Automated Plant Watering System

GROUP EN-04

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Content

Introduction

Due to the prevailing economic crisis in our country, we are facing unprecedented food shortages, so there is an urgent need to increase the national production rate to overcome food scarcity and malnutrition among children. To suppress this food crisis, the government has advised the public to engage in home gardening. "*Amid the fuel crisis and looming food crisis, the government has decided to declare Friday as a holiday for State employees except for those who are engaged in providing essential services and to allow them to engage in agricultural activities in their home gardens."* - [published on DailyMirror 15th June 2022]. By doing home gardening, people will get their daily essential nutrition at a minimum cost. But it appears to many (government and private sector workers) as an unthinkable task to manage this among their busy schedules because home gardening is something that needs continuous monitoring and extensive care.

So, as undergraduates of the Electronic and Telecommunication Department, University of Moratuwa, we are planning to design an electronic device which can be used as a solution to this problem, and we are very much concerned about the cost because the device that we are constructing should be affordable for everyone, including low-income receivers.

Proposed Solutions

After brainstorming, we have arrived at some feasible options that can be done within an 8 - 10 weeks period.

1. Greenhouse control system:

An automated system targeting greenhouses to monitor and control humidity, temperature, and nutrition levels required for plants. This is done by using real-time sensors and IoT things that communicate wirelessly through Bluetooth or WiFi.

2. User notifier on taking care of plants:

An automated system to remind the user to water and add appropriate nutrition to plants. This can be accomplished by developing a device with a system that can send push notifications to the user's mobile.

3. Automated Plant Watering System:

Automatic plant watering systems that can water plants when the moisture level in the soil drops below a certain level (which can be adjusted by the user) and notify the user to refill the watering container.

Idea Validation

When we enquired about the problem, we got some solutions. But every solution will not be executed perfectly. There are many reasons for each solution to be avoided.

When considering the greenhouse as a solution, according to the current price rate (24.06.2022), the cheapest functional greenhouse requires around 35000 LKR to assemble. In the case of repairing, the cost of the repair is also high, like its price. which is a three-quarter of many government staff's salaries. Because of the initial investment, it is not suitable for low-income families.

We need a backyard to set up a greenhouse. But most middle-class families don't have a backyard because most of them are in apartments, and others have limited space.

And there are some products, like

1. Garden cloche, 6 pack plant protect bell cover mini greenhouse (Rs 8,266)
2. Portable garden greenhouse outdoor warm greenhouse (Rs.19,260)

and more. Nothing is easily affordable for low-income families.

The second solution, developing a system to notify the user about watering plants and adding enough nutrition on time, had to be disregarded because of the availability of such apps in the marketplace. There are many apps available, but only a very few can be used without any hassle. Here the problem is, even if we are reminded to water the plant, when we out of home, it is not useful all the time, So we had to avoid these options.

Among all the solutions we had, we came up with designing the “Automated plant watering system” after we researched all our solutions very thoroughly. We considered mainly the cost per product, durability, repairability, and customizability. While we are comparing our product with other solutions and the products currently available in the market, the price of our product is the key factor to attract buyers so we figured out that we would be able to design our product very much affordable when we compared it with the cost of other similar products in the market. And when people buy a product, they should be able to repair it quickly if there are some minor issues. In our case, the product can be easily repaired and has less complexity than other products. For example, if there are issues with greenhouses, it is very hard to get them back to their original condition and it will cost a high amount as well. With this Automated plant watering system, we can water and maintain home gardens in 1m2 area, so it can be manageable in apartments. And it will be easy to reproduce with fewer resources.

Unlike other similar products which are already on the market, components and parts of our product are available in the local market. Therefore, users can replace parts very easily. This product is designed to be splash and dust-proof. The enclosure will protect circuits and electronic components from dry and wet environments.

And our product is easily customizable as well. Users can customize the water level, notifications, and some other stuff as they want, unlike other fixed products and application software.

Even though it is a low-cost product, it can be upgradable according to budget and user expectations. We are planning to add a timer as a refinement to our product, so it will allow our product to work only for a limited time each day, so it can save water and other resources. And we are discussing adding a feature to adjust the volume of water released by the system according to the specific plants. Plants should not be watered too much or too little. In hot weather, it may be tempting to repeatedly water plants, which can adversely affect plant growth. Hence, controlling watering frequency and amount appropriately with a product like ours is a must.
In conclusion, after thorough research using several media, the initial project idea was refined and redefined to better suit the current requirements of the intended users.

Survey Results

After we built up our idea, we wanted to know about the real situation among our targeted people. So, we conducted a survey through Google Form. The survey is enough to justify our proposed problem and our finalized solution. So we came out of our assumption and strongly moved through it with the evidence of the survey. We finalized our decision with the responses of 170 targeted users.

From the conducted survey, more than three fourth of the population currently engages in home gardening.

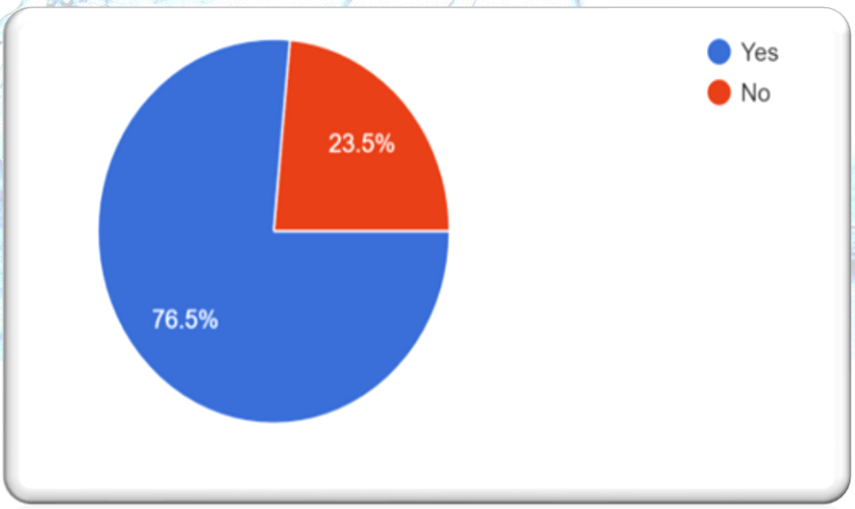

Figure 1: Responses on engaging in home gardening

Most of the respondents were informed that sometimes they have time to take care of their plants, which is not ideal for cultivation. Many plants, at their young age, are highly sensitive to the rate of watering. Without taking care of such plants daily, they can yield poor crops. Hence, it is clear from our responses that people are not inclined to invest in taking care of their plants consistently, and the need for a product like an automatic plant watering system is very high.

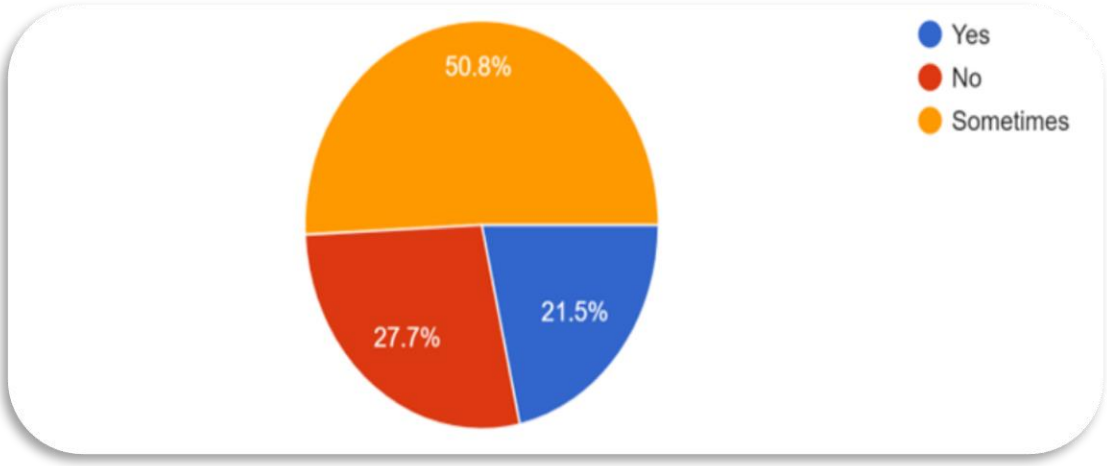

Figure 2: Response to having time to maintain the home garden

Even though similar products are widely present in the market, a significant number of responses indicate a preference for a low-cost automatic plant watering system.

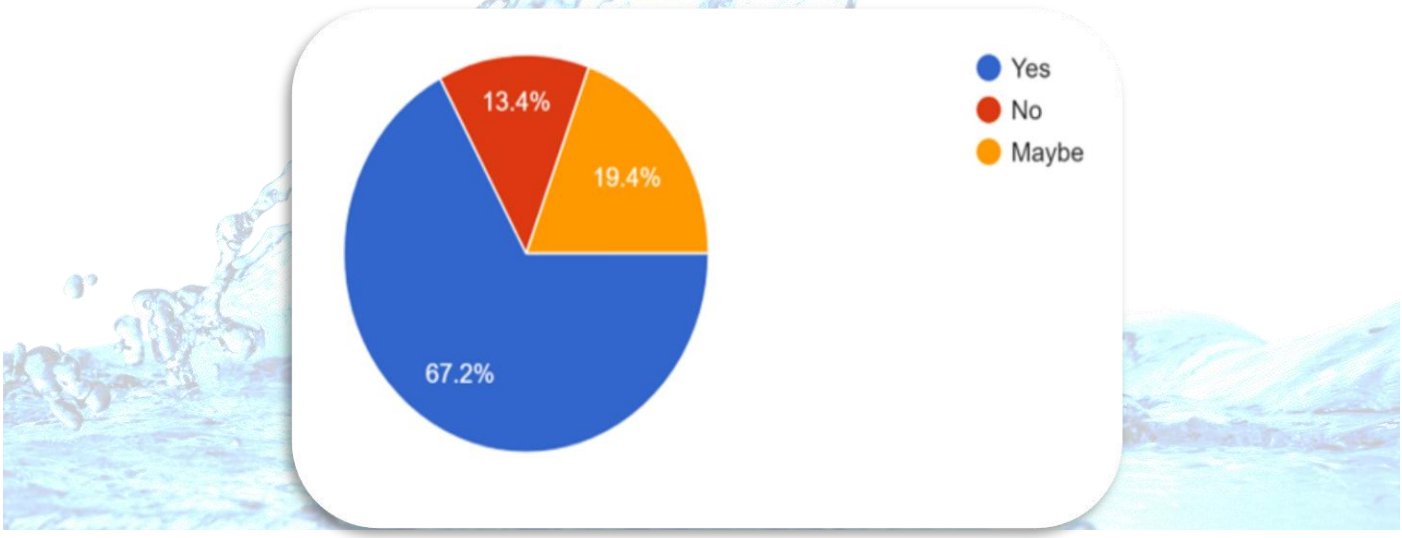

Figure 3: Preference for having a low-cost plant watering system

Our initial plan was to build a system where users needed to check the water level of the container and refill as required to reduce the cost. But the survey showed users prefer to be notified when the water level is empty as it reduces user intervention in plant maintenance.

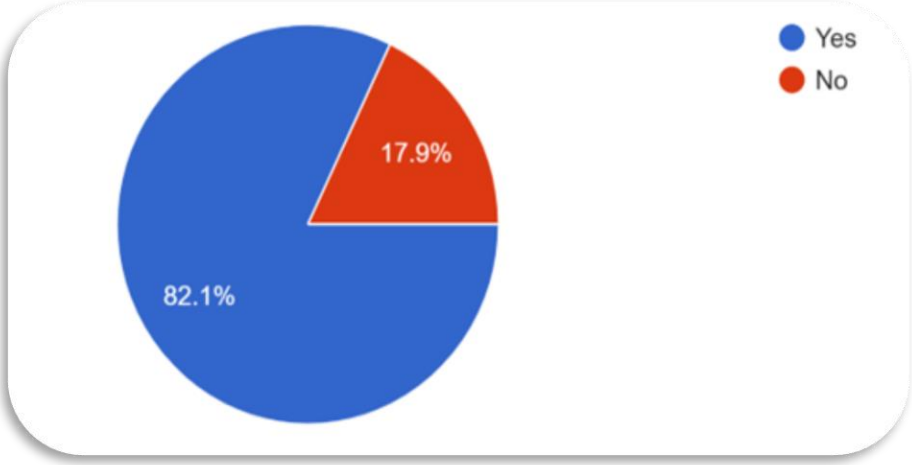

Figure 4: Preference for the ability of the system to notify when the reservoir is empty

Technical Specifications

Performance in quantitative terms.

NE555 timer initial error of timing -3%

Power consumption

LM324 – +/- 60mA, 9V

NE555 – 250mA, 9V

Motor – 12V, 8W

Product dimensions 120mm * 80mm *25mm

Weight - 250g

Lifetime of the product: 6 months for circuit

Warranty terms:

1. The product is only splash resistant to water and does not expose the system to water for extended periods of time.

2. Any physical damage done by the user will not be covered under the warranty.

3. Water pumps that receive no warranty should immerse the pump in a water reservoir while in use.

Technical feasibility

Performance requirements

The system is an analogue system; hence it needs no software implementation.

The timer circuit can provide a pulse for up to 11 ms.

The sensitivity of the probes (soil) can be adjusted and probes for water sensitivity is calibrated while preparing the circuit but can be tuned by the user if required.

The motor is capable of pumping water up to 5 m vertically at a flow rate of 600L/H.

The system can provide up to 1.5 liters of water per single operation.

Product Architecture

Block diagram

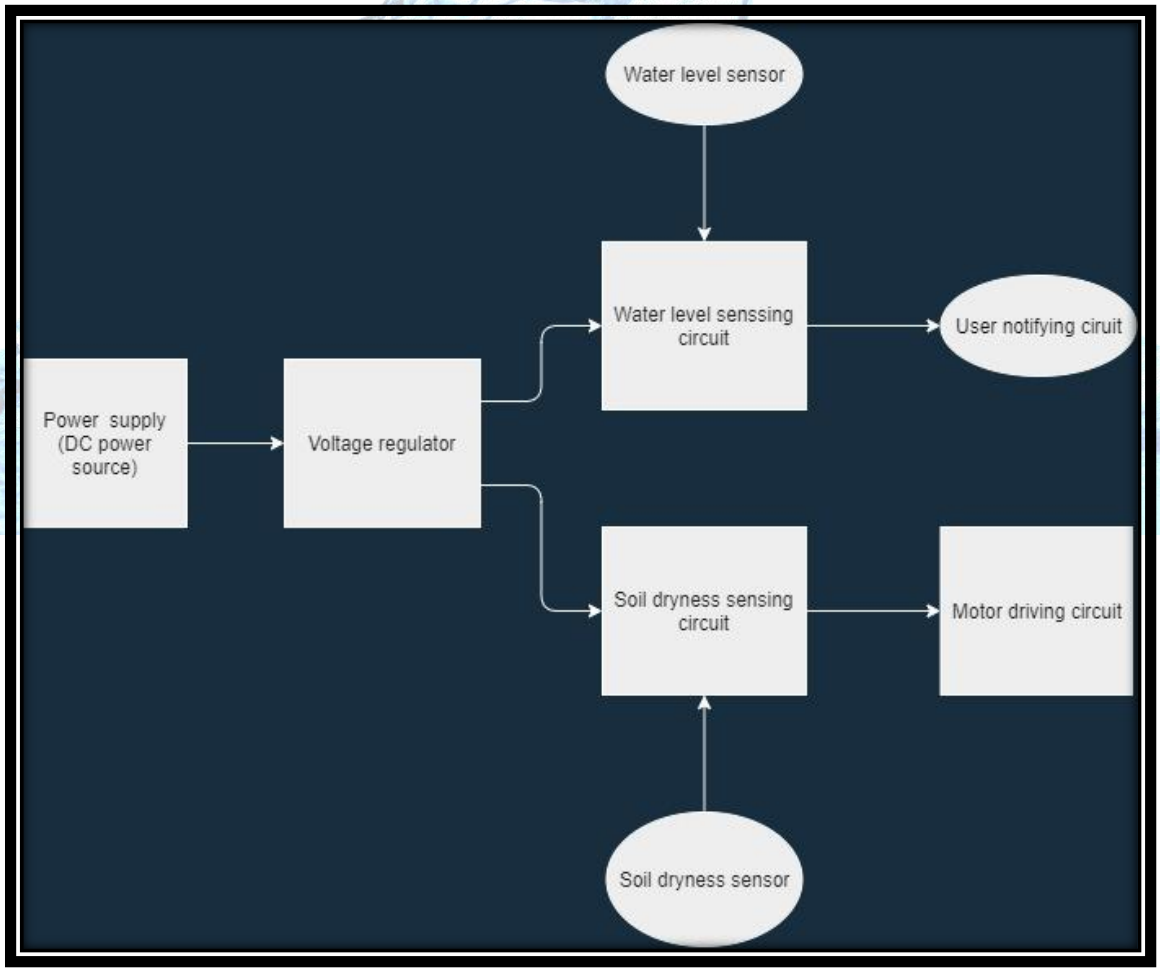

Figure 5: Block diagram representation

Circuit Diagram

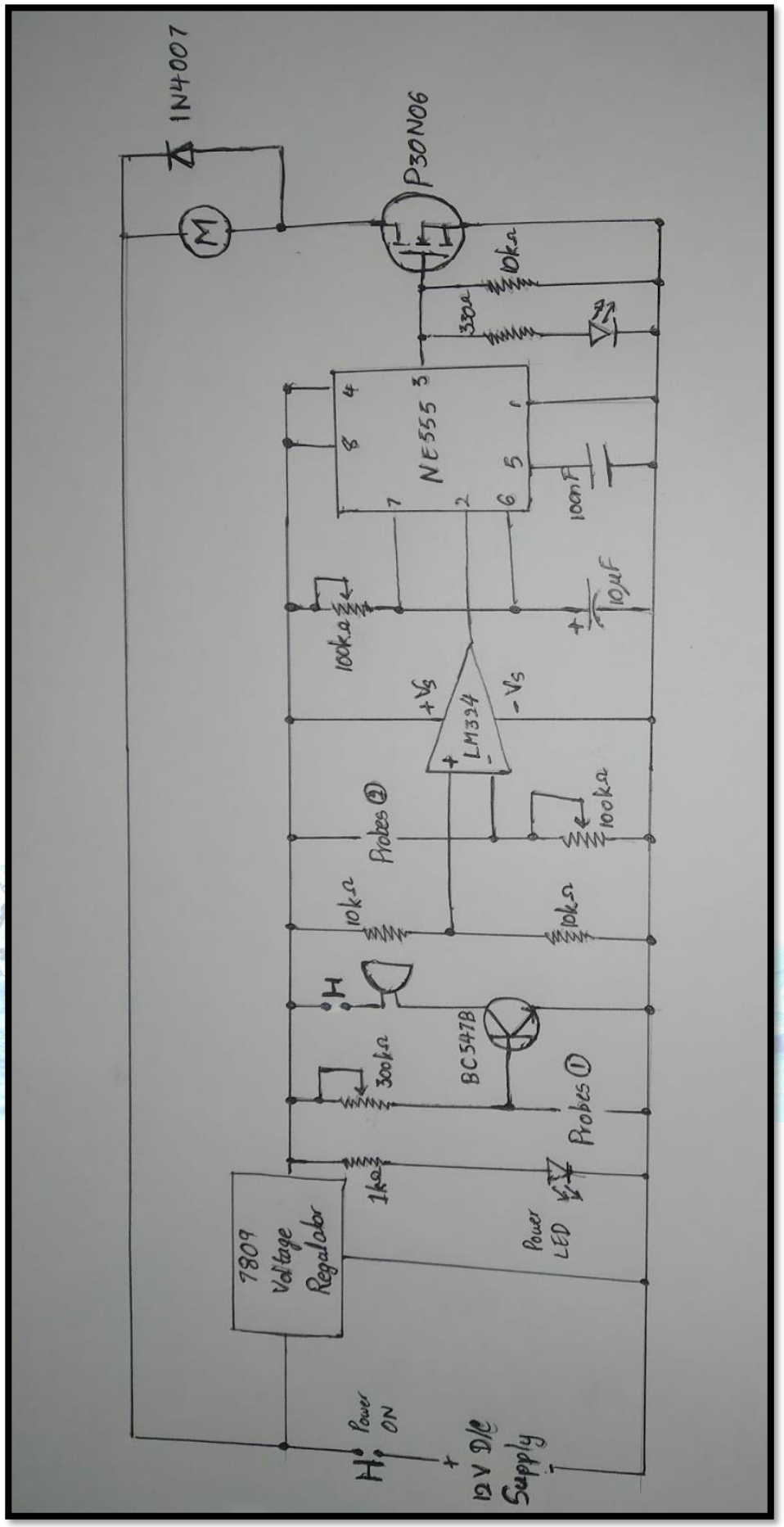

Figure 6: Circuit

Enclosure Design

The enclosure contains two knobs (to control soil dry sensitivity and watering duration), two holes for 2 LEDs (indicates Power ON and motor ON), two push switches (Power On/Off and water sound On/Off), a wire connector (6 wires), and a wire connector for power supply. Inside, it contains 4 plugs, which we can use to connect the lid to the cover.
The size of the enclosure only depends on the size of the PCB and other circuit components, so there will not be a massive enclosure. It is a very lightweight one with an easy-to-handle size.

- Color: Mostly Gray and Black
- Material: Plastic

UI and UX

There is a push switch (Power On/OFF) to Power On the product. When the product is powered on, the LED (Power On) will be on.
There are 2 knobs to control soil dry sensitivity and watering duration. The user needs to adjust the soil dry sensitivity according to the nature of the soil and the watering duration according to the nature of the plant.
The other LED is for indicating that the motor is whether On or Off. The LED is On while the motor is On. Otherwise, it is Off.
The other push switch is for controlling the buzzer. The buzzer is activated when the water level is low. If the user wants to deactivate the buzzer, they can do so using the push button.
We label every UI control so that users will not get confused while using it, and it has a very easy-to-use UI.

Initial Sketches

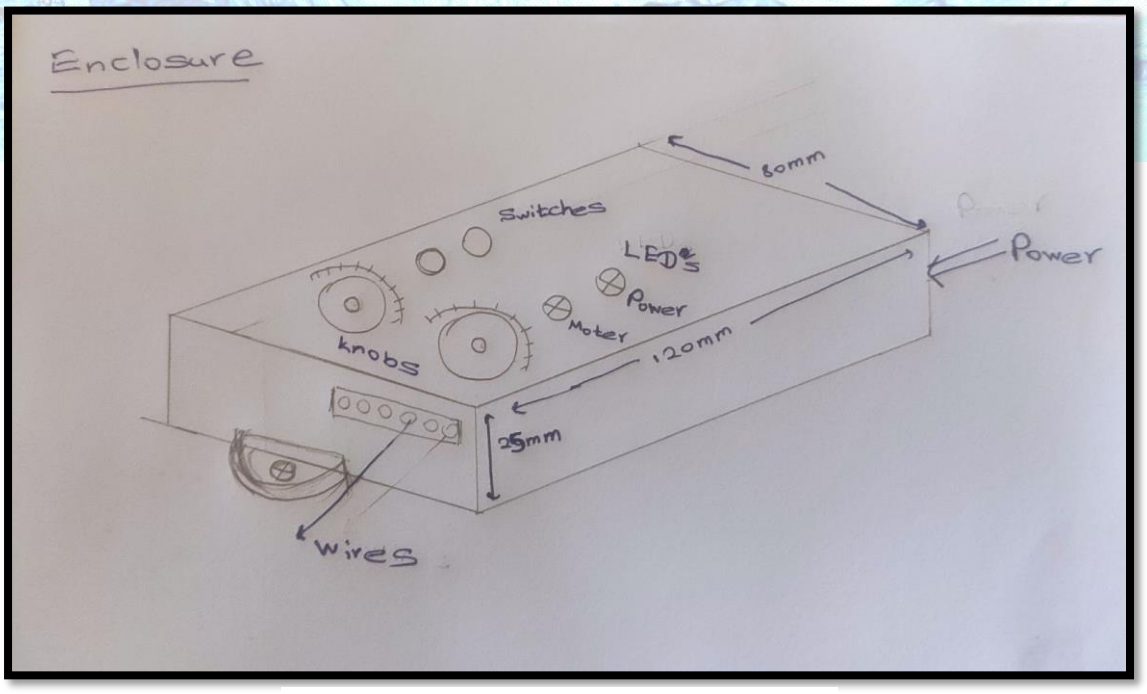

Figure 7: Initial sketches of product enclosure

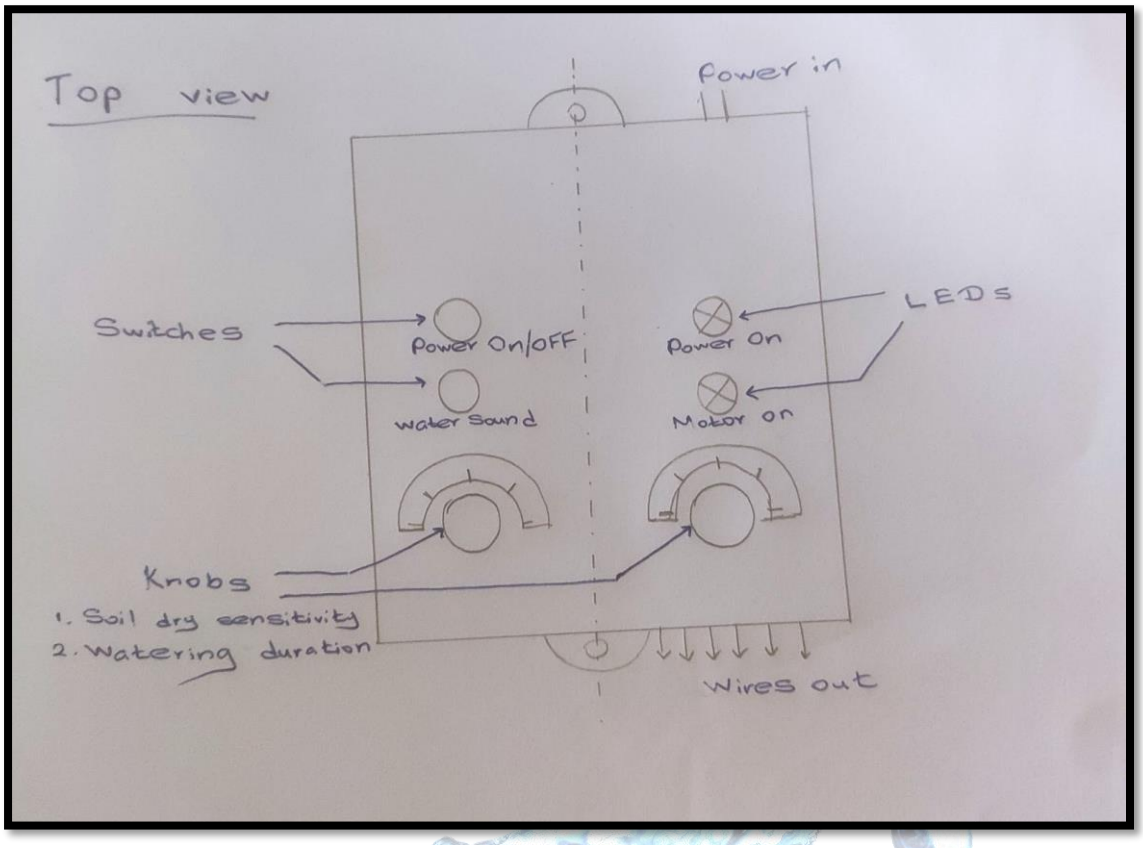

Figure 8: Initial sketches of product enclosure

After discussing the drawing of initial sketches of the enclosure with the group, the final sketch of the enclosure was designed using SOLIDWORKS.

Final SOLIDWORKS Sketch of Enclosure

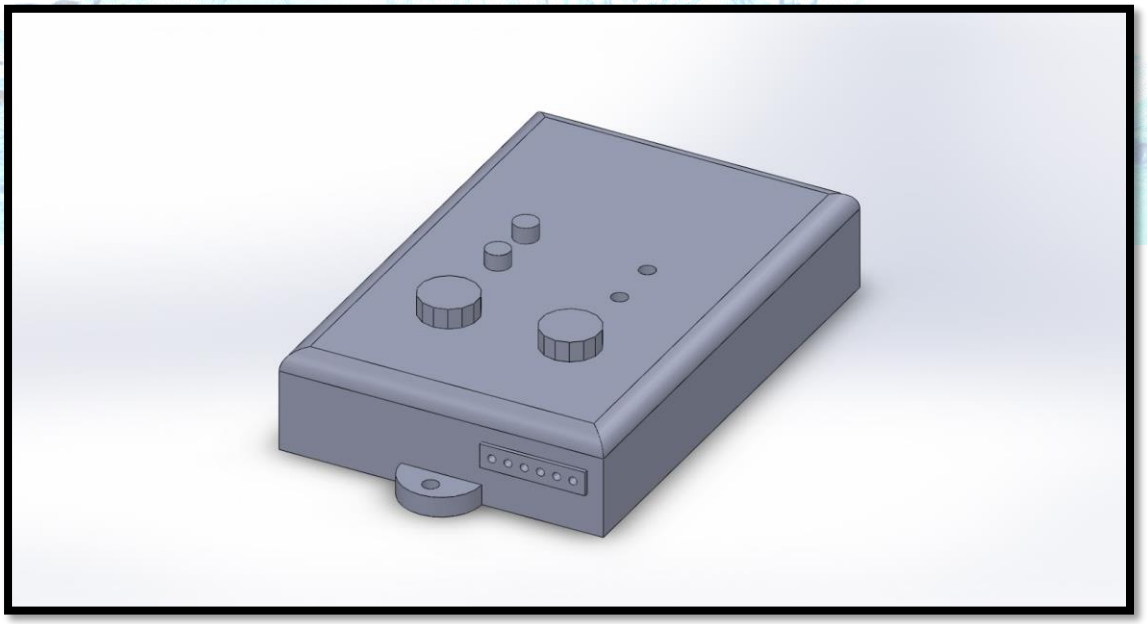

Figure 9: SOLIDWORKS design of product enclosure

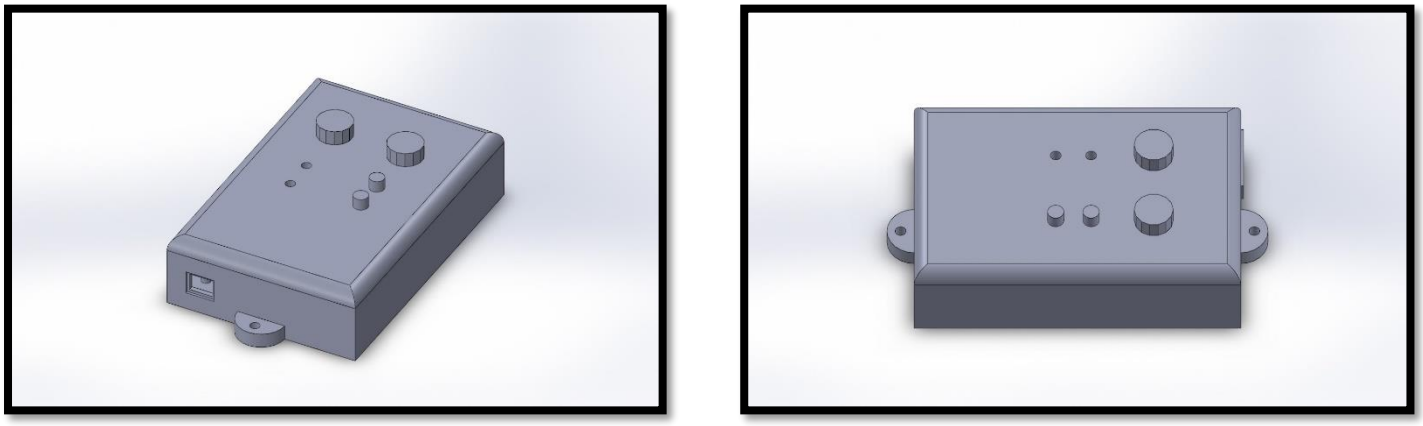

Figure 10: SOLIDWORKS design of product enclosure

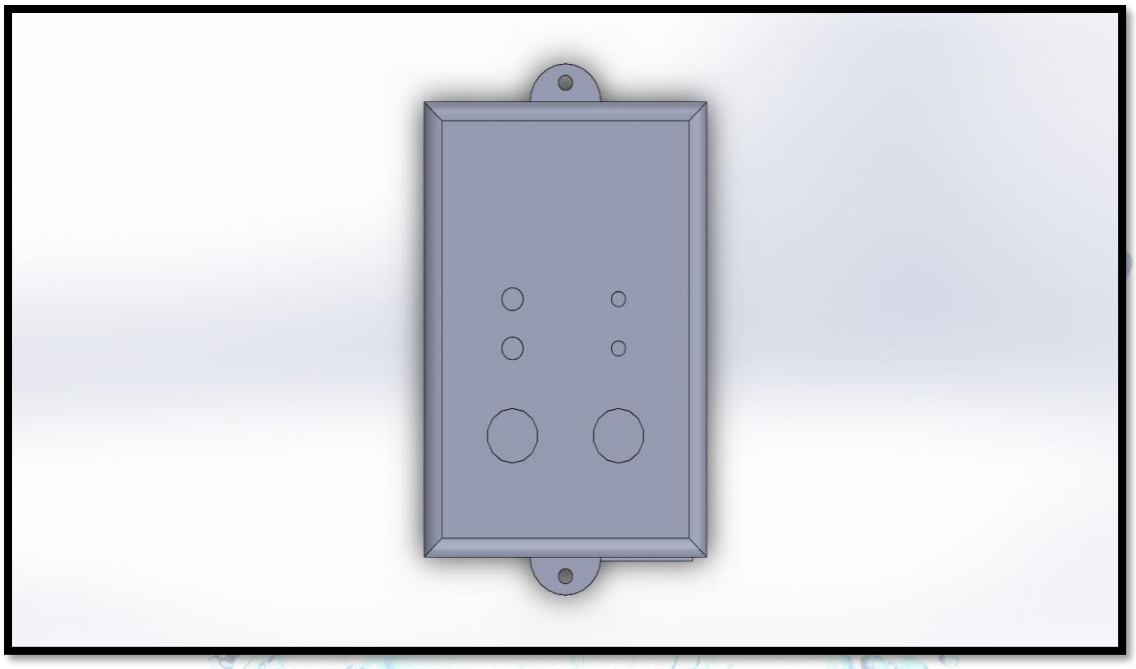

Figure 11: SOLIDWORKS design of product enclosure – Top View

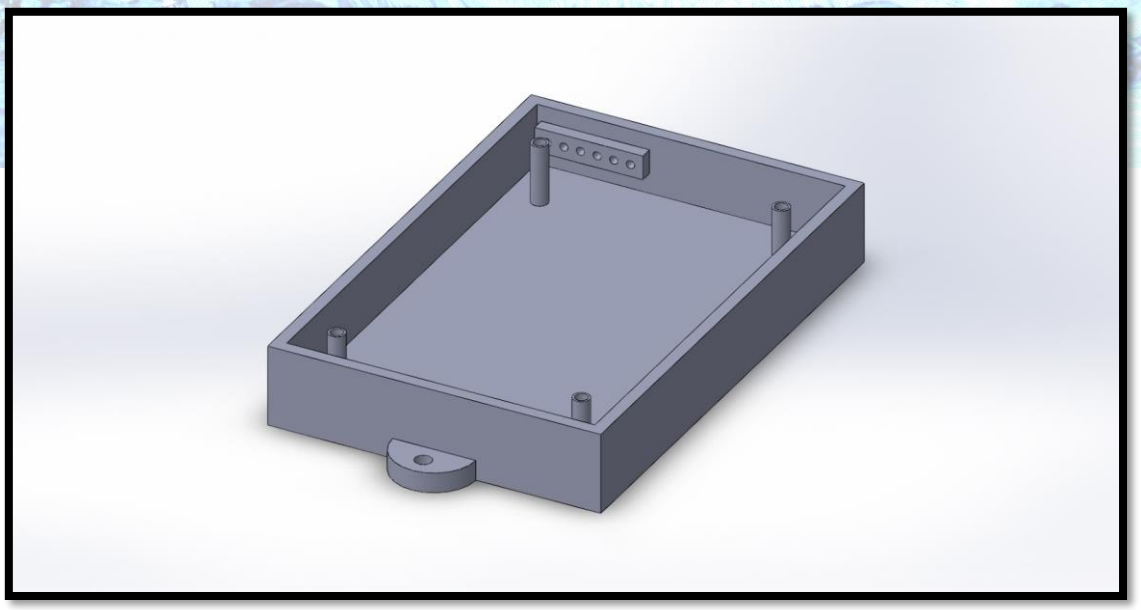

Figure 12: SOLIDWORKS design of product enclosure – Inside View

Marketing and Sales and Beyond

Product packaging

We are going to provide our product as pre-assembled. So, the user will receive it as a completed one. So, we planned as below.

- Initially the user doesn't need to open the enclosure so that it will be closed.
- The enclosure will be covered by polythene to protect the electronic circuits from the wet environment before it has been assembled.
- The probes are provided inside the box but separately from the enclosure, it won't be covered with polythene, but the ports of the probes will be covered.
- Then whole components will be packed within a cardboard box.
- The user manual will be printed in the cardboard box.

Maintenance

After the user sets up the system, it doesn't need daily maintenance. But the user is required to check the sensitivity and timer once a month to protect the plants.
The user should be aware of other impacting factors on plant growth.
Our system is maintaining only the humility of sand.

Repair

There is a power LED and a motor LED on the enclosure to indicate the power status and functional status of the motor to the user.
If one of them does not work, then the user will need the help of a technician to troubleshoot it.

Reuse/Recycle

Since we are using a plastic enclosure, the probability of damaging the enclosure is very low. So, even if the components have any failures, we can replace them with new ones or repair them and reuse the system.

We are only using plastic, electronic components, and cardboard in our product. So plastic and cardboard can be recycled. All the electronic components can be recycled unless they are refurbished /reconditioned (repaired, upgraded) and used again.

We are using recyclable plastics for the enclosure, so we can recycle the enclosure and PCB. The PCB recycling machine is specially designed for recycling circuit boards to get the metal.

Disposal

All the electronic components can be disposed of as e-waste as there are many ways to dispose of e-waste nowadays

Project Budget

Components	Cost per Component	Cost
DC jack - 1	**Rs 90.00**	**Rs 90.00**
7809 Voltage regulator - 1	**Rs 60.00**	**Rs 60.00**
300kΩ pots - 1	**Rs 250.00**	**Rs 250.00**
BC547B transistor - 1	**Rs 10.00**	**Rs 10.00**
9V buzzer - 1	**Rs 60.00**	**Rs 60.00**
330Ω resistor - 1	**Rs 1.00**	**Rs 1.00**
10kΩ resistors - 3	**Rs 1.00**	**Rs 3.00**
100kΩ B potentiometers - 2	**Rs 40.00**	**Rs 80.00**
100uF capacitor - 1	**Rs 10.00**	**Rs 10.00**
100nF capacitor – 1	**Rs 4.00**	**Rs 4.00**
LED yellow/red – 2	**Rs 6.00**	**Rs 12.00**
Push switch – 1	**Rs 50.00**	**Rs 50.00**
1N4007 diode – 1	**Rs 3.00**	**Rs 3.00**
NE555 timer – 1	**Rs 30.00**	**Rs 30.00**
LM324 IC – 1	**Rs 40.00**	**Rs 40.00**
P30N06 N channel MOSFET – 1	**Rs 90.00**	**Rs 90.00**
Total		**Rs 793.00**

Table 1: Cost for components

PCB printing cost:

As per the current market for PCB printing, Rs. 6.00 is charged per single point. So it will cost us around Rs. 500.00

Enclosure Cost:

It costs Rs. 500.00 for 3D printing for only one product. But for mass production, we don't want to go for 3D printing. So, the enclosure cost can be minimized.

Product Price

As we are very much concerned about the price of the product, we are thinking of a product price of around Rs 1800.00

Marketing

The targeted users are

-Government and Private sector workers - especially low-income people
-Who is fond of using technology in their day-to-day life.

Strategy

-Advertising through social media.
-Creating a website and promoting the product through the website.
-Use influencers

Selling method

-Sold in local markets like hardware shops and electronic shops.
-Sold through the website and other online shopping pages (Daraz, Amazon)

Sales Price

We have assumed our selling price as Rs. 2100.00, which includes the following

- Manufacturing
- Components
- Packaging
- Marketing
- Profit

As of now we have decided our sales volume is 150. It may increase in the future with the feedback from our customers.
This is only a proposal. We can minimize the production cost based on the targeted user's feedback and the related future work.