DEPARTMENT OF COMPUTER SCIENCE ENGINEERING,

SCHOOL OF ENGINEERING AND TECHNOLOGY,

SHARDA UNIVERSITY, GREATER NOIDA

AUTOMATED PLANT WATERING SYSTEM

A project submitted

In partial fulfillment of the requirements for the degree of

Bachelor of Technology in Computer Science and Engineering

By

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April, 2022

Certificate

This is to certify that the report entitled “Automated Plant Watering System” submitted by **“**Shubham Gupta (2018006327), Mukul Rajput (2018013543), Shray Sharma (2018008770), Shaan Raj Pradhan (2018010540)**”** to Sharda University, towards the fulfillment of requirements of the degree of **“Bachelor of Technology”** is record of bonafide final year Project work carried out by him in the **“**Department of Computer Science and Engineering, School of Engineering and Technology, Sharda University**”**.

The results/findings contained in this Project have not been submitted in part or full in any other University/ Institute for award of any other Degree/Diploma.

Signature of Supervisor

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Place:

Date:

Signature of External Examiner

Date:

Acknowledgement

A major project provides an excellent opportunity for self-improvement and learning. We consider ourselves fortunate and grateful to have had so many wonderful people assist us in completing the project.

Firstly, we would like to thank Dr. Nitin Rakesh, HOD, CSE who gave us an opportunity to undertake this project.

My grateful thanks to **Ms. Shaveta Khepra** for their guidancein our project work.

Ms. Shaveta Khepra, who in spite of being extraordinarily busy with academics, took time out to hear, guide and keep us on the correct path. Without her assistance, we don't know where we would have ended up.

Department of CSE looked over our progress and arranged all facilities to make project easier. We choose this moment to acknowledge their contribution gratefully.

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Abstract

The purpose of this research is to create an IoT-based Automated Plant Watering System using various modules such as the Arduino UNO and a moisture sensor. Plant monitoring is one of the most important responsibilities in any agricultural or agriculture setting. It is quite difficult to monitor the plant in certain conditions because human interaction is not accessible 24 hours a day, seven days a week. To solve this problem, the Moisture sensor detects whether the soil is wet or dry, and the sensor readings are sent to the ADC for microcontroller processing. The moisture sensor detects the presence of water and transforms it to an analogue signal that is fed into a small controller through an ADC. If the analogue signal climbs beyond the threshold value, an analog- to-digital converter (ADC) converts it to digital format and provides the water. This IoT device provides peace of mind to the farmer or gardener, as the sensor will automatically display the quantity of moisture content in the soil in the mobile application, where the user can also view a real-time photograph using the camera module. As the security is the major concern in the current world so the mobile application contains a 2-step verification for user login.

Index Terms microcontroller, monitor, sensor, threshold, camera module.

Contents

Chapter1: Introduction

Plants serve an important role in maintaining the ecological cycle and are the cornerstone of a food chain pyramid, thus proper monitoring of their growth and health is necessary. As a result of automation and Internet of Things (IOT) technology, plant monitoring systems are getting smarter. One of the characteristics emphasized in this topic is smart decision-making based on real-time soil moisture data.

The automated water system design with IOT is feasible and cost-effective for planning water resources for plantation (group of a plant). We can demonstrate how, by implementing an automated water system architecture, we can reduce the amount of water used in various plantations (groups of plants). To monitor the water level, the system framework includes a moisture chain that is suitable for microwaves (wireless), a soil moisture sensor, humidity and temperature sensors located in the root zone of the plants, and a level of water (ultrasonic) sensor installed in the tank. The data from the sensors will be collected and sent to a web server (cloud).

The background of the chapter emphasizes the study of IOT in the field of agriculture. This highlights how, by utilizing real-time data, we can utilize IoT technology to make our plantings smarter and more reliable. This chapter also guides newcomers through the process of installing IoT technology and learning the foundations.

Agriculture provides a yearly income to nearly 60% of the population in India. In today's digital world, many farmers still use archaic practices in their fields, resulting in extremely low plant yields. Despite the fact that we live in a culture where practically everything is handled and run automatically, there are still a few key areas in our country where automation has yet to fully take hold, possibly due to a variety of causes, one of which is cost. A good example is agriculture.

Crop monitoring systems are becoming an important aspect of our country's agriculture and agricultural sectors since they may be utilized to grow crops in controlled environments with high yields. The management of industrial machinery and processes that replaces human labor is known as automatic. An automated system requires less human energy, which means it is less likely to make mistakes.

Farmers may just inspect the system with their smartphone to obtain a wider image, and it is unlikely that the farmer will notice the system's efficiency using this technology. Incorporating modern technology into the field will solve major agricultural challenges.

Automation, industry, power, health, and tracking systems are all examples of areas where the Internet of Things (IoT) idea may be used. The proposed strategy is built on an Internet-based agricultural monitoring and irrigation system that assists farmers in adopting new contemporary technology that increases revenue while requiring less labor.

Agricultural development contributes to a country's economic progress. Any type of agricultural land can be used using the basic setup. The Internet of Things (IoT) is a system that connects a variety of technological gadgets. With today's technology, anyone can get access to any information they want. The proposed method connects the Internet to the leading system in the field of plants, as well as smart phones to check the results, and it works extremely well. To monitor various environmental variables, the suggested system's services, such as soil temperature and humidity, are arranged in a vegetation area. This sensor is low-cost and does not demand a lot of electricity.

A web application that runs on a server was developed. The script, programmer, and coding for the app are split into two parts. The application produces the same results as when it was tested using the http protocol. In the event of installable mobile software, look for direct communication with the board. The internet's high speed allows the results to be seen in less than half a second. The code is flash-based and applied to the server. The primary goal of this project is to improve the agricultural monitoring and irrigation system in order to address the challenges that farmers in India face.

We utilize IoT modules and Arduino as the project's controller in this project. Moisture sensors, for example, are used in this study. Knowing all of this provides you with the information you need to make well-informed judgments. The soil moisture sensor detects whether the soil is dry or wet. The water pump will automatically open when the soil dries out.

The ADC provides sensor values for Arduino control to process. An analog-to-digital converter converts an analogue signal into a digital representation (ADC). The soil temperature and storage temperature are displayed, and the same readings are updated online using the controller's IoT module. This soil moisture data is then delivered to the user's mobile app, and while a farmer can't utilize this technology to monitor the system's performance across a vast region, they can do so with their smartphone.

Overview:

This project proposes an automated plant watering system based on Arduino software and hardware, as well as entrepreneurial abilities and traits. It's simply a system that assesses soil moisture with an Arduino soil moisture sensor and then automatically activates a vertical water pump to water the plant when a specified moisture threshold is reached, as programmed in the Arduino IDE. All of the scripts were written using the Arduino IDE application. Part of the hardware is made up of Arduino and generic electronics.

Project Description:

The product is built with the economic attributes in mind and with a reasonable quality. The automated system accompanying the plant in watering it automatically is rather a conveniently hand-held product with an easy-to-carry weight and fit-on-table size. The problems of creating a product of an automated system are identified through the method of problem identification. The process of design embodiment consists of layout design and the necessary coding as well as a bit of analysis throughout the project. The detail design includes the design, drawings, and assembly as well as the cost analysis. The prototyping provides the details of fabrication and finally the product testing result.

1.1 Problem Definition

Water scarcity is the most pressing issue in agriculture. Water is being squandered because it is not being used efficiently. The adoption of the Internet of Things in this industry will aid in reducing water scarcity and waste. Sensors are used to measure temperature, humidity, and light, and further processing can be done based on the results. We suggest a system that will record all of the information about the soil as well as the temperatures measured by various sensors. Sound data will be transferred to the processor, resulting in a warning message and the appropriate amount of water being delivered to the crop.

If the humidity limit is above the specified level and no water is provided to the plant, the advanced system will pick up the moisture sensor input and send the input signal to the microcontroller, who will then communicate the discharge signal to the solenoid valve through the 5V 4 transmission station. Water will be available.

The process of project creation is divided into several parts, the first of which is to comprehend the problem and all of its needs. To get the information needed to develop the project, further extensive literature research is required. The first module of project development will be to connect IoT-based system components. In due course, further coding modules and other hardware requirements will be developed.

The other issue is that while the user is not at home to inspect and water the plant, he or she can view all of its data remotely.

1.2 Project Overview/ Requirement Specifications

1.2.1 Functional Requirements

1.2.1.1 Introduction

The way this system works is that the Soil Moisture Sensor SEN13322 will be embedded in the soil of the pot in this Plant Monitoring System. A threshold value is set for the moisture sensor, and the result is shown in the relay's LED. The relay's red LED will begin to blink. When the red LED illuminates, it indicates that the threshold value has been exceeded. When the Threshold value is met, the microcontroller sends a signal to the 5V 4-Channel relay. As water is brought to the plant, the moisture sensor determines if its limit value has been achieved, and a little controller sends a signal to the transmission system. The power supply is shut off when the transmitter gets a signal. After that, the moisture content is sent to the mobile app, where the user may observe the moisture content in real time as well as a photo of the plant. The camera module utilized is the OV7670, which is a 0.3V, low-cost CMOS. It can produce images with a resolution of 640x480 pixels at 30 frames per second, or 30fps. This module requires 3.3V, which we can provide from our Arduino board. This sensed data after getting monitored is then sent to the mobile application.

1.2.1.2 Input

As we turn on the system the soil sensor starts to sense the moisture content in the soil and send this data to the microcontroller which does the further operations. (Fig. 1)

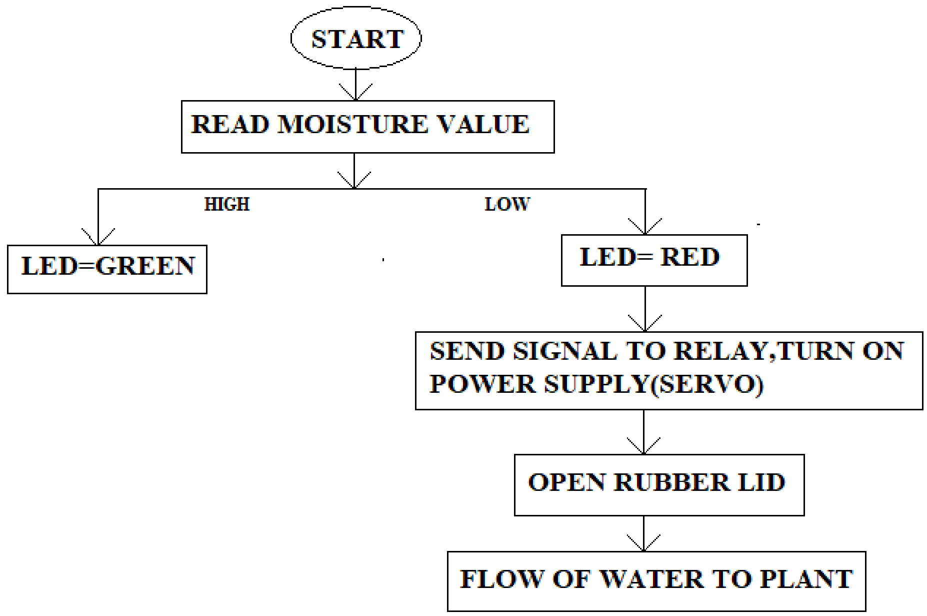


Fig. 1 Flow Diagram

1.2.1.3 Processing

Further the processing is done in the microcontroller as the coding has been done in it to sense and supply water accordingly, as this data is sent to the relay and the servo motor opens the water valve to the plant and the water is supplied to the plant. (Fig. 2)

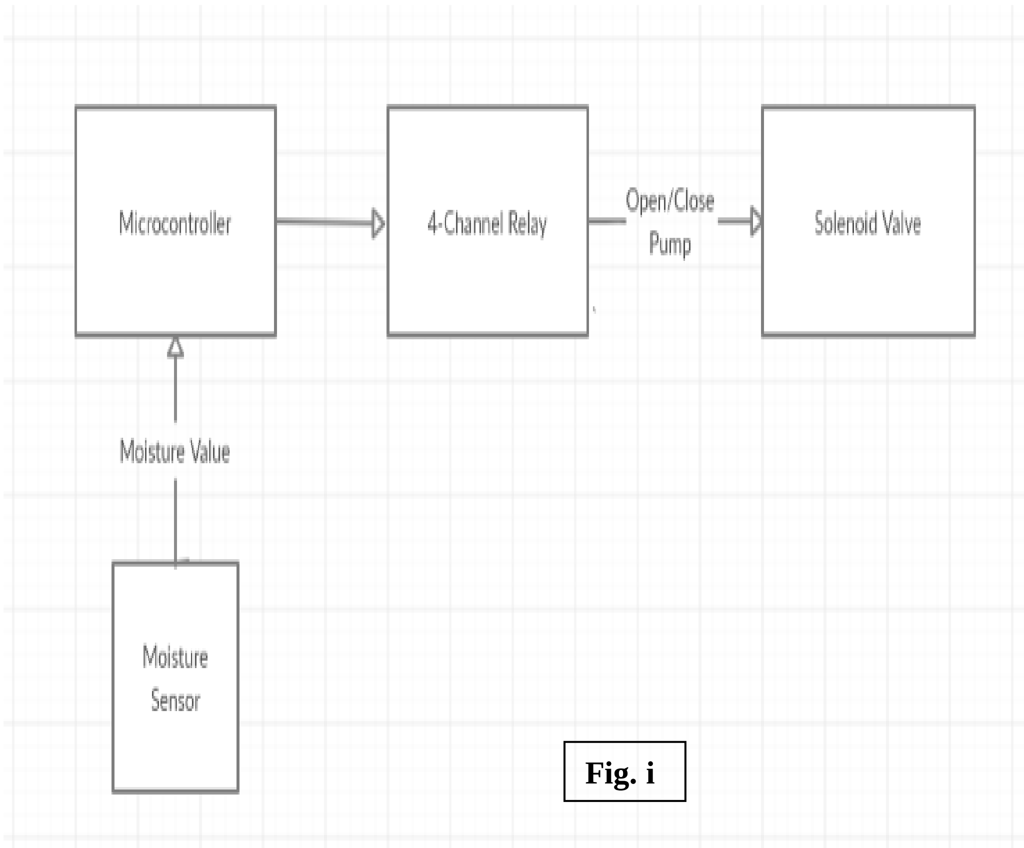


Fig. 2 Process Flow

1.2.1.4 Security

The application is protected with a 2-step verification as the app has an OTP system in it. When the user tries to login into the system, he needs his account password and needs to provide with an OTP that is sent to his email id. For this an API has been made.

1.2.2 Normal Requirements

1.2.3 Non-functional Requirements

These are the specifications, as the name implies, that are not specifically correlated with particular functionsoffered by the device.

1.2.3.1 Performance Requirements

Execution based on the relation; high execution of the system may lead to higher usage of the batteries so we have connected our system to the direct AC supply.

1.2.3.2 Reliability

Our IOT based Automated Plant Watering System is very reliable in our daily lives as we do no need to take care of our plants on the daily bases, in fact we can check our mobile applications for that and also its secure.

1.2.3.3 Availability

Availability is the major thing that is required to work with our project, as we would definitely make our product available and also support will be available to every user.

1.2.3.4 Security

Security in registration is the technique to ensure that information of the user doesn’t get compromised as it is the important thing on our project. This is done with an OTP verification in the mobile application. User need to enter the correct OTP in the app in order to gain access.

1.2.3.5 Maintainability

It is defined as the probability within a given time of conducting a successful repair operation. As such, practicality tests the straightforwardness and speed at which, after a disappointment occurs, a system can be returned to operating status. Convenience is a trademark that is credited to a PC application in the event thatit may be used rather than the one in which it was developed as part of operating systems without the need for major reconstruction. Porting is the job of performing whatever work that is necessary to maintain the PCprogram going in the new environment.

1.2.3.6 Ability of Learning

It is simple to operate and reduces the workload of the user.

1.3 Hardware Specifications

Minimum Requirements	**Windows**
Operating-System (OS)	Windows 7
Processor	Dual core, Intel i3
RAM	2 GB RAM
DISK Space	The amount of disc space available depends on the partition size and whether or not online help files are allowed. The Math Works installer would tell you how much disc volume your partition needs.
Graphics-Adapter	Graphics adapter (8 bit) and display

1.3.1 Hardware Requirements

1.3.1.1 Arduino UNO R3

Increased memory and higher data transfer speeds are now possible. The Arduino Uno may be used as a keyboard, mouse, joystick, and more on Linux and Mac (a Windows inf file is required and available in the Arduino IDE).

Next to the AREF, the Arduino Uno R3 includes SDA and SCL pins. In addition, two extra pins have been added near the RESET pin. The IOREF, for example, allows the shields to adapt to the voltage supplied by the board. The other is unconnected and will be used in the future. The Arduino Uno R3 is compatible with all existing shields, but it can also adapt to new shields that require these extra pins.

1.3.1.2 5V 4-Channel Relay

A 5V 4-channel relay interface board is used to power each relay, which requires 15-20mA driver current. A high-current relay is integrated (AC250V 10A; DC30V 10A).

There is a standard interface available that can be controlled directly by a microcontroller (for Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic). LEDs indicate the state of the relay output.

1.3.1.3 Soil Moisture Sensor (SEN13322)

The Soil Moisture Sensor is a straightforward gadget for sensing moisture in soil and other materials. The soil moisture sensor is simple to set up and operate.

The sensor's two huge exposed pads serve as probes, and combined they work as a variable resistor. When there is more water in the soil, the conductivity between the pads improves, resulting in lower resistance and a higher SIG out.

Simply connect the VCC and GND pins to your Arduino-based device (or compatible development board) to get the Soil Moisture Sensor working, and you'll get a SIG out that depends on the quantity of water in the soil. When exposed to a damp environment, one of the most well-known issues with soil moisture sensors is their limited lifespan.

We've had the PCB coated in Gold Finishing to combat this (ENIG or Electroless Nickel Immersion Gold). The gold plating ensures that the item will last in a wet environment.

1.3.1.4 20 Female to Male Jumper Wires

Female to male jumpers is especially handy for connecting standard 0.1″ male header pins like commonly found on breakout boards to female header contacts such as on a solderless breadboard. They also can be used to make extension cables by connecting the female end to the male end of another cable.

The cables have 10 different wire colors which repeat every 10 wires. The rainbow colors make it easy to match the same wire at both ends of the cable.

The individual wires are easily pulled apart by hand to create single jumper wires or to make smaller cables consisting of multiple wires which are handy for keeping wires together when connecting small buses or running multiple wires to a sensor.

1.3.1.5 Camera Module OV7670

The OV7670 Camera Module is a compact, high-sensitivity, low-voltage CMOS image sensor module for image capture and processing. Its image sensor is the OV7670. The sensor may output the entire frame, sampling, and multiple resolutions of 8 bits of data via SCCB bus control. The VGA image of the product can achieve a maximum of 30 frames per second.

The image quality, data format, and transmission manner are all totally customizable by the user. The SCCB programming interface can control all image processing processes, including gamma curve, white balance, saturation, and chroma.

The OV7670 is a low-cost image sensor DSP with a maximum frame rate of 30 frames per second and a resolution of 640 × 480 ("VGA") pixels, which is comparable to 0.3 Megapixels. The DSP can pre-process the acquired image before sending it out. The Serial Camera Control Bus can be used to configure this pre-processing (SCCB).

1.3.1.6 Red / Green Led

The Bi-color LED is a useful little component that allows two colours (red and green) to be combined in a single LED while only requiring two pins (cathode and anode). The colour of the LED is determined by the polarity of the connection, which allows only one colour to be displayed at a time. LEDs with two or even three colours typically have three or four pins, allowing for a wide spectrum of blended hues.

Two pins may appear to be a disadvantage, but this is not the case. This LED can simply be used to visually identify polarity direction in a circuit. Alternatively, it could save me an extra i/o pin on a future Arduino project, as in my case.

1.3.1.7 Container

A medium-sized portable container for transporting, storing, and using water is known as a water container, water canister, or water can. Canisters are large plastic bottles that are occasionally referred to as such. Drinking water, wastewater, and showering can all be done with water canisters.

1.3.1.8 Power Supply

A power supply is an electrical device that provides electricity to at least one load. It often converts one type of electrical power to another, although it can also convert solar, mechanical, or chemical energy into electrical energy.

Electricity is supplied to components by a power source. Typically, the word refers to devices that are built into the component that is being powered. Computer power supplies, for example, convert AC current to DC current and are often found in the back of the computer case with at least one fan.

1.3.1.9 Stopper/ Rubber Lid

A bung, stopper, or cork is a cylindrical or conical truncated closure that is used to close a bottle, tube, or barrel. Unlike a lid, which encloses a container from the outside without displacing the inner volume, a bung is partially placed within the container to act as a seal. These can be used with any type of glass bottle.

1.4 Software Specifications

Arduino
Android Studio
Spring Boot
IntelliJ Idea

Language:

C and Java

Chapter2: Literature Survey

2.1 Existing System:

- **"IOT Based Smart Plant Monitoring System":**
  - The goal is to eliminate the requirement for manpower and thereby reduce error. For use in a big region.
  - Software and hardware used are LM35, ADC ARM7, LCD, C, C++, Arduino, WIFI, Bluetooth, WiMAX.
  - In this the algorithm or the methodology used is hybrid and due to this Zigbee and WSN are compromised.
  - According to the findings of the investigations, there is a waste of water and the motor's power consumption can be lowered.
  - The major drawback is that is not cost effective on a small-scale usage.

- **"Plant Talk: A Smartphone based Intelligent Hydrophonic Plant Box":**
  - The goal is for procedures to be able to be conducted on any smartphone or computer.
  - Software and hardware used are Python, Water spray, water pump, Temperature Sensor, pH sensor, humid sensor, co2 sensor, waterlvl sensor.
  - In this the algorithm or the methodology used is ZigBee protocol and nutrient Film Technique.
  - The findings are that the suer can talk to the plant at any time in any space. Also, it is very expensive and is not practical for mass markets.

- **"Smart Plant Monitoring System":**
  - The goal is to monitor moisture, temperature, and light levels.
  - Software and hardware used are Android, .Net, cloud-based server, two APIs.
  - The mobile application deployed in the mobile device informs the user about the device status and weather status in the location of subscribed monitoring device using which user can perform the curation of the system.
  - Findings of this project was that the notifications given by the hardware device to user

the hardware device checks the moisture or humidity of the plant soil and id the threshold value, the weather forecast has been invoked to check if in next 1 hour if it would rain or not.

- **"Smart Irrigation: IoT Based Irrigation Monitoring System":**
  - The objective is to achieve a sustainably managed, accountable responsible and treated system.
  - Software and hardware used are transmitter and receiver, hygrometer sensor, humidity sensor, DC motor and a dedicated web server and APIs.
  - The Wi-Fi module, which is utilized to post sensor data to the online cloud, is one of the algorithms and approaches used. Python, Java, and JavaScript are also used.
  - The findings show that the data is saved on the server and that it is retrieved based on the conditions. As a result, the system may modify itself accordingly.

- **"Plant Watering and Monitoring System Using IOT and Cloud Computing":**
  - The main goal is to decrease human intervention and water waste by watering the plants according to their needs.
  - Software and hardware used in this are cloud computing, GSM module, moisture sensor, pH sensor.
  - This sensor can be used to detect soil moisture or determine whether there is water in the vicinity of the sensor. The system can be accessed remotely by users.
  - The goal of this study is to develop a versatile, cost-effective, easily adjustable, and, most significantly, portable solution that will help us tackle our water waste problem. It's a compact system with a lot of power.

Literature Table:

S NO.	TITLE	AUTHOR/ YEAR	OBJECTIVES	Software / Hardware Requirements / Programming	ALGORITHM / METHODOLOGY / Techniques / Methods	RESULT (ACCURACY or ANY OTHER PARAMETER)	FINDING / Achievement	DRAWBACK
1.	IOT BASED SMART PLANT MONITORING SYSTEM	KawaleJayashree et al 2018	1.The automated system will reduce the need of man power hence reducing the error. For a large-scale area, .	LM35, ADC.ARM7, LCD C and C++, Arduino, Wi-Fi, Bluetooth, WI-Max,	Hybrid approach that comprise: 1)Zigbee, 2) WSN		the wastage of water and the consumption of power by motor can be reduced so that they are conserved for the future use.	Not cost effective on small scale usage
2.	Plant Talk: A Smartphone-Based Intelligent Hydroponic Plant Box]	Lan-Da Van et al 2019	1.IoT-based intelligent hydroponic plant factory solution 2.All Plant Talk operations can be performed through an arbitrary smartphone or a computer.	Python, LED lighting, water spray, water pump, Temp-sensor pH-sensor Humid-sensor CO2-sensor O2-sensor WaterLVL-sensor Wi-Fi LTE Timer	1.ZigBee protocol 2.Nutrient Film Technique	The Plant Talk intelligence effectively lowers the CO2 concentration, and the reduction speed is 53% faster than a traditional plant system.	The Plant Talk designer and the user can access Plant Talk at any time in any place	Very expensive and not practical for mass markets
3.	IoT Based Smart Irrigation Monitoring & Controlling System in Agriculture	Md Mehedi Islam et al\ 2020	The feature of this paper includes monitoring temperature, humidity, pH and water level in agricultural field through sensors.	Temperature sensor Water level sensor Soil moisture sensor pH sensor Raspberry pi3	1. Soil moisture condition. 2. Pump on/off. 3. Water level. 4. Pump on/off. 5. Server.		The intention of this research work is to establish a flexible, economical, easily configurable and most importantly, a portable system which can solve our water wastage problem. It is a robust system and small in size.	Possibility for wrong Analysis of Weather Conditions

5.	SMART PLANT MONITORING SYSTEM	SreeramSa dasivam et al 2015	1) Detecting moisture, temperature, light conditions.	Android, .Net gadgeteer (monitoring hardware), cloud-based server(parse), two APIs (android/iOS/windows device, monitoring hardware device)	The mobile application deployed in the mobile device informs the user about the device status and weather status in the location of subscribed monitoring device using which user can perform the curation of the system.	Manual Mode - Efficient and accurate readings Automated mode - 80-90%	Notification given by hardware device to user The hardware device checks the moisture or humidity of the plant soil and if the threshold value (when the plant needswater), the weather forecast has been invoked to check if in next 1 hour if it would rain or not.	
6.	Automatic IoT Based Plant Monitoring and Watering System using Raspberry Pi	Anusha k et al 2018	prototype for plant monitoring and watering system using Raspberry pi. To develop system for Real Time Application	Raspberry pi (Model B 3.1), temp. sensor, Humidity sensor, moisture sensor, server with data base and IoT enabled web-based application	The mobile application deployed in the mobile device informs the user about the device status. Python/C++, java Java script	Each sensor with its unique identity can access changes in the Environment continuously. Various devices can access through IP address	Web app has been developed Sensor captures information when login take place. Two times login has to take place for secured and safe communication.	
7.	SMART IRRIGATION: IOT Based Irrigation Monitoring System	Shaif Choudhury et al 2016	To achieve a sustainably managed, Accountable, Responsible and trusted Irrigation.	Transmitter and Receiver Hygrometer sensor Humidity sensor Temperature sensor DC geared Motor dedicated web server and APIs	Wi-Fi-module is used to upload the sensor data to web-cloud. Java, JavaScript, Python	Smart Irrigation system can solve the problem of water shortage.	The data is stored in the server. Based on the conditions, data would be retrieved. So that, the system can adjust itself according to that	
8.	IoT Based Smartphone-Based Intelligent plant monitoring system	Rajkumar et al 2018	The feature of this paper includes monitoring temperature, humidity, pH and water level in agricultural field through sensors.	Android, .Net gadgeteer (monitoring hardware), cloud-based server(parse), two APIs (android/iOS/windows device, monitoring hardware device)	1. Python/C++, java 2.Nutrient Film Technique		The intention of this research work is to establish a flexible, economical, easily configurable and most importantly, a portable system which can solve our water wastage problem.	Cost Less efficient

9.	Smart Plant Monitoring System Using IoT Technology	Ankur Kohli, Rohit Kohli et al 2020	The planning of system is designed to locate the numerous needs of the plant parameters monitoring.	Arduino UNO/Atmega interfacing board, ThingSpeak Server through NodeMCU board soil moisture sensor, DHT11 sensor, level sensor	The mobile application deployed in the mobile device informs the user about the device status and weather status in the location of subscribed monitoring device using which user can perform the curation of the system.		Notification given by hardware device to user the hardware device checks the moisture or humidity of the plant soil and if the threshold value (when the plant needswater), the weather forecast has been invoked to check if in next 1 hour if it would rain or not.	Time Less efficient
10.	PLANT WATERING AND MONITORING SYSTEM USING IOT AND CLOUD COMPUTING	Ms. Yogeshwar Barhate, Mr. Rupesh Borse, Ms. Neha Adkar, Mr. Gaurav Bagul 2020	The primary objective is to reduce human intervention and avoid water wastage by watering the plants as per the requirements	Cloud Computing, GSM module, Moisture Sensor, pH Sensor	Sensor can be used to detect the moisture of soil or judge if there is water around the sensor. Users can access the system remotely.	pH sensor will detect the soil fertility. Sensors like Temperature, Humidity, Moisture is used for detecting the soil condition	The intention of this research work is to establish a flexible, economical, easily configurable and most importantly, a portable system which can solve our water wastage problem. It is a robust system and small in size.	Water wastage Human effort

2.2 Proposed System

The developed system will take input from the moisture sensor and send the signal to the microcontroller, which will then send the output signal to the solenoid valve via the 5V 4 relay channel to water the plant if the moisture value threshold is above the marked level. If the moisture value threshold is below the marked level, no water will be supplied.

The user's mobile application receives the measured moisture content and displays a real-time photograph of the plant as well as the moisture level. The real-time image of the plant can be viewed whenever the user wants on the mobile application. The user application is password-protected, allowing the user to log in and preserve his plant information.

The user application is developed by making todays security concerns into account by adding a 2-step verification for the user to login so that his data is secured and no intruder can enter the system and get the data.

First step verification is the normal user login then the second step is the OTP verification, for which an API has been developed which will generate an OTP which will be sent to the user's email-Id and will be valid only for 2 minutes. Also, after generation of an OTP the user cannot generate another OTP for a time span of 60 seconds. This data is stored in a MongoDB database.

Also, logs are being created for all the users who try to get into the system and generate OTP and whatever operations they perform are being recorded into the log files.

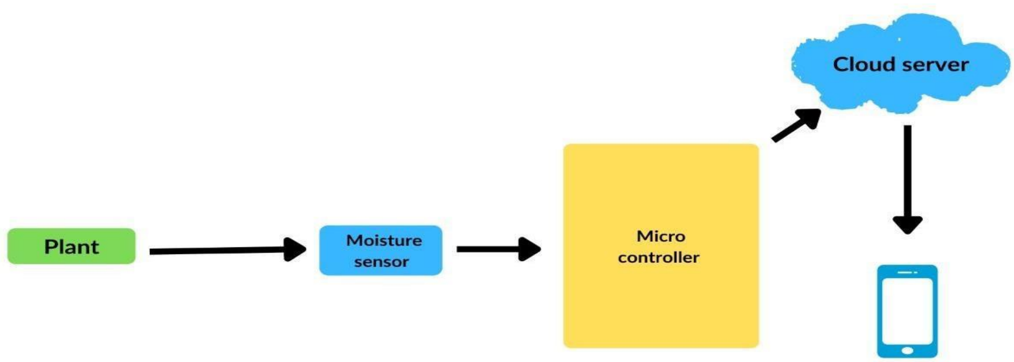


Fig 3 System flow

2.2.1 Approach used

The project's development is separated into several parts, the first of which is to comprehend the challenge and all of its requirements. Then, in order to obtain the knowledge needed to build the project, a thorough literature review is required. The first module of the project's development will be to connect the components for the IoT-based system. Further code modules and other hardware requirements will be completed at a later date.

2.3 Feasibility Study

Any comprehension of the major specifications for the scheme is necessary for feasibility study. Feasibility Dimensions for Computers would be as shown in:

- **Technology**

Is the project technically possible?

Is it a component of the state of the art?

Will failure be limited to the need for an implementation meeting the level?

- **Finance**

Is it financially practicable?

Is it realistic for the software company and its customer or company to achieve production at a reasonable pace?

- **Time**

Can the time for the idea to be sold, beat the competition?

- **Resources**

Will the corporation have the capital necessary for success? Two major variables used in the study of viability are:

a) Technical Feasibility
b) Economic Feasibility

a) Technical Feasibility

The purpose of this analysis is to check the technological viability, that is to say, the system's technical requirements. Any built system does not have a strong need for the technological resources required. This will add to intense strains on the intellectual resources available. It would bring to the customer's already firm hopes. Since this system can only be applied with minor to no modifications, a bare minimum must be met.

- The ability to produce output in a given amount of time due to the system's ability to handle multiple users.
- Ability to process and respond quickly in particular situations.
- A set number of transactions at a specific speed. Possibility of sending data to a remote place.

In the following ways, practical evaluation of feasibility can be carried out.

i. Satisfiability

In order to make it valid, if there is at least one way to make this project viable for the customer and he is fully satisfied with the product and is being used by them properly without any issues.

b) Economic Feasibility

The project's cost and benefit are examined in an Economic Feasibility study. That is, a detailed analysis of the project's development costs is carried out as part of this feasibility study, which includes all required costs for final development, such as hardware and software resources, design and development costs, and operational costs, among other things. After that, it is determined whether the initiative will be financially beneficial to the organization.

c) Social Feasibility

The phrase "social feasibility" refers to the process of determining whether or not a proposed project would be accepted by the general public, therefore this project is both social and feasible.

d) Operational Feasibility

It is primarily concerned with human organizational as well as social factors. The following points should be taken into account: the system interface is standard, user-friendly, and offers substantial help. As a result, no additional training is required.

2.4 Risk Management: -

2.4.1 Risk Identification

2.4.1.1 Product Size Related

R1 Our product is made in a small compact box which is very easy to carry or to place anywhere.

2.4.1.2 Customer Related

R2 Since its consumer isn't a professional individual and it poses a challenge in interpreting the customer's additional specifications.

R3 If the consumer offers unnecessary details; it can result in an undisclosed danger.

2.4.1.3 Technical Risk

R4 There is no technical risk as of now in our system as it is also secured with otp verification.

2.4.2 Strategies used to manage Risks

S1 By reducing box size, we can prevent Chance R1.

S2 Meeting with the customer regularly reduces the risk to some extent.

S3 R3 properly develops the system to incorporate modifications at a later stage and retains all necessary paperwork to minimize the risk, as previously stated.

S4 As consumer demand changes, we will continue to increase the

software's functionality.

S8 We will prevent R7 by providing adequate tool instruction.

Chapter 3: System Analysis and Design

3.1 Software Requirement Specification

The work of this system begins with the fact that the soil moisture sensor SEN13322 is embedded in the soil of the pot of this plant monitoring system. The humidity sensor is programmed with a threshold and the result is displayed on the LED of the relay. The LED on the relay will flash red. If the red LED is lit, it indicates that the threshold has been reached. As soon as the threshold is reached, the microcontroller sends a signal to the 5 V4 channel relay. Sending and sending signals to the power supply to open the solenoid valve that supplies water from the water tank to the line connected to the system. While the system is being watered, the humidity sensor determines if its limits are being met and a small controller signals the gearbox. The transmission receives the signal and turns off the power. This measured moisture content is then sent to the mobile application, allowing the user to see real-time moisture and plant photo.

The camera module used is the inexpensive 0.3V CMOS OV7670. This mobile application is integrated with a 2-step verification for security purpose of user's data in which when the user logins he has to verify his account by the OTP generated that is sent to his mail which is valid for 2 minutes.

3.1.1 Product Perspective

In view of its composition, the 2 electrodes of the soil moisture sense and accordingly the system works and camera takes the image.

3.1.2 Product Functions

Its major function is to measure soil moisture and camera module to take pictures of the plant and application to check that.

3.1.3 User Characteristics

3.1.3.1 Large Organizations

When fully developed, the system can be used as part of the office, houses, and gardens.

3.1.4 Design and Implementation Constraints

Determine the imperatives that can be enforced by various models, confines of equipment, etc.

- Standards Compliance

3.1.5 Assumptions and Dependencies

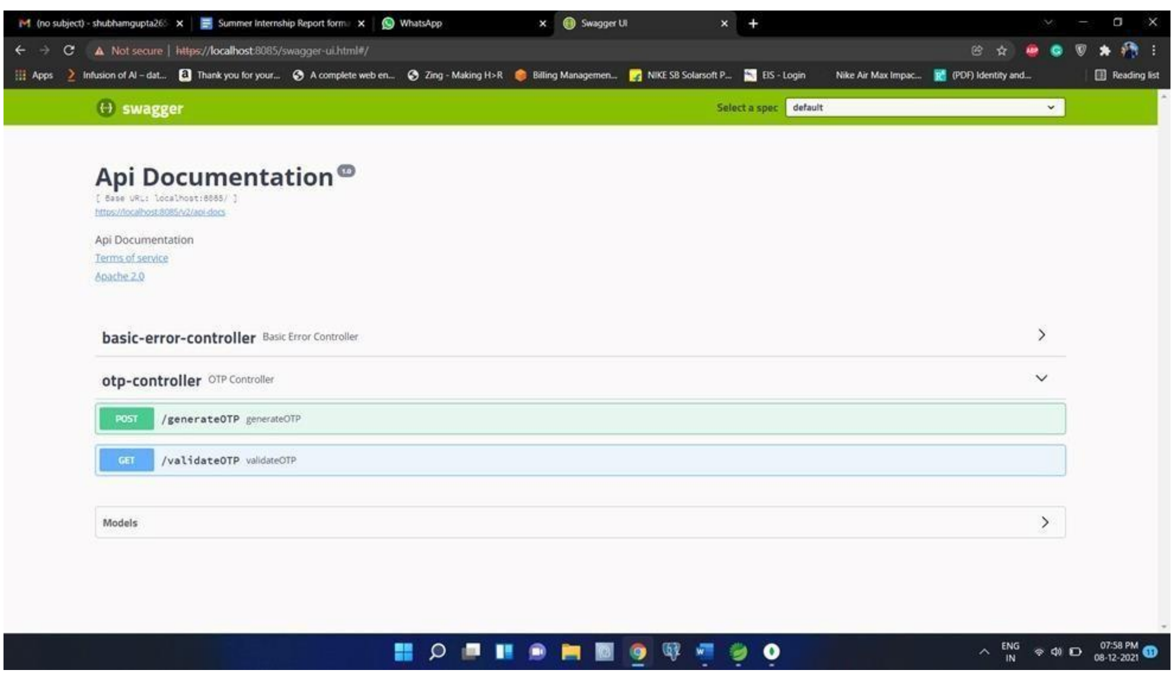
- There should be Internet service.

- The device's operating system should be up to date.
- There should be proper power supply.
- Water supply should also be proper.
- Sensor should be maintained properly and replaced is not working.

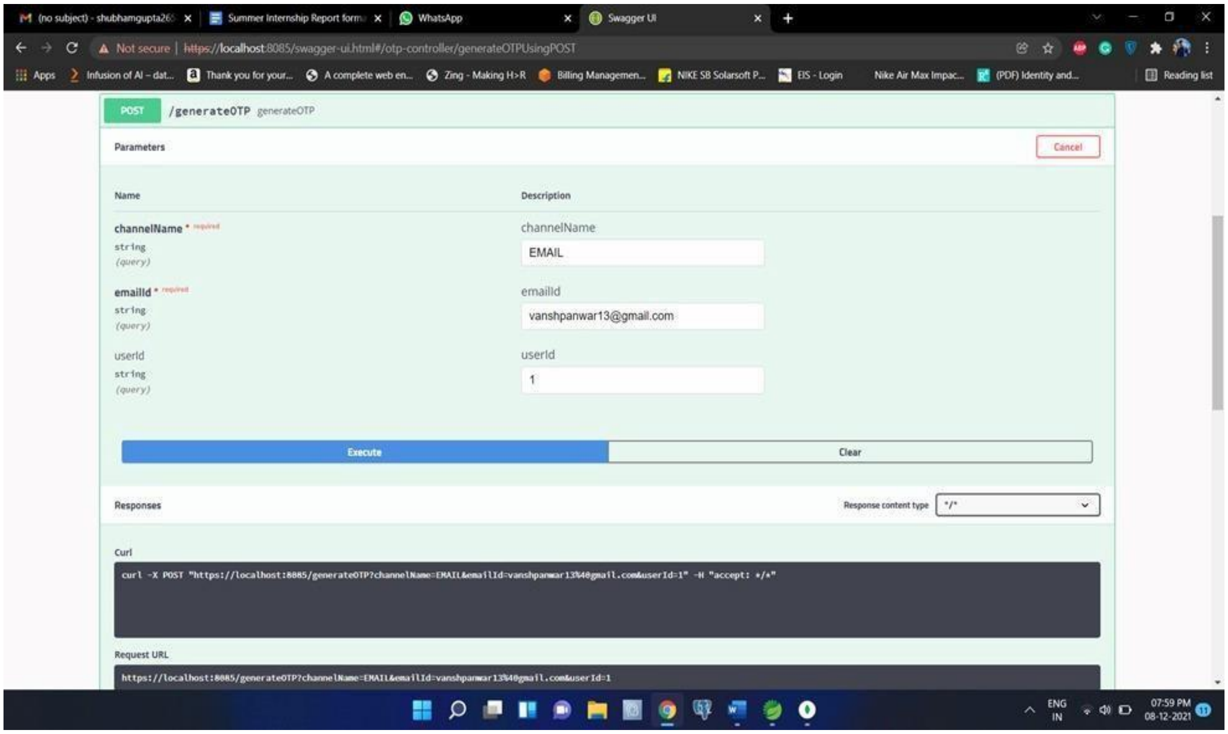
3.1.6 Project Security

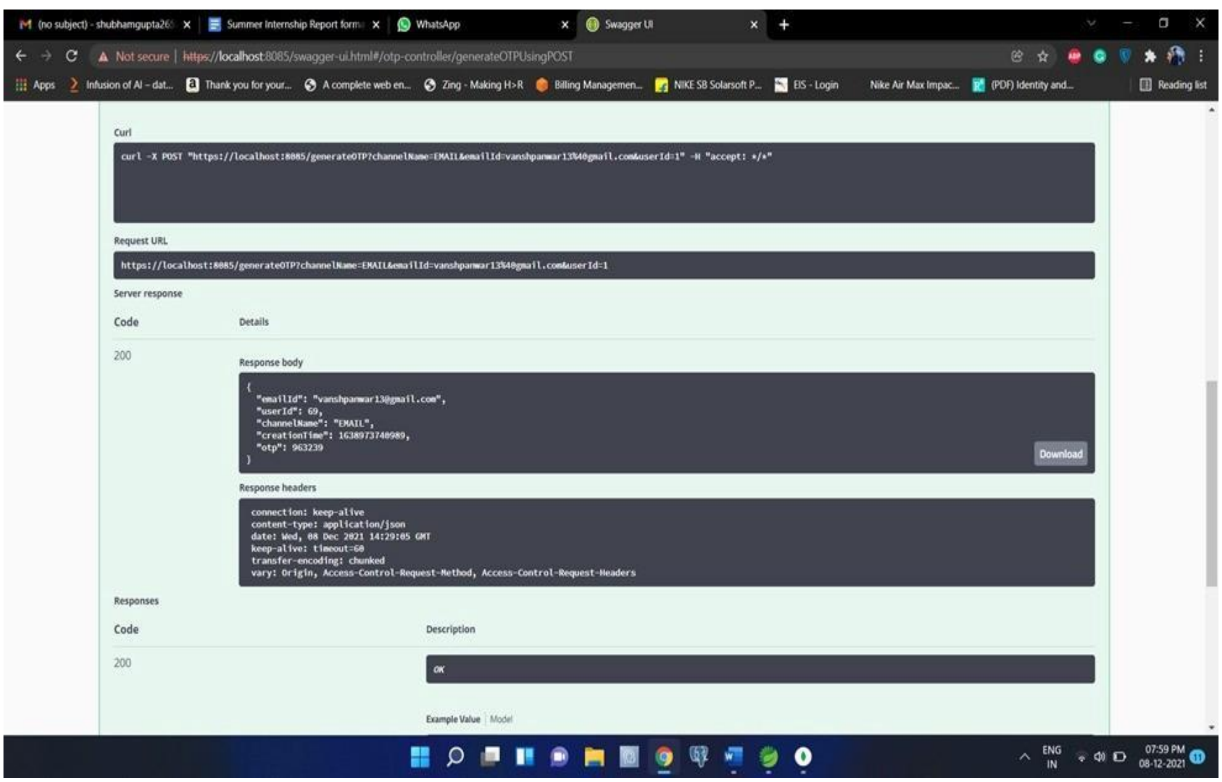
In this IoT based smart monitoring system, security is a major concern in the whole IoT system. The application that we have developed is having a login page as the first UI in which after the successful login of the user we have asked the user for a 2-step verification in which we have developed an API for OTP verification in which an OTP will be sent to the user email id with the help of java mail sender library. The generated OTP will be valid for 2 minutes i.e., OTP will expire after 2 minutes from the generation time which will be taken from the current system time. Also, if the user has generated an OTP, he/she cannot regenerate the OTP in the time span of 60 seconds. If the user enters the wrong OTP, it shows OTP is invalid. Also, we have made log files of all the users that try to enter the system, whole data is being recorded in the logger. This user data is being stored in the database along with the OTP generated for a particular user. The database used in this system is MongoDB.

API UI:

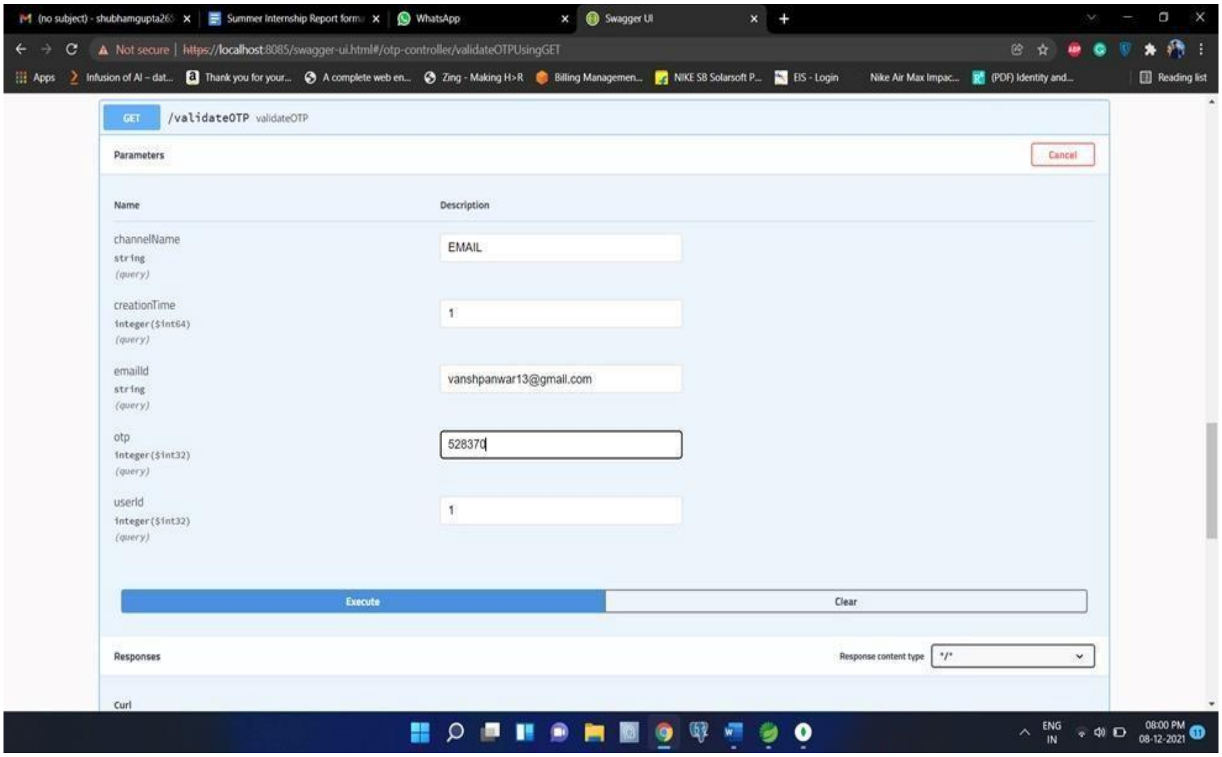


Generate OTP:

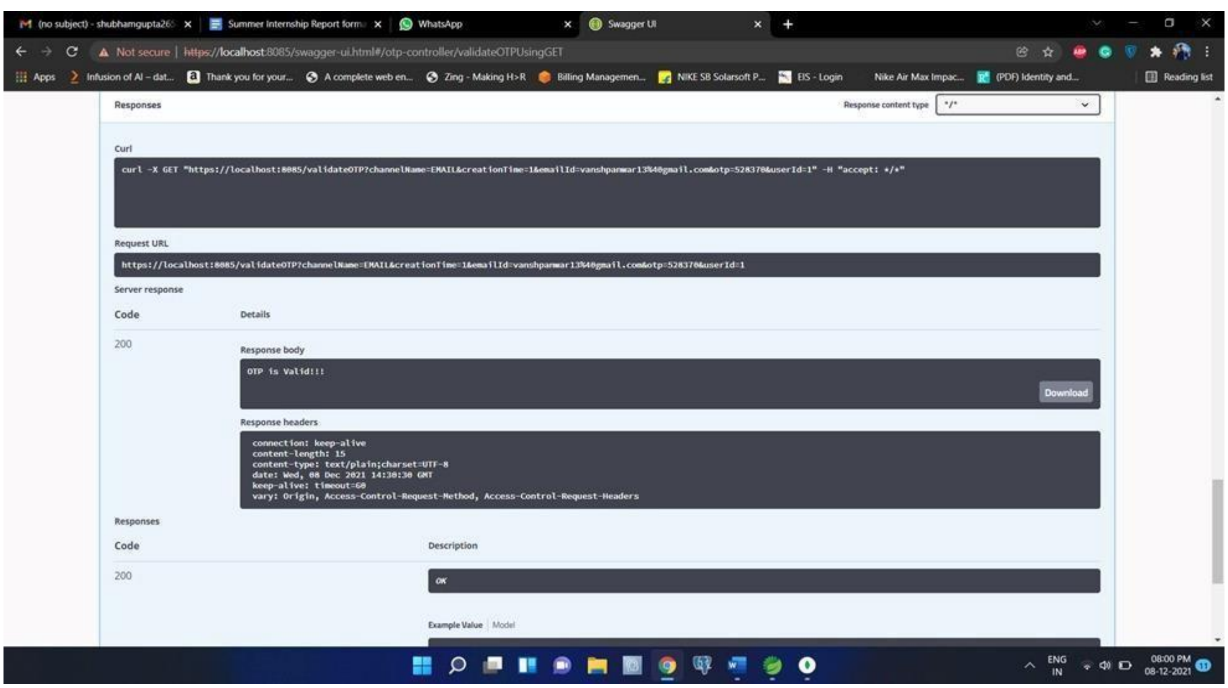




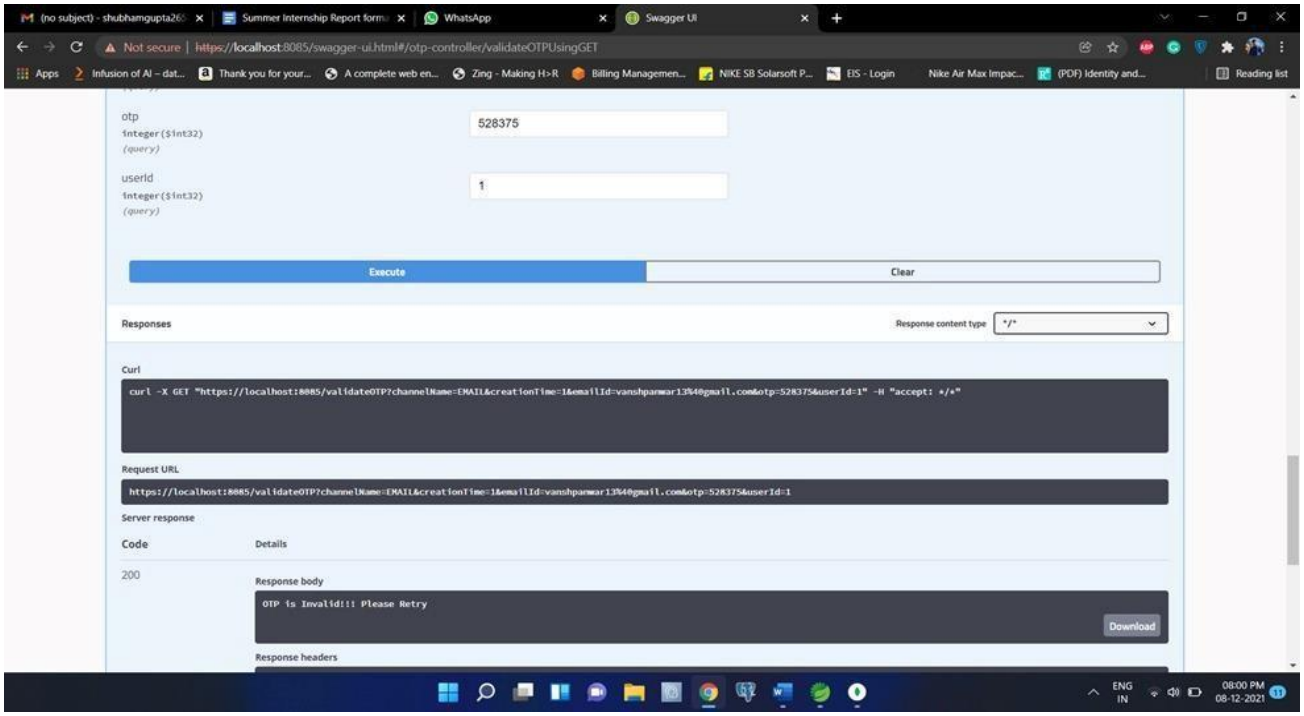
Validate OTP:



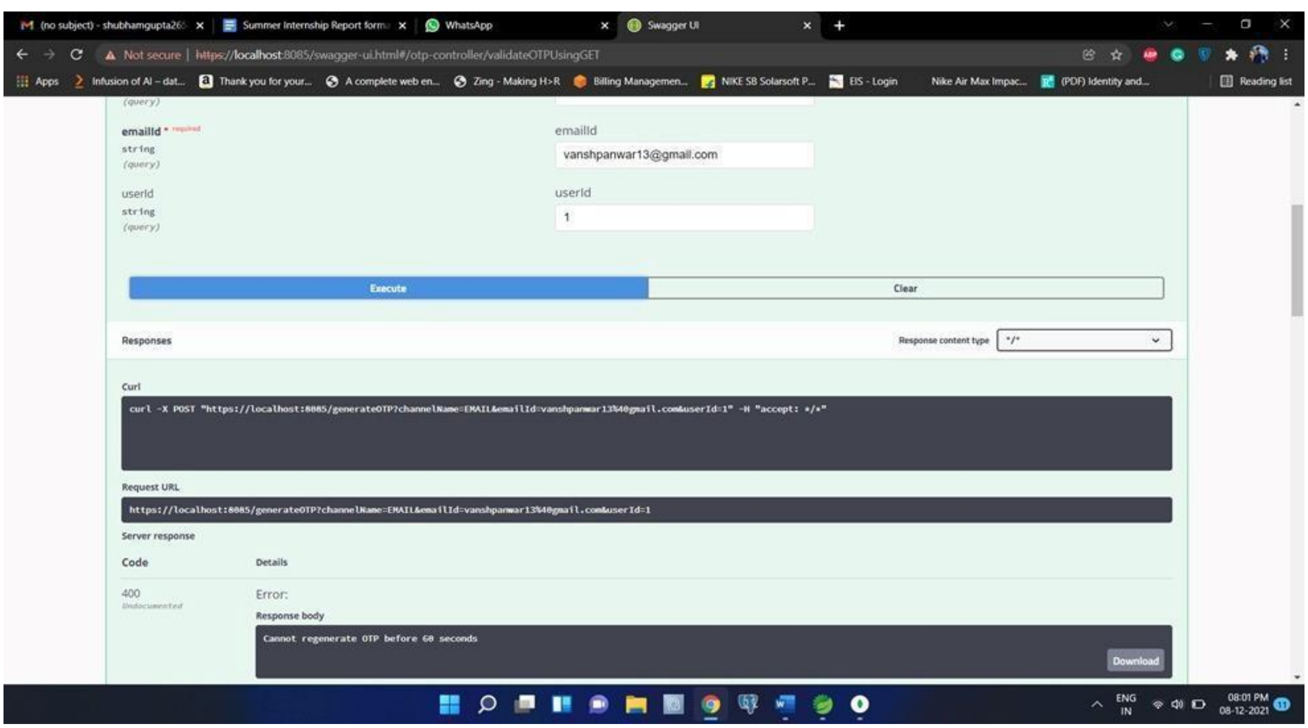
OTP is Valid:



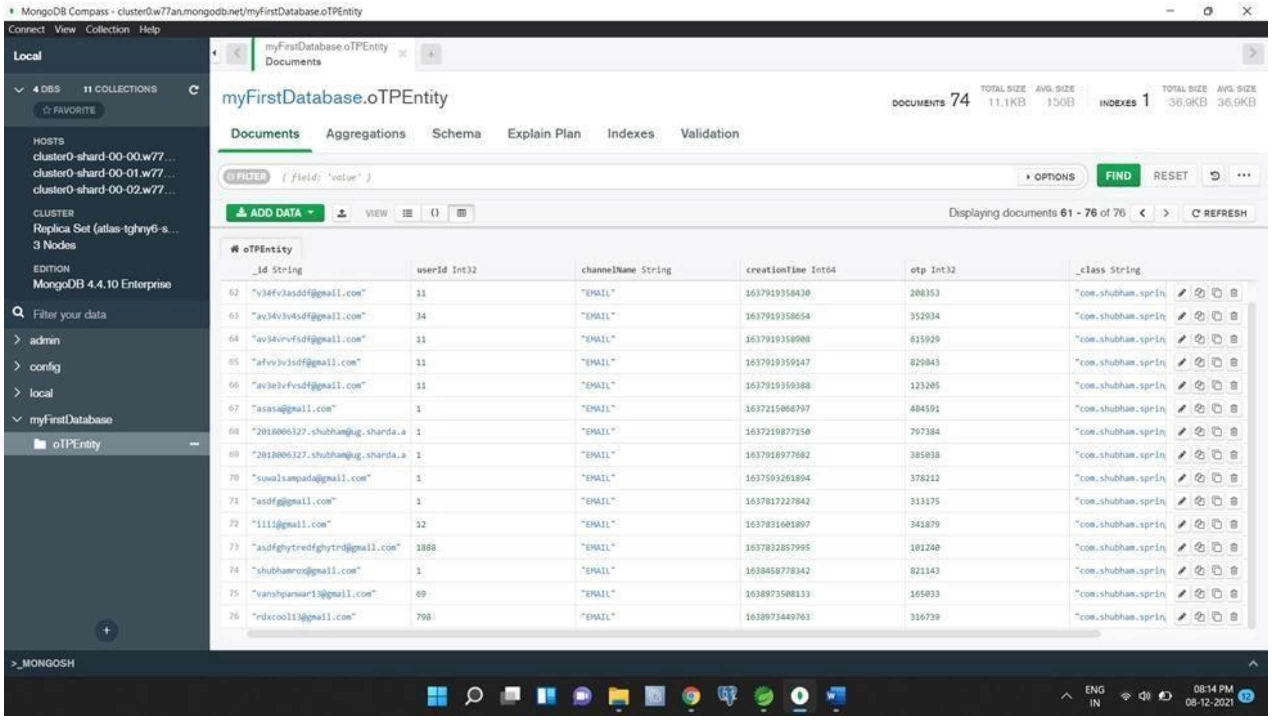
OTP is Invalid:



Cannot regenerate OTP before 60 seconds:



MongoDB Database:



3.2 Flowcharts/DFDs/ERDs

3.2.1 Case Diagram

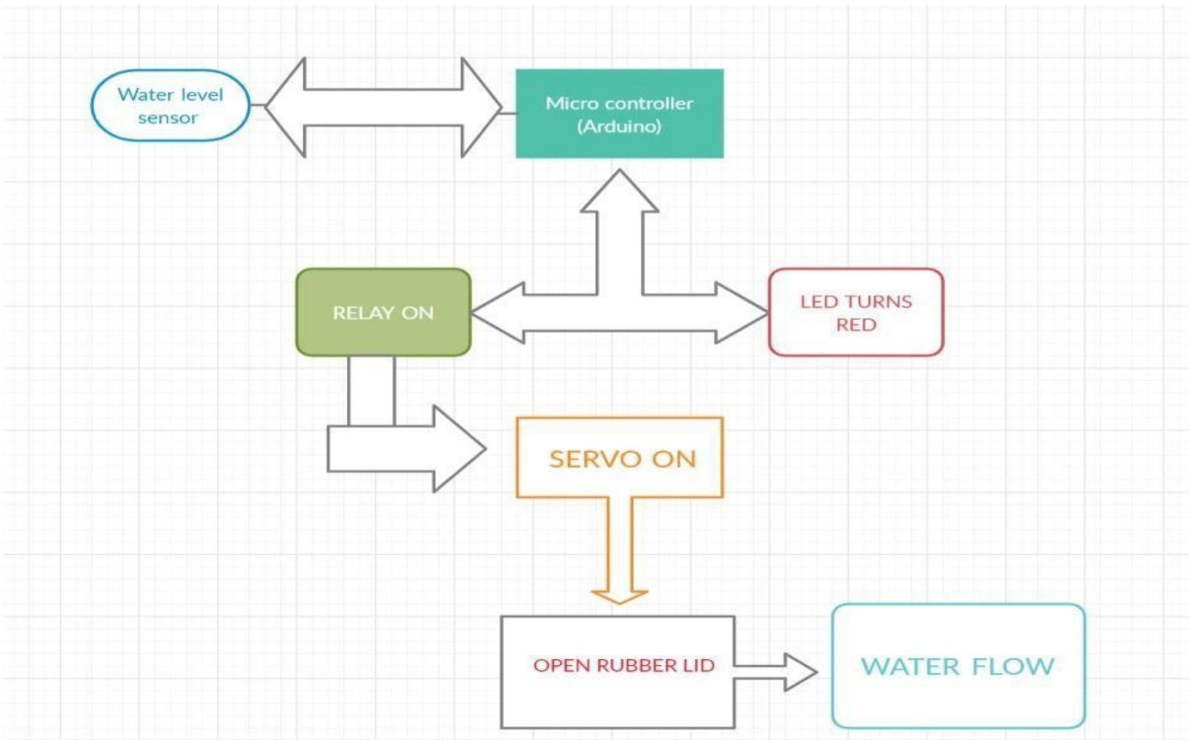


Fig 4 Case Diagram of proposed system

3.2.2 DFDs

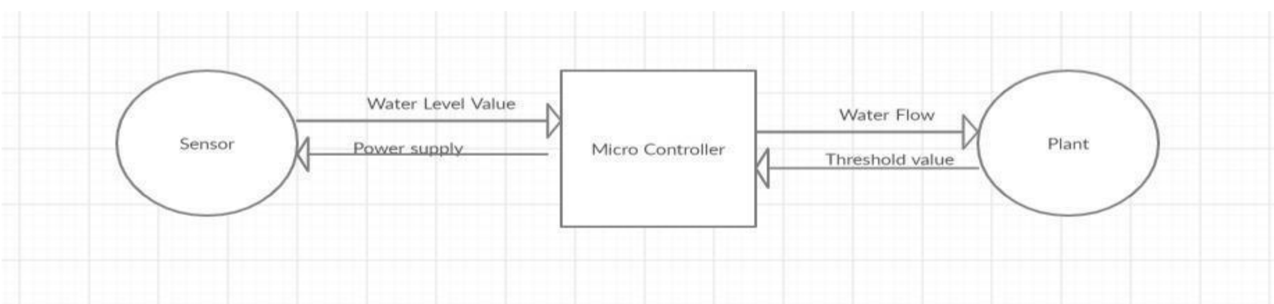


Fig 5 DFD Level 0

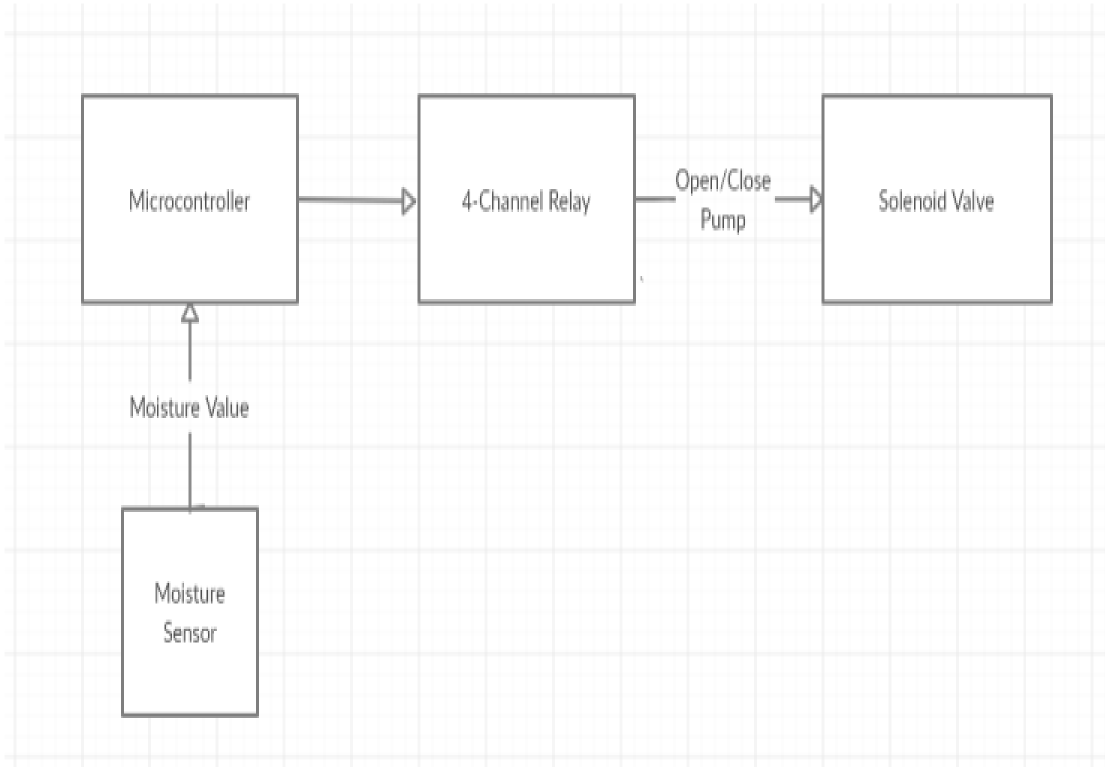


Fig 6 DFD Level 1

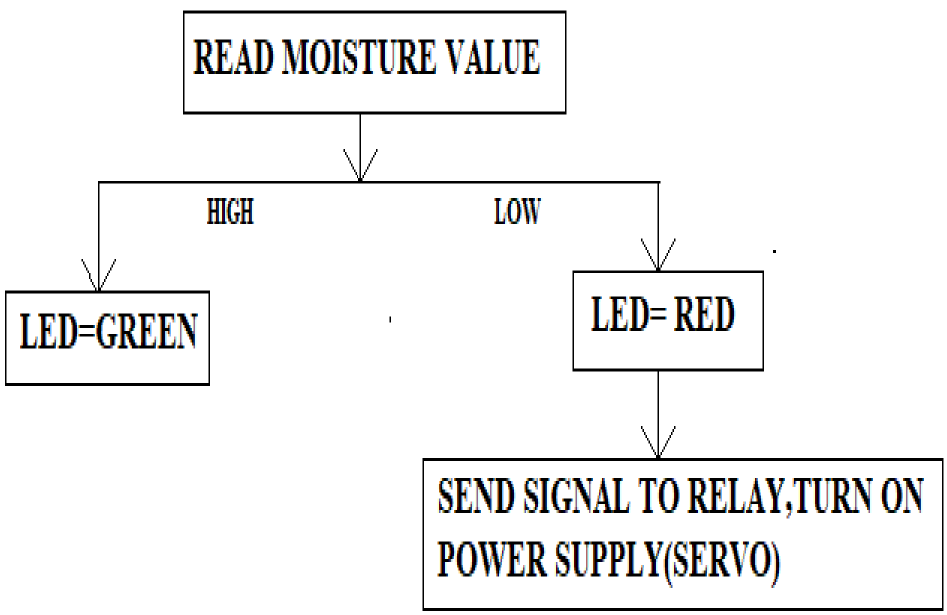


Fig 7 DFD Level 2

3.3 Design and Test Steps/Criteria

The components utilized in this project are listed below, along with a brief explanation, as stated in the preceding sections. The effective completion of the project is dependent on the implementation of the supplied components. Moisture Sensor (SEN13322), ESP microcontroller, 5V 4-Channel Relay, Jumper wires, Stopper, and Camera Module are among the components utilized (OV7670). Figure 6 depicts the integrated project with hardware/components.

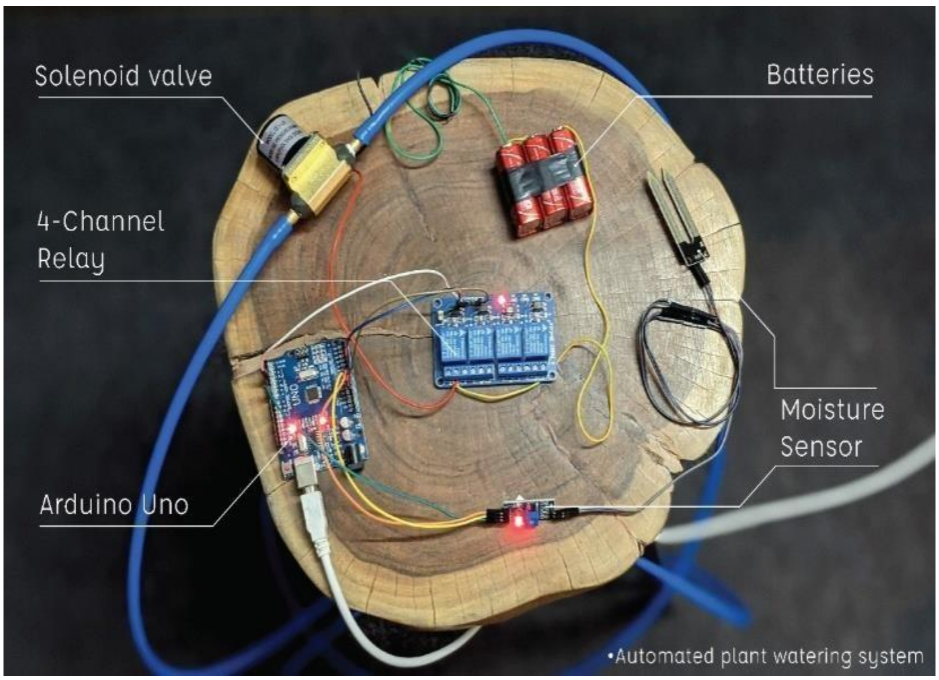


Fig 8 Connected System

3.3.1 Process Model

A process is grouped into a model of the same kind by the Process Model. As a consequence, a model describes a mechanism on a type-level basis. Even though, paradigm has now reached the type stage, it is still a process of instantiation. The same method model is often used to create multiple iterations and has various instantiations. A system model should be used to prescribe how tasks can be carried out concerning the currently taking place.

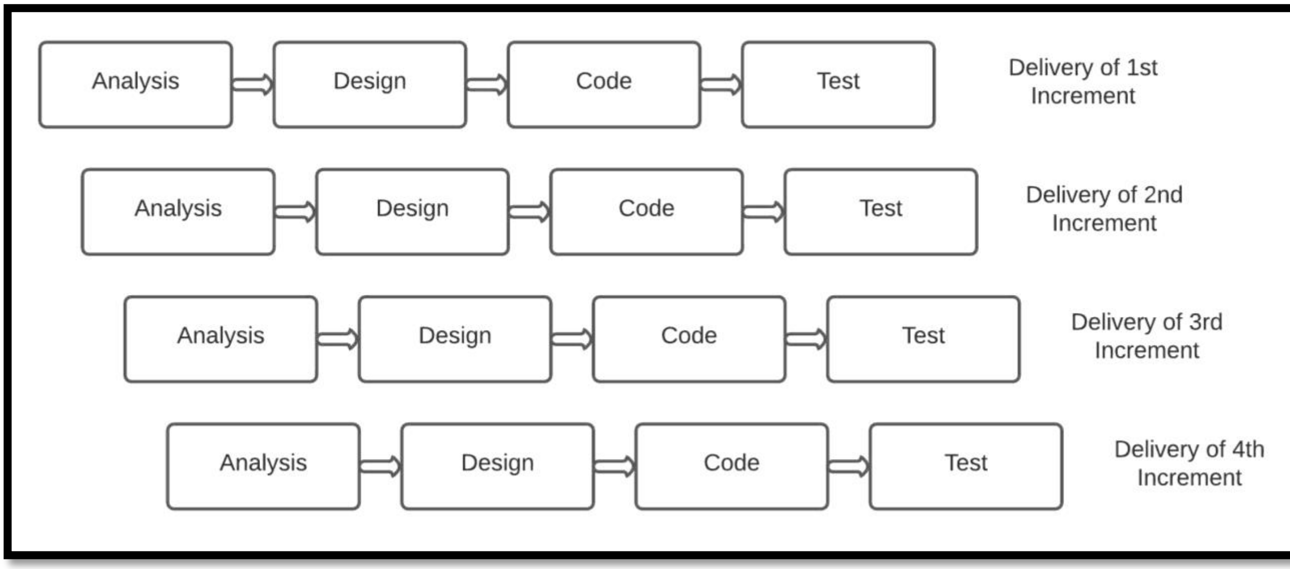


Fig 9 Process Model

The objective of a model is as follows:

- **Descriptive:**
    1. Keep track of what occurs during a procedure.
    2. Consider an outside expert's perspective who examines how an operation is carried out and determines whether changes are to be made to make it more successful or reliable.

- **Prescriptive:**
    1. Definition of the procedures needed including how they're being performed.

- **Explanatory:**
    1. Provide details on the rationale behind such methods.
    2. Centered on logical reasoning, analyse and compare various potential courses of action.
    3. Make a strong connection between both the procedures and the standards which that model wouldmeet.
    4. Also, before the the positions at which tracking data can be obtained.

3.3.1.1 Incremental Model

The loop model in our method is seen as an incremental solution. (Pictured) On the basis of the design and implementation of the project is chosen the S/w engineering process model. We have chosen an IncrementalModel for our project.

A small collection of specifications is enforced easily and distributed to the authority/customer using the Incremental model.

- Changed & extended demands can be added step by step.
- It combines elements with the iterative prototyping theory of the linear sequential paradigm.
- A deliverable increment of the S/w is generated by each linear sequence.
- The Linear Sequence is divided into four sections: -

1. **Analysis:** Device & software specifications are reported and reviewed.
2. **Design:** Includes four software attributes: Data structure, S/w Architecture, representation of theinterface & procedural information.
3. **Coding:** This step is used to convert the design into machine code.
4. **Testing:** Works with S/w logical internals and guarantees that all declarations are right to detect allsecret errors.

Advantages of Incremental Model:

- Generates S/w function rapidly & early during the life cycle.
- More versatile & less expensive for changing specifications.
- Easier for checking & debugging
- Customers will react to each designed product.

Why is the Incremental Approach used?

In order to boost the project's performance and usability, the key aim of using the model is to add additional features to the current modules. Using this model, we will adapt to changing consumer needs, which helps toexpand the project in a very short period. The next increment in the previous raise incorporates input from consumers and several extra requirements. The process is replicated before the project is completed.

Characteristics of Incremental Model:

1. These models allow the rapid implementation and delivery of a new set of industry requirements toclients and then updating and expanding functionality step by step.
2. Each increment generates the commodity sent to the consumer and proposes certain adjustments andincrements that differ with certain extra criteria compared to previous ones.
3. The radical model prevents the initiative from being completed all at once. This is useful for designing and checking components, enabling the project to be modularized for easier management.

Ultimately, the growth of the project in increments is easier. We will create a working prototype form 1 with only core tasks and then in subsequent increments, expand on this layout. By splitting the entire system into separate priority groups, this will serve to reduce system complexity.

3.3.2 Breakdown Structure (Modules Analysis)

- **Communication:**

The phase of product creation begins with user and developer interactions and the requirements of the world. We also gathered the project-related specifications according to work requirements.

- **System Design:**

A process model that is used in the implementation of the system. This activity also determines the Breakdown Structure (Modules). In the Breakdown Structure, various components used in the frameworkare shown.

- **Project Planning:**

Full calculation and timing of the entire time line diagram for project development and for monitoring are included. Tasks are often expected to identify tools, time line, and other details relevant to the project.

- **Modeling (Analysis & Design):**

It entails thorough review of specifications and project planning. In the analysis of demands, system analysis is done in accordance with customer requirements and what the start of the system will be in which direction it moves and what the destination will be is provided by the analysis process. In architecture, device design takes place according to research.

3.3.2 Requirements for the system

3.3.2.1 Moisture Sensor (SEN13322)

The volumetric content of water in the soil moisture sensor is measured using two probes. Current can pass through the soil thanks to the two probes, and the resistance value is utilised to compute the moisture content. The soil sensor used in the experiment is shown in Figure 10.

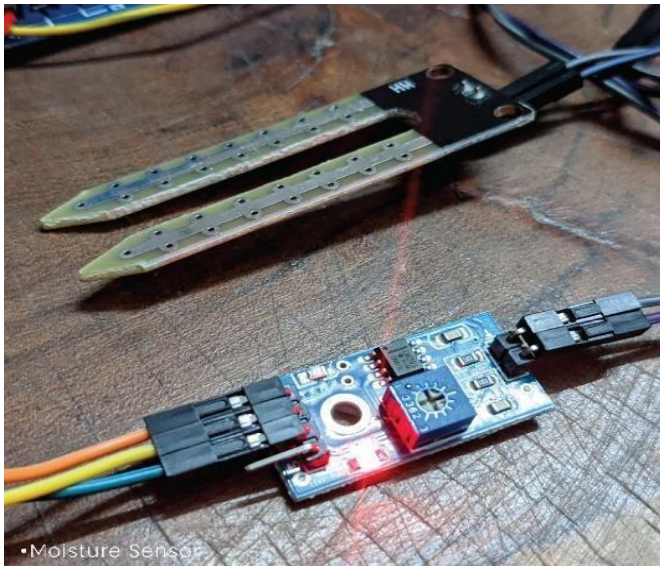


Fig 10 Soil Moisture Sensor

3.3.2.2 Arduino UNO

The Arduino Uno microcontroller board uses the ATmega328P CPU (datasheet). On this board, you'll find 14 digital input/output pins, 6 analogue inputs, a 16 MHz ceramic resonator, a USB connector, a power jack, an ICSP header, and a reset button. The kit includes everything you'll need to get started with the microcontroller. Figure 11 depicts the Arduino Board.

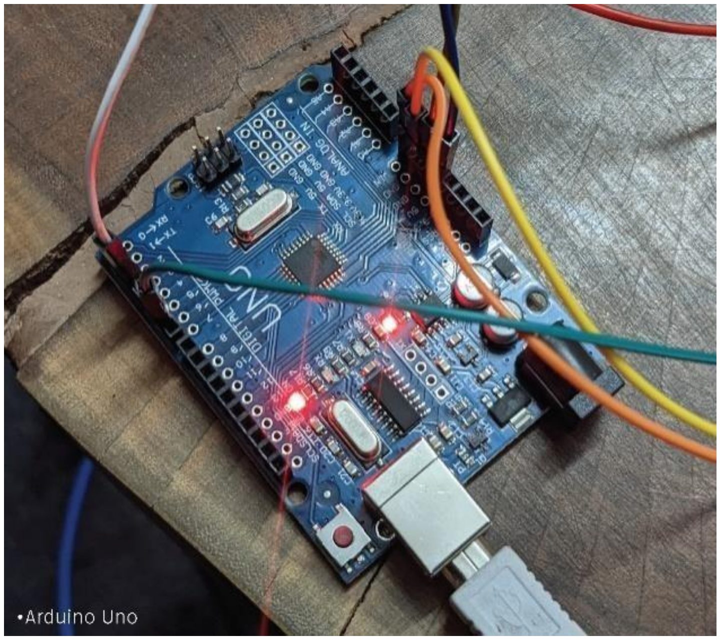


Fig 11 Arduino UNO Board

3.3.2.3 5V 4-Channel Relay

Relays are electrical and electromechanical switches that are used to close and open circuits. It controls how an electrical circuit's circuit connections open and close. Figure 12 depicts the relay.

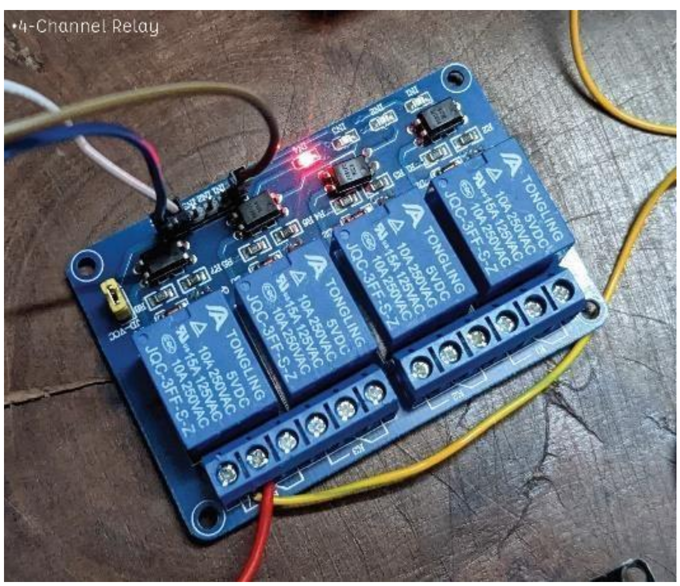


Fig 12 4-V Channel Relay

3.3.2.4 Solenoid Valve

A solenoid valve is an electrically controlled valve. Solenoid valves differ in the properties of the electric current they utilize, the intensity of the magnetic field they create, the mechanism they use to direct the fluid, and the type and qualities of fluid they control. Figure 13 depicts a solenoid valve.

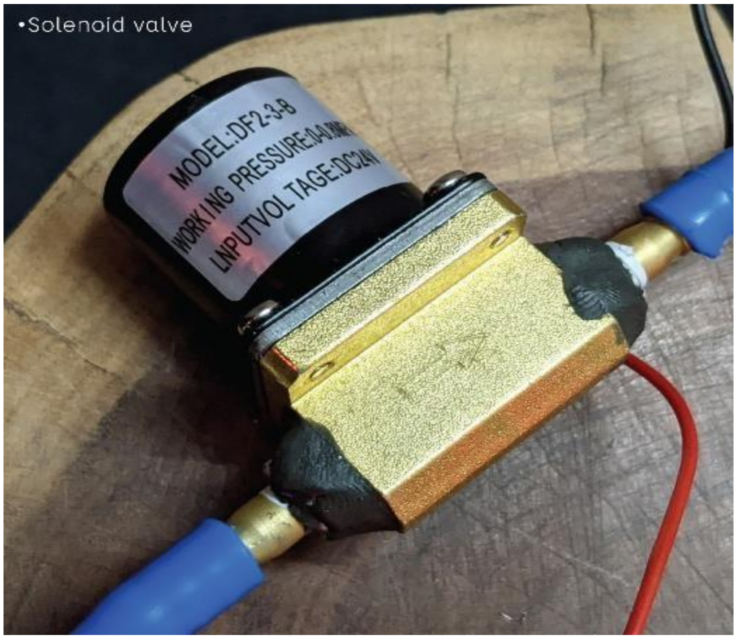


Fig 13 Solenoid Valve

3.3.2.5 Power Supply

A battery is a device that uses one or more electrochemical cells with external connections to power electrical equipment. In this project three 9V batteries are used in series. Fig 14.

Fig 14 Batteries

3.3.2.6 Camera Module

The OV7670 Camera Module is used to provide the real-time picture of the plant when the user wants to see his/her plant. Camera module is shown below in Fig 12.

Fig 15(a) Camera Module

Fig 15(b) Camera Module

3.3 Algorithms and Pseudo Code

The following is an overview of the different development measures that have been taken to achieve the ultimate aim of our project.

Input: Soil Moisture Content
Output: Water Supply and Image of Plant

Phase 1: Starting the power supply

Phase 2: Put the sensor probes in plant soil

Phase 3: Sensor senses the moisture content in the soil

Phase 4: This data is sent to the microcontroller

Phase 5: Microcontroller sends this data further to the relay

Phase 6: Relay then sends signal to open the valve and water starts to flow from servo motor

Phase 7: Water is supplied to the plant and gets auto cut-off

Phase 8: Sends photo of plant to computer/application

Phase 9: Turn off the system

Module 2:

In this phase we have a mobile application in which we have a login screen and then after login the user has to verify his account with an OTP verification which is send to his email.

Implementation: -

Code:

```
int water;                    //random
variable

 void setup()

{
pinMode(3,OUTPUT);       //output pin for relay board, this will send signal to
the relay pinMode(6,INPUT);       //input pin coming from soil moisture sensor
```

```
}

void loop()

 {
water = digitalRead(6);    // reading the incoming signal from the soil moisture
sensor

if(water == HIGH)          // if water level is full then cut off the relay
{
digitalWrite(3,LOW);       // if low then cut off the relay
}

else

{
digitalWrite(3,HIGH);      //if high then water is supplied
}

delay(400);
}
```

3.4 Testing Process

3.4.1 Software Testing

3.4.1.1 Introduction: -

The role of software testing is to ensure that programmes are efficient and accurate. Software testing is an observational science investigation conducted to provide consumers with information regarding a product's quality in the environment in which it is intended to function. This can include but is not limited to running a programme or application to detect errors.

3.4.2 Unit Testing: -

In this case, each module is evaluated independently. The standards for defining unit test modules were selected to identify modules that have key functionality. A module may be either an individual or a method.

The unit testing functions that will be tested are as follows:

Choose the handwritten document's scanned input image.

- Preprocessing can be used.
- Make use of segmentation.
- We are using Feature Extraction to extract features.
- Take out a digital character.

3.4.3 Integration Testing: -

During integration planning, relevant components are integrated and analyzed as a group. Integration testing takes unit-tested pieces, such as data, and organizes them into bigger aggregates, then applies integration test plan tests to those aggregates to create the integrated testing framework.

3.4.4 Validation Testing: -

At the start or end of the production process, this approach is used to determine if the software satisfies the specified specifications.

3.4.5 GUI Testing: -

The practise of reviewing a product's graphical user interface to check that it meets standards, such as maintaining navigation between icons/buttons with source code, is known as GUI testing.

Test Cases: -

Use Case ID	1
Test Case Name	Check Water Supply
Test Case Description	Soil Moisture is measured and accordingly water is supplied.
Steps	1. Turn on system 2. Measure soil moisture
Expected Results	Water Supplied
Actual Results	As expected

Use Case ID	2
Test Case Name	Take Plant photo
Test Case Description	The camera module should take a photo of the plant.
Steps	1. Turn on system 2.Take plant photo
Expected Results	Photo taken
Actual Results	As expected

Chapter 4: Results/Outputs

Following the development of the project, it is put to the test on a plant with real-time input. It was tested when there was no water in the soil and when there was water in the soil to see how the project performed. When the moisture was measured, the information was transferred to the mobile app, where the user could view the moisture as well as a picture of the plant.

The given picture in the below figure shows the plant and the soil moisture sensor dipped in the soil when there is no moisture in the soil. Then after measuring the moisture content and the input in provided to the microcontroller the water is supplied.

Fig 16 Pot without Water (System ON)

In this step, the microcontroller detects the input and accordingly the output is provided to the relay and the water is supplied to the plant from the pipe through the solenoid valve and the plant is watered as shown in the below picture.

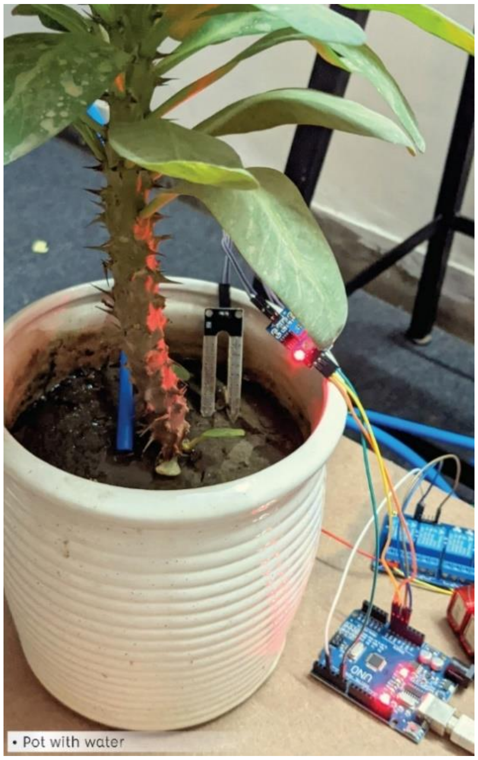


Fig 17 Pot with Water (System ON)

As you can see in the below picture, a closeup on to the soil, water is present in the plant as when soil moisture starts to measure the water content and as the water content in the soil gets low, water is supplied again through the pipe from the solenoid valve.

Fig 18 Pot with Water (Close look)

Here below we can see that the camera module has taken a photo of the plant when the system was not turned on.

Fig 19 Image by camera module (without water)

Here below we can see that when the water is supplied to the plant the camera has taken a photo of the plant.

Fig 20 Image taken by camera module (With water)

Chapter 5: Conclusion

The goal of this project is to create an Automated Plant Watering System that monitors the moisture level of the plant's soil and supplies water based on that moisture content via a solenoid valve. The work focuses on monitoring moisture, feeding it into a microcontroller, and the outputting it to a 5V 4-Channel Relay. The finest of the algorithms operating in the domain of plant monitoring systems were evaluated during the creation of this product. The main goal was to find an algorithm that would provide us a decent balance of processing time and water supply to the facility. The picture and moisture content that is measured are made available to the user through a login-based mobile application, where the data is saved and the user may see real-time data. This proposed project is designed to assist farmers in making their produce more profitable by assisting them with security, travel, college, and other needs. Water waste and motor power consumption can be minimized as a result of this effort, allowing them to be saved for future use. This system delivers comprehensive sensor monitoring activity in fields that is extremely simple to control. It also gives the plants a lot of protection. Finally, proposals for further changes to this system were made.

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