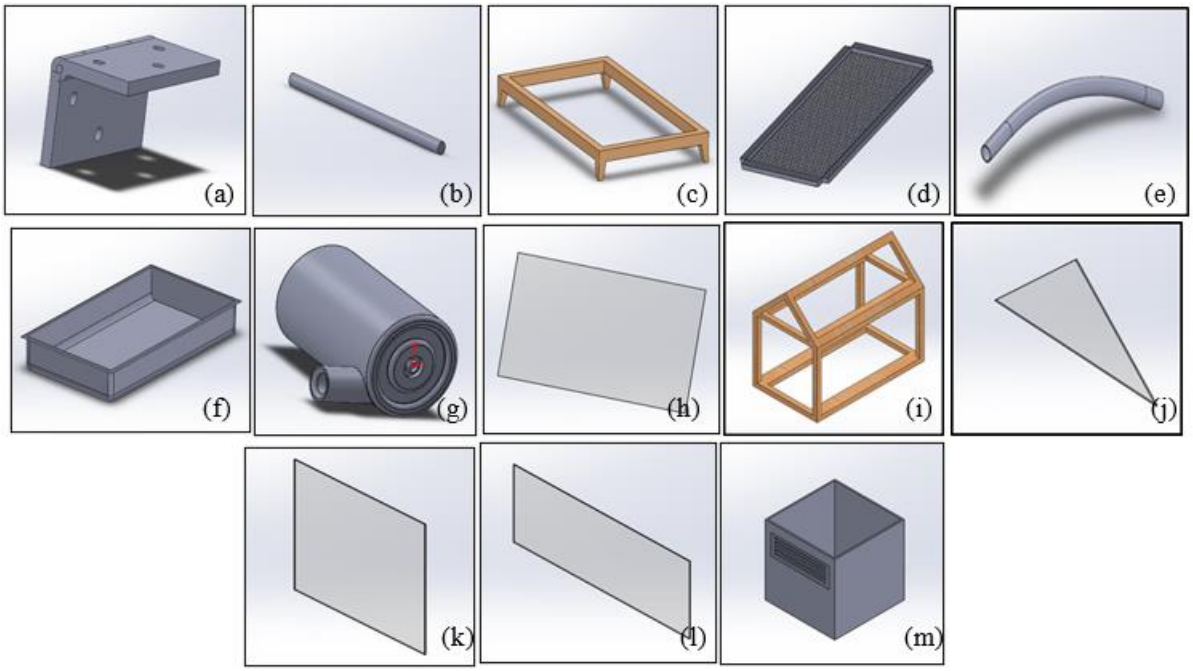


Figure 1: System part drawn by SolidWorks 2019 (a) door's hinger, (b) hinge pin, (c) wood liner, (d) net, (e) silicone tube, (f) water tank/tray, (g) water pump, (h) side Perspex, (i) main part of wood, (j) roof Perspex (triangular), (k) front Perspex, (j) roof Perspex (rectangular), (m) Arduino bank

2.3 Assembly part of Automatic Plant Watering System

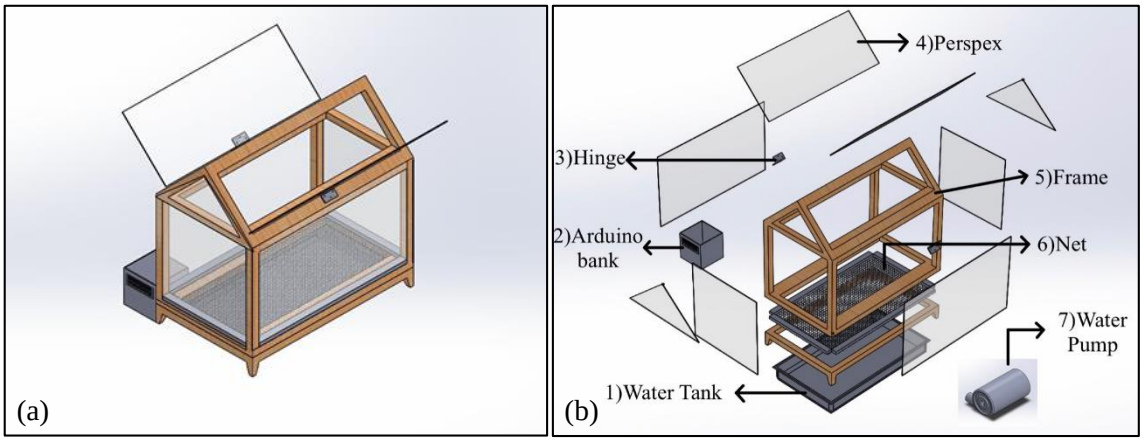


Figure 2: Assembly part of Automatic watering system, (a) full assembly, (b) Exploded view.

Figure 2 (a) shows all the parts and components are assembled by using SolidWorks 2019 Software. First things first, the base for this product was inserted and attached with the water tank/tray. Then the wood panels were attached based on the selected design as it will form the frame of this product. Next, the net was placed at the bottom of this product and attached. Furthermore, the compartment which contains Arduino Uno and water Pump was placed at the back of the main parts. Finally, the acrylic panels were attached to the outer side of the frame. The diagram above shows the complete design and assembly for the Automatic Plant Watering System. **Figure 2 (b)** shows the exploded view is generated in the assembly portion have 13 different parts were used to reach the final product. **Table 3** shows the parts description of the Automatic Plant Watering System.

Table 3: Parts description of Automatic Plant Watering System

Item	Parts	Description
1	Water tank	Store water
2	Arduino bank	Place Arduino Uno, battery, and pump
3	Hinge	Attach the top part with the body
4	Perspex	Protect the plant
5	Frame	Housing to store plant
6	Net	Let the excessive water flow back into the tank
7	Wate pump	Move water from the tank to plants

2.4 Electrical components

Figure 3 shows all the components for the electrical parts for this project. This project could not be done without some electrical touch. It needs a brain to tell it to pump the water, hence these items were used to make a system to make it smart just like it expected to be.

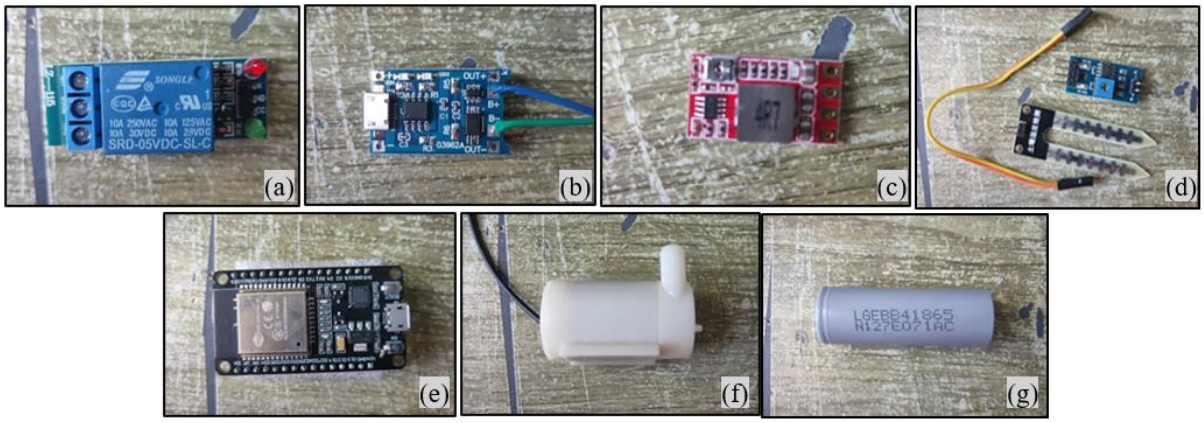


Figure 3: shows the electrical components, (a) Lithium Battery, (b) Pump motor PCB circuit board, (c) ESP32 Microcontroller, (d) Soil Moisture Sensor, (e) Buck DC-DC Voltage Module, (f) Lithium Battery Charger Module, (g) Relay Module

2.5 Fabrication process

The fabrication process of the automatic watering system has been divided into three. They are wiring with water tank installation and frame fabrication process. Firstly, woods are cut using the grinding machine to produce the frame of this model. All the woods are placed and joined together. During this process, nuts and screws of appropriate size are used to attach the parts based on the selected design. Next part process, the housing for the water pump and Arduino Uno board are designed and attached with the main part. Then, the silicone tube was cut with proper length and few tiny holes were punched through the tube and attached to the framework to make the sprinkling effect while water is supplied before it was connected properly to the water pump and the tank. Next, the top part of this project relates to the main part using the hinge as it was screwed into the frame. Finally, the acrylic panels are attached to the frame.

2.5.1Wiring with water tank installation process

Figure 4 shows the wiring process for this project. The plan for this electrical part was to have a system that will give water to the plants when it's the correct timing. The rough idea is to have a system to be the gate or valve for the water to be let out. The valve will be opened when it is told. **Figure 4(a)** shows the complete system that has been equipped with all the components and was installed at its housing inside the Arduino bank. **Figure 4(b)** shows a light notification that has been installed in this system as it will light up to notify the user when it senses the low humidity of soil. This light was installed to make it easier for the user to identify that the system is working as it should, and to make

the project have a better look and impact. **Figure 4(c)** shows the installation process of the voltage out from the charger module to voltage into the buck converter. **Figure 4(d)** shows the high-capacity battery that was used to supply enough power for this system. **Figure 5** shows the circuit diagram for the Automatic Plant watering System.

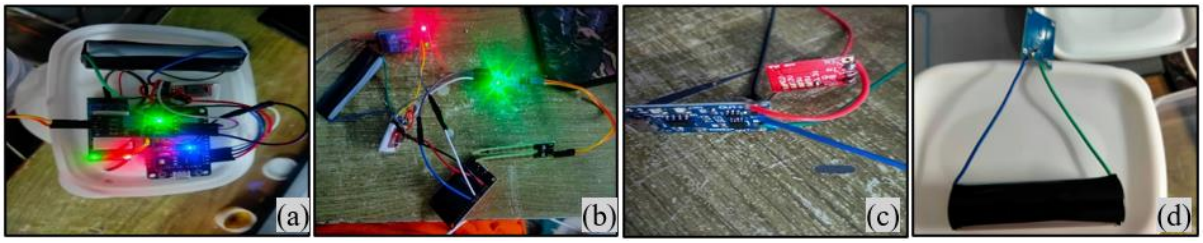


Figure 4: Wiring and water tank installation, (a) quick overall look for the wiring process, (b) the installation of the light notification system, (c) connection between charger module and a buck converter, (d) installation of battery

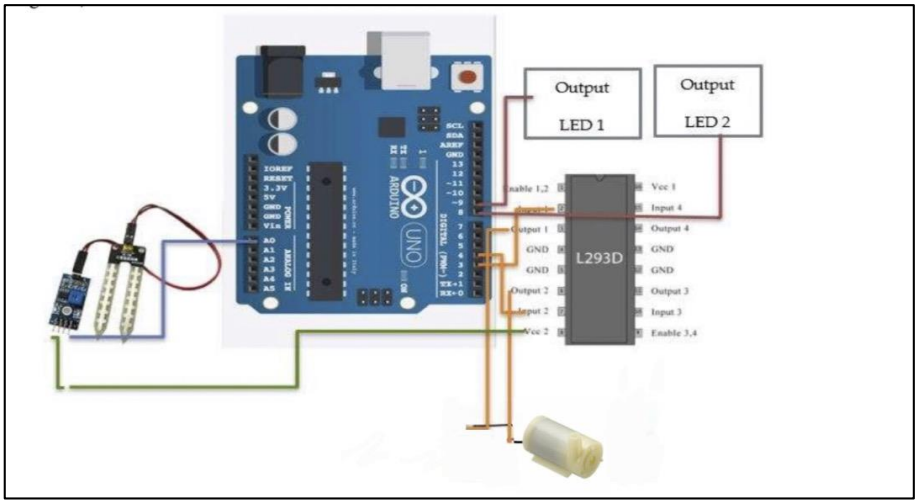


Figure 5: Circuit diagram for Automatic Plant Watering System [8]

2.5.2 Housing fabrication process

Referring to the picture planned in designing this product, the outer housing is made using woods and nails to obtain the structure. There are three main parts for the housing which are the roof, body, and four stands that will act as the legs for the structure. The nails that are used are about 20mm long and enough to connect two pieces of wood. **Figure 6** shows the fabrication process for the wood and hammering parts for this project. The figures show step by step how the process was regulated. **Figure 6 (a)** shows the process of measuring the wood pieces into wanted lengths. This is vital to be focused on as wrong measurements could lead to an unbalanced structure and may cause the whole arrangement to collapse when pressure or force is applied to the wood pieces. In **Figure 6 (b)** the tools such as hammer and nails, and wood pieces are ready in place and about to get into the process of hammering. Next, the process is undergoing the process of connecting the wood pieces as shown in **Figure 6 (c)**.

Figure 6: The process of nailing and hammering for the Housing part

3. Result and Discussion

3.1 Water flow schematic for the automatic watering system

Figure 7 shows the schematic diagram of water flow in this Automatic Watering System. it is the structure of the project and for figure (b), it is the full water tank with ESP32 box below it.

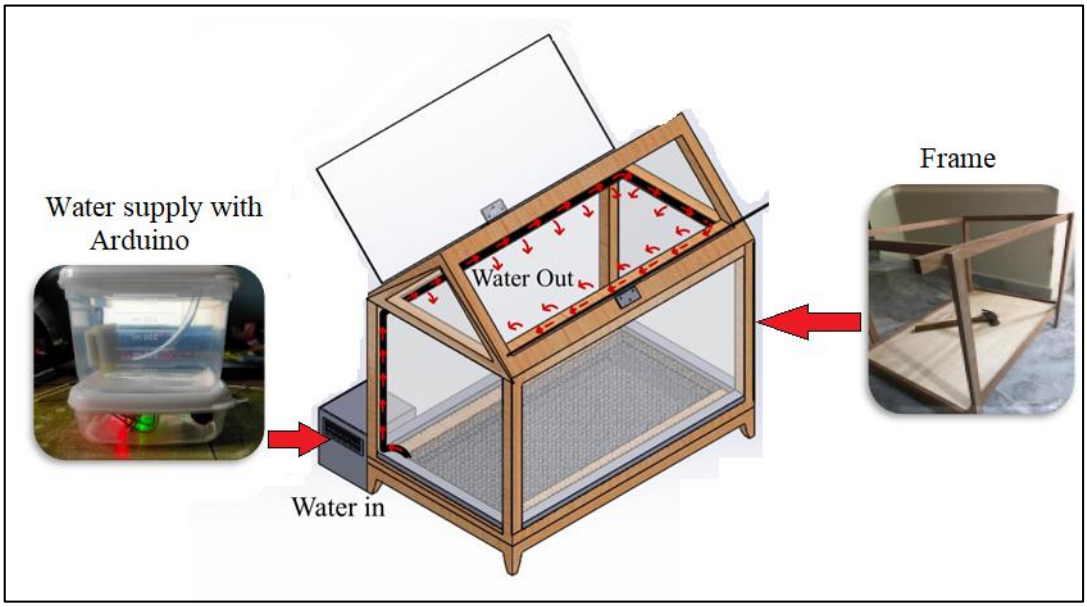
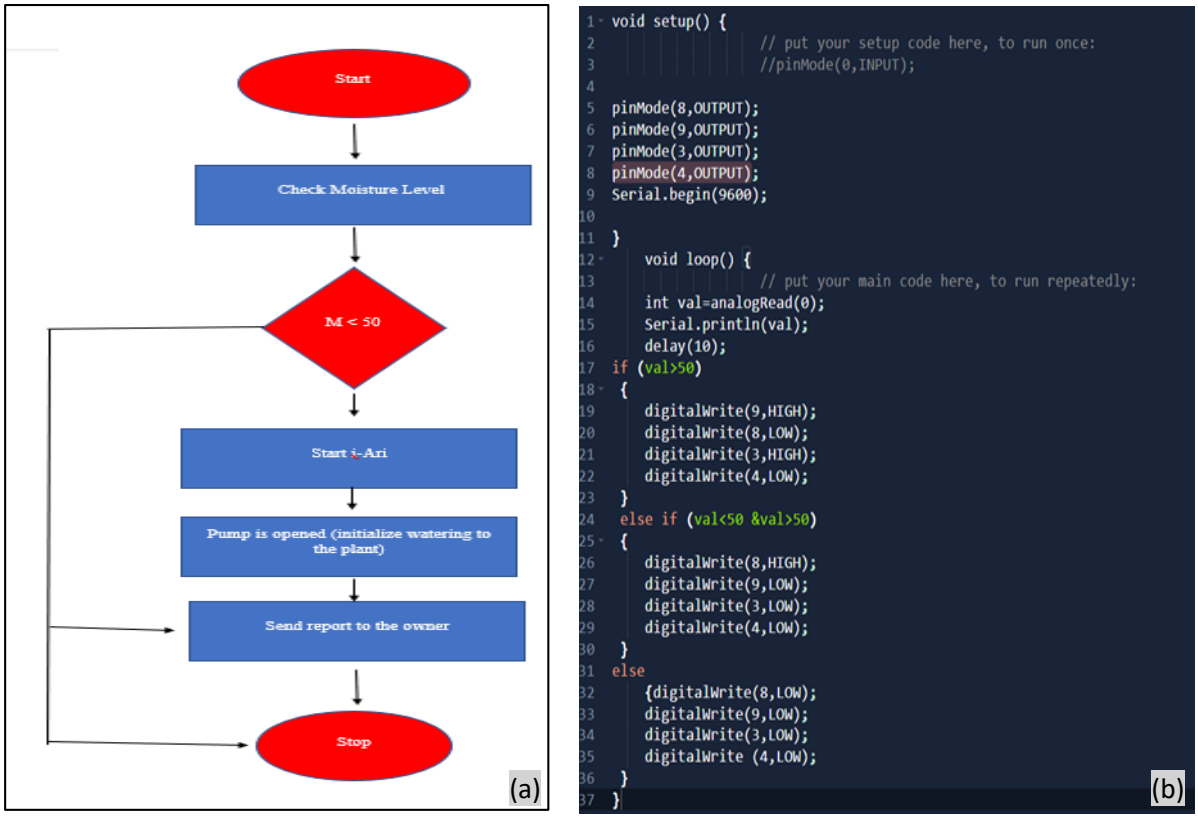


Figure 7: Flow watering system with the actual design

3.2 ESP-WROOM-32 module with ESP32-D0WDQ6 chip control system programming

Figure 8(a) shows the coding flowchart before prepare programming. **Figure 8(b)** shows programming script has been established for output display for this tool. When the ESP32 receives a logic high signal from the wireless internet connection, it will inform the user by turning on the first beep. To control the motor and overall operation, the Automatic watering System used an ESP32 microcontroller under a relay control switch in the project. The motor can be powered by an external 3000 mAh battery connected to the microcontroller.




```
void setup() {
                // put your setup code here, to run once:
                //pinMode(0,INPUT);

pinMode(8,OUTPUT);
pinMode(9,OUTPUT);
pinMode(3,OUTPUT);
pinMode(4,OUTPUT);
Serial.begin(9600);

}
    void loop() {
                // put your main code here, to run repeatedly:
    int val=analogRead(0);
    Serial.println(val);
    delay(10);
if (val>50)
 {
    digitalWrite(9,HIGH);
    digitalWrite(8,LOW);
    digitalWrite(3,HIGH);
    digitalWrite(4,LOW);
 }
 else if (val<50 &val>50)
 {
    digitalWrite(8,HIGH);
    digitalWrite(9,LOW);
    digitalWrite(3,LOW);
    digitalWrite(4,LOW);
 }
else
    {digitalWrite(8,LOW);
    digitalWrite(9,LOW);
    digitalWrite(3,LOW);
    digitalWrite (4,LOW);
 }
}
```

Figure 8: ESP-WROOM-32 module with ESP32-D0WDQ6 chip control system programming (a) Flowchart coding preparation (b) programming code

3.3 Functionality of Sensor

Table 4: Soil Moisture Level Sensor Functionality

Soil Moisture Indication	Water Pump Level	Notification
Wet (<50)	Low	NOT SENT
Dry (>50)	High	SENT
Wet (<50)	Low	NOT SENT
Dry (>50)	High	SENT

This is the result of the watering device after 4 times as shown in **Table 4**. There are soil moisture indications, water pump level, and notification that are observed in the test. From the first test, the notification is not sent because of the wet (<50) soil condition. This immediately set the water pump level to low. From the second test, the condition of the soil is dry (>50). Therefore, the water pump is automatically on a high level thus the system waters the plant inside, and the notification is sent to the owner. Both conditions, wet (<50) and Dry (>50) are repeated to check if the system did have an error.

3.4 Comparison of watering system

They are characteristic are obtained from design and analysis results in different watering plats techniques.

Table 5: Comparison of characteristics for different Watering System/Devices

Item	Automatic Watering System/Devices Characteristics	Manually	Easy2Grow Autopod [6]	Moisture Matic Automatic Watering System [7]	Automatic Plant Watering System
1	Provide	Water	Water	Water	Water
2	Technology	Hose/Sprinkler	Gravity	Sponge Wick	ESP32 & Gravity
3	Interaction	Human Power	None	None	Special Application
4	Capacity of Water (Liter)	N/A	8.5 - 15	0.35 – 0.75	0.5
5	Tool Cost (MYR)	50	603.60	44.75 – 49.74	58
6	Time for the water to travel from tank to plant (Second)	Depends on human & hose	15	5	5
7	Portable to anywhere	No	Yes	Yes	Yes
8	Power source	N/A	Electric	Electric	Battery
9	Saving space	No	No	Yes	Yes

4. Conclusion

In conclusion, this innovation provides a good solution for home use which requires lower cost and is easy to operate. This system has been proven to accomplish all the main goal to help the working people which has a tight daily schedule. This system will sense the humidity of the soil and notify the user to water the plant. Therefore, this invention will help the user by watering the plant by itself. It is such a convenient and efficient way to help this type of person. It is so beneficial to those who have a tight schedule, are busy with their work, and don't have much time at home but still wanting to have the landscape in the house or outside of the house. This is because the moisture sensor can sense if the humidity of the soil and the timer automatically water the plant as the timer is set up. The recommendation that can suggest it can also be built bigger if the plant that the owner have bigger plants.

Acknowledgment

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