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RÉPUBLIQUE ALGÉRIENNE DÉMOCRATIQUE ET POPULAIRE

وزارة التــــــــــــــــــــــــــــــــعـليـم العـــــــالي والبـــــــــحث العـــــلـمـــي

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sujet

Efficient Smart Irrigation System Using Wireless Communication

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Belaiba

Belazzoug

Bentouila

Abstract

In this thesis, we have a prototype of an intelligent remote irrigation system, based on IoT technology, To achieve this work, we used compatible sensors and actuators to control where information is processed and displayed by the ESP32 microcontroller which is connected by “Cloud” website which we programmed on PC computer and LCD display.

The objective of the project is to study the implementation of an agricultural project with high quantitative and qualitative efficiency in terms of ease and precision of controlling the needs of agricultural plants while rationalizing the consumption of water resources, in addition a saving of time and physical resources and material effort for the farmer thanks to the automatic and manual remote control system by computer or telephone as well as the compensation of the costs of electricity production using solar energy.

Keywords: Smart Irrigation, ESP 32, Solar Energy, Internet of Things, VSC

Résume:

Dans ce travail, nous avons un prototype d'un système intelligent d'irrigation à distance, basé sur la technologie IoT, Pour réaliser ce travail, nous avons Utilisé des capteurs et des actionneurs compatibles pour contrôler où les informations sont traitées et affichées par le microcontrôleur ESP32 qui est connecté par site Web « Cloud » que nous avons programmé Sur un ordinateur PC et d'affichage LCD.

L'objectif du projet est d'étudier la mise en place d'un projet agricole à haute efficacité quantitative et qualitative en termes de facilité et de précision de contrôle des besoins des plantes agricoles tout en rationalisant la consommation des ressources en eau, en plus d'un gain de temps et de ressources physiques et effort matériel pour l'agriculteur grâce au système de contrôle automatique et manuel à distance par ordinateur ou téléphone ainsi que la compensation des coûts de production d'électricité en utilisant l'énergie solaire.

Mots clés: Irrigation intelligente, ESP 32, Energie solaire, Internet des objets, VSC.

ملخص:

قمنا في هذا العمل بتجسيد نموذج مصغر لنظام سقي ذكي عن بعد يعتمد على تقنية إنترنت الأشياء لتنفيذ هذا العمل، استخدمنا أجهزة الاستشعار والمحركات المتوافقة للتحكم حيث تتم معالجة و عرض المعلومات عن طريق وحدة التحكم المتمثلة في ESP32 الموصول Site Web "Cloud" الذي برمجناه على حاسوب ولوحة العرض LCD.

الهدف من المشروع هو دراسة إنشاء مشروع زراعي ذو كفاءة عالية كما و نوعا من حيث سهولة ودقة التحكم في احتياجات النباتات الزراعية مع ترشيد استهلاك الموارد المائية، بالإضافة إلى توفير الوقت و الجهد البدني و المادي للفلاح بفضل نظام التحكم الأوتوماتيكي و اليدوي عن بعد بالحاسوب أو الهاتف الذكي وكذا تعويض تكاليف توليد الكهرباء باستغلال الطاقة الشمسية.

كلمات مفتاحيه: السقي الآلي, ESP32, طاقة الشمسية, إنترنت الأشياء.

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General Introduction

General Introduction

The water scarcity crisis that the world is facing today is the biggest in modern history the need for an effective water management for agriculture is at peak natural disasters and global warming get worst by year thus water resources.

Our smart irrigation system is designed to monitor corps growth by employing a wireless network of sensors to send soil moisture data temperature and humidity and control the water flow

In this thesis we try automating the process for farmers will improve the productivity and allow a better management, integrating power saving features will reduce cost this features will change lives if they get implemented correctly, Our smart irrigation system includes a user friendly interface so anyone can use it and give it a try

This dissertation is structured into three chapters: The first chapter presents the solution for the water problem of Smart Irrigation in the face of the global water crisis and we can use different types of hardware and software in this work in the second chapter and the third chapter we can make the design and the Realization of an intelligent system of the management of irrigation.

The thesis ends with a general final conclusion, perspective, and bibliographical references.

Chapter I:

Smart irrigation in the face of the global water crises

I. 1 Introduction

The amount of fresh water readily available to people around the world has declined and Continue to decline due to a number of factors including population growth, water pollution, global climate change, planning and inadequate management of transnational waters and ineffective water management. Supply and distribution systems. Consequently, the likelihood of water shortages, crises and related conflicts increases globally in the coming years, especially in developing and less developed regions. The issues surrounding water-related conflicts and disasters are numerous, complex and pose significant challenges. In order to effectively address these issues, new ways of thinking, development and implementation of planning and management practices of water usage, as well as a clear understanding of future water availability and demand, are needed.

So we will talk in this chapter Primary Part on the global water crisis and second Part on Presentation of different irrigation systems.

I. 2 Primary part: The global water crisis

I. 2. 1 Overview of the global water crisis

Water is the most important natural resources. Agricultural is the main consumer of water resources 75% to be priciest. We need an efficient water management using the latest technologies to monitor corps and plants [1].

I. 2. 2 The global water crisis in numbers:

The global scale of water withdrawals has increased about nine times .By continent, water withdrawals have increased, Five times in Asia and Africa.

Despite the current population and the number of factories and their consumption of water. Agriculture is the main consumer of water, reaching 90% in 1950 and more than 80% today [2]

I. 2. 3 The main causes:

The current water crisis has many deep roots, which ultimately affect everything from crops to public health, among these issues:

a. **Climate change :**

Climate, spatial and temporal variability of precipitation affects agriculture and food security

b. **Water shortage :**

Competition for water resources between industries, regions and nations is already taking place.

Natural disasters, hurricanes, earthquakes and floods cause disruption and pollution of water supplies [3]

I. 2. 4 How to deal with the global water crisis:

One of the concerns currently facing the world is whether we will have the amount of water needed in 2050 to provide it to 9 billion people. What are the proposed solutions?

I. 2. 4. 1 Solution related to watering and irrigation techniques:

a) Watering your garden more efficiently :

When water becomes a scarce resource, it is imperative to protect it. There are still many gardeners who cultivate their land poorly. The garden blooms every three days throughout the summer, so we have to adapt our habits. Requirements are about 6 liters per square meter each day.

To avoid evaporation, we must bring the water closer to the plants to improve the watering process and save on the water bill

b) Choosing the right type of soil :

When designing and managing an irrigation system, the type of soil must be considered. A sand with only 5% of its weight in organic matter will yield water. On the other hand, soil rich in limestone can contain nearly 30%. This amount of retained water has a direct impact on the frequency of irrigation. For example, a clay will have enough water in reserve during the dry season to provide a crop for a month.

c) Analysis of green spaces :

A precise analysis of the many zones of green space is crucial for its good conceptualization. The most efficient irrigation systems divide the land into different irrigation zones that correspond to different types of plants with different water needs. Each of these vegetation forms has different water requirements and should be treated as a separate entity. Watering requirements are also influenced by differences in sunlight (shaded area or full sun).

More water is often needed to keep grass and many other plants healthy. Green space can be divided into multiple zones without imposing water requirements on all vegetation or providing excessive water to mountains and trees, reducing overall water consumption [4].

I. 2. 4. 2 Solution related to daily household use:

Globally, industry and agriculture have made significant progress in containing their growing water needs. It is only now that household consumption continues to increase.

a) The flow limiter :

It is necessary to reduce the diameter of the water passage. The hydraulic deficit is reduced by 50 to 60% with the current equivalent pressure.

Figure I- 1: Flow limiter

b) The garden sprayer :

The principle of the garden sprayer is the same as that of the reducer. It also allows the water jet to be aerated, which limits the actual flow rate by providing a feeling of equivalent power. The expected saving is around 50%.

Figure I- 2: Garden sprayer

c) The economical shower head :

The basic operation of the device involves friction between water droplets.

igure I- 3: economical shower head

d) The shower stop :

This system attaches to the base of the shower curtain, immediately after the faucet. Quite practical, it temporarily stops the flow of the shower

Figure I- 4: Temporarily stop the flow of the shower

e) The thermal mixing valve :

A more complex system that enables us to control the temperature on the one hand and the strength of the flow on the other hand, and thus the user reduces water consumption while searching for the appropriate temperature [4]

Figure I- 5: Thermal mixer

I. 3 Secondary Part: Presentation of the different irrigation systems

I. 3. 1 What is a smart irrigation system?

Smart irrigation is a method of using science and technology to save water in irrigation. It contains weather sensors, soil sensors, and various controllers. The sensor monitors the current weather conditions and the actual ground humidity, and the controller controls the solenoid valve to open or close. Using an automatic smart irrigation system. Scientific judgment on whether, when, and how much water is needed. It is suitable for water-saving management in lawns, farmland, and other areas. [5]

I. 3. 2 The different irrigation systems, the advantages and disadvantages:

The irrigation systems which can be divided into two categories are:

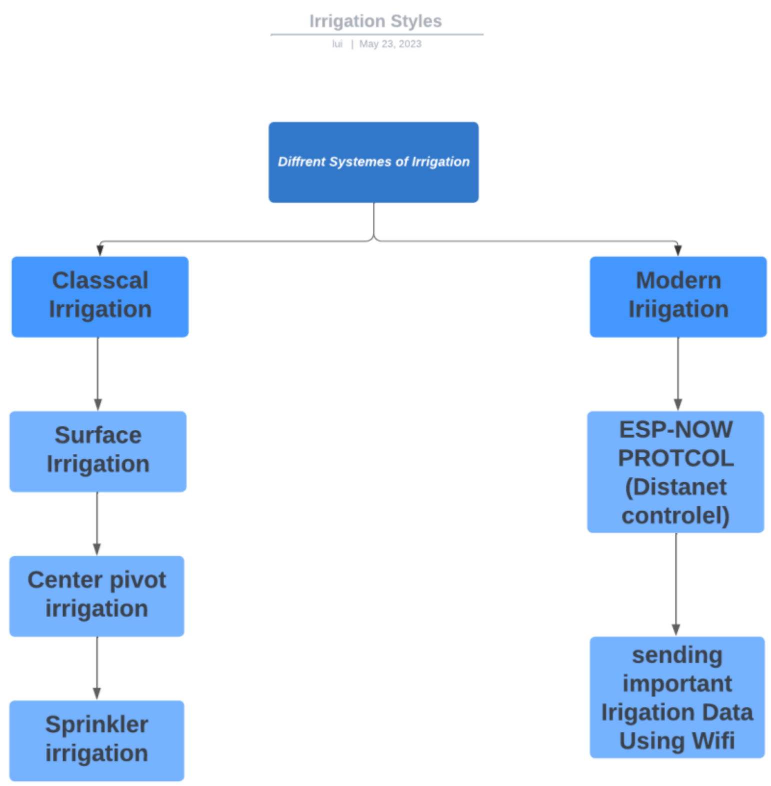


Figure I- 6: different irrigation systems

I. 3. 2.1 Classical irrigation:

Where the farmer collect water by buckets, using pumps, or with the help of animals from wells, and where it is moved and distributed in an unarranged manner.

Due to the inefficient distribution of water between plants and the high loss and waste of water in conventional irrigation methods, it is inexpensive but inefficient.

- **Surface irrigation :**

Surface irrigation Water was dispersed using channels and ribs under the influence of gravity. The pipes distribute the water to other secondary pipes in the plots. On the other hand, a lot of water evaporates since the system is not covered.

Among the advantages and disadvantages of surface irrigation [6].

advantages	Disadvantages
- good distribution of water on the "surface" - apparent ease of use - Controllable dose.	- This is the oldest method used. - Waste of water, either by evaporation or by leakage into the ground. - its effectiveness is linked to the quality of the soil Water loss

Tableau I- 1: advantages and disadvantages of surface irrigation1

So this category can do by:

- Submersion (basin irrigation).
- In soil furrows (furrow irrigation).

Figure I- 7: Surface irrigation 1

- **Pivot Irrigation**

A sprinkler irrigation method called "center pivot irrigation" involves sprinklers rotating around a pivot. The result is a circular irrigated area that produces a distinctive circular pattern in aerial views [6].

Figure I- 8: pivot Irrigation

- **Sprinkler irrigation**

This irrigation system works as part of an integrated or closed irrigation system.

The water flows through pipes buried under the plots. It is directed towards mobile pipes which distribute it among the different civilizations by sprinkler systems. It mimics light rain that does not disturb plants or young plants.

Among the advantages and disadvantages of Sprinkler irrigation [6].

advantages	disadvantages
- working monks Necessary compared to other irrigation methods - more suitable for desert areas due to the permeability of the soil,	- il réside dans le coût élevé de l'installation et d'entretien par rapport aux des autres méthodes d'irrigation

Table I - 2: Advantages and disadvantages of Sprinkler irrigation 1

So this category can do by:

- Fixed ramps.
- Mobile ramp (pivoting).

Figure I- 9: Sprinkler irrigation

- **Drop by drop Irrigation**

A drip irrigation system is the only one that can be used for micro-irrigation. This economical system only uses what the farm needs. Pay special attention to the settings, which should be as precise as possible. To avoid choking the drops one at a time, the water should be filtered, especially in areas with heavy water.

Among the advantages and disadvantages of drip irrigation [6].

advantages	disadvantages
- Time saving for farmers - respect Environmental - Optimal irrigation. - Great water savings.	- All plants receive exactly The same amount of water. - Periodic cleaning of the filters.

1 Tableau I - 3 Advantages and disadvantage ages of drop by drop Irrigation

So this category can be done by:

- A pump unit
- tubing- main/sub-mains and laterals
- Couplers
- Sprinkler head
- Other accessories such as valves, bends, plugs & risers

Figure I- 10: Drop by drop Irrigation 1

I. 3. 2. 2 Modern Irrigation

a) Distances Irrigation:

One of the approaches today is remote irrigation. It helps agriculture solve several problems by providing much convenience to farmers.

Depending on the device used, it is possible to distinguish different forms of remote irrigation:

- **ESP-NOW:**

ESP-NOW is a wireless communication protocol based on the data-link layer, which reduces the five layers of the OSI model to only one. This way, the data need not be transmitted through the network layer, the transport layer, the session layer, the presentation layer, and the application layer. Also, there is no need for packet headers or unpacks on each layer, which leads to a quick response reducing the delay caused by packet loss in congested networks [7]

Advantages:

Disadvantages:

Limited data Transmission (250 byte)

Limited usage (only specific data types can be transmitted)

I. 3. 3 Agricultural part

Irrigation is used in traditional irrigation techniques without any technical reference, and the slope is often in large quantities, resulting in large water loss and environmental degradation due to high water level irrigation and soil salinity.

The approach is based on unique field measurements of soil properties (moisture at field capacity, bulk density), Planting (root depth) to determine irrigation dose and water yield curve, Tread to determine the amount of water provided by the farmer when irrigating.

The calculation of irrigation efficiency reveals that farmers reduce the irrigation dose for plants, so we recommend improving irrigation based on smart methods and determining the suitable irrigation dose for plants and crops.

I. 3. 3. 1 The amount of water Consumed by the plants (Watering rate)

This is the amount of water needed for each irrigation to feed the plant, The role of water in plant development is complicated: it serves as a solvent for both soil minerals and compounds produced by cells, allowing them to be transported to the point of use.

As such, it can be considered a food source for plants because it is a component of living matter itself.

- **Role of Roots :**

The real organ of absorption is the root system of the plant, which requires an ideal temperature, sufficient aeration, abundant food, as well as favorable conditions for the absorption of water, all of which contribute to the growth of the plant.

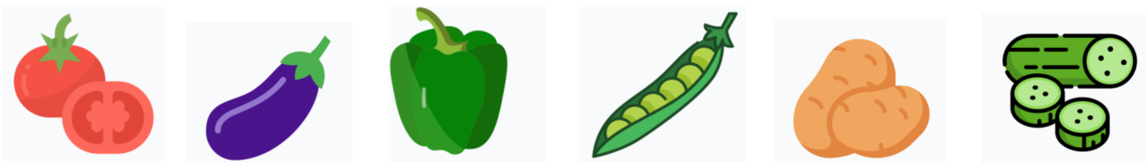
- **Factors that affect water consumption:**

✓ **Climatic factor :** These are represented by:

- Temperature: as the temperature rises, a plant's water loss becomes greater.
- The luminosity of the place considered :Exposure of plants to sunlight causes more frequent evaporation and transpiration,
- The wind: Generally speaking, the water needs of a plant increase with wind speed.

Plant growth is also temperature dependent. For each crop there is an optimum temperature range for growth

Crops: Optimal crop growth temperature



18-23 °C   22-26°C   18-23°C   18-25°C   15-26°C   22-26°C

✓ **Physiological factors:** are those that are inherent to the plant itself.

- Their nature: some plants adapted to dry environments transpire much less than others.
- Age and size of the leaves: adult mature leaves evaporate faster than young leaves [6].

I. 4 Conclusion

We talked in this chapter about two Section, so we saw in the first section effect of water on the world and suggested solution about it and in the second section we talked about the different types of classic and modern irrigation with their characteristics and its pros and cons, they differ in their performance and comfort.

Smart and remote irrigation serves to optimize water consumption with comfort assurance to users, it is also related to the factors that increase water consumption by plants have already been mentioned.

Chapter II:

Description of The Hardware and Software Used

II. 1 Introduction

In this age of high technology and electronics, human's way of life should be smart, simple, easier and more convenient, Many people have a lot of trouble to water their garden plants, especially when they are far from their home. Here, the idea is to automate the plant watering and irrigation system and to control it remotely.

To do this, sensors and detection actuators are used with a microcontroller to create a smart switch to control the agricultural system. This chapter is devoted to explaining the components used in this system.

II. 2 Material part

Presentation of specifications

Our irrigation system is based on a PCB’s connected to sensors and water flow motors that are remotely controlled.

For the realization of our smart irrigation system we need the following elements:

1. ESP 32
2. Sensors :
    - Air temperature and humidity sensor (DHT22)
    - Soil moisture sensor
    - Level Sensor
3. Relay
4. Display OLED
5. Water pump
6. Solar panels
7. solenoid valve

Software:

- ARDUINO IDE
- EasyEDA
- VSC Edit

II. 2. 2 Description and characteristics of the Material used

II. 2. 2. 1 ESP 32:

- **General presentation:**

The ESP32 series is a low-cost, energy-efficient silicon-based microcontrollers integrate dual-mode Wi-Fi and Bluetooth. The ESP32 series uses a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variants. It also includes integrated antenna switches, RF balun, power amplifiers, low noise receiver amplifiers, filters and power management modules. Espressif Systems developed the ESP32, which is produced by TSMC (Taiwan Semiconductor Manufacturing Company) using their 40nm manufacturing process.

The module requires a micro USB cable and can be programmed directly from the Arduino IDE with the installation of an extension. Its layout makes it suitable for quick-connect plates. It is an evolution of ESP 8266 [8].

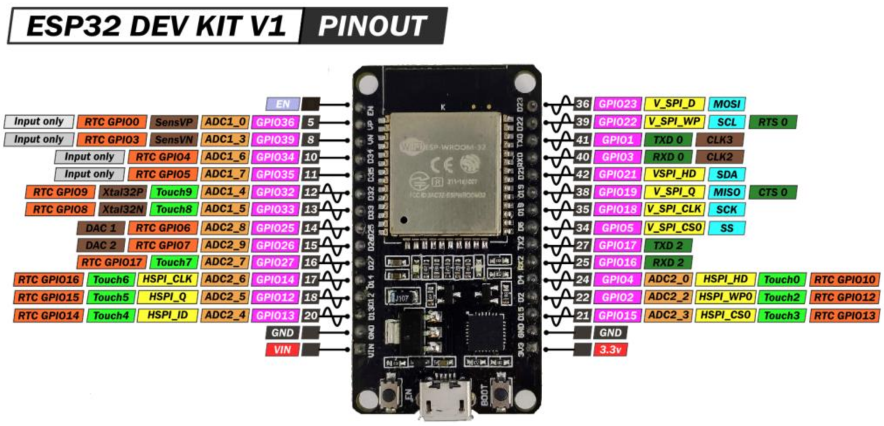


Figure II- 1: ESP32 DEV KIT V1.

- It can also be useful if you want several ESP32 devices to communicate with each other without the need for a router, which is much more powerful than the ESP 8266.
- The ESP 32 is programmed easily, much faster than an Arduino card.
- The ESP 32 has 30 pins 25 GPIO pins 15 pins of the mare useable for input and output the others can be only used for output or input only, and the software is much more complete [8].

- **Advantages :**

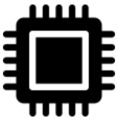
- Robust Design :

ESP32 is capable of functioning reliably in industrial environments, with an operating temperature ranging from –40°C to +125°C

- Ultra-Low Power Consumption:

Engineered for mobile devices, wearable electronics and IoT applications, ESP32 achieves ultra-low power consumption with a combination of several types of proprietary software.

- High Level of Integration :



ESP32 is highly-integrated with in-built antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules.

- Hybrid Wi-Fi & Bluetooth Chip :

ESP32 can interface with other systems to provide Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces

II. 2. 2. 2 Sensors:

- **General on the sensors**:

A sensor is a device that transforms the state of a physical quantity (Temperature, Pressure, Humidity, Force) observed into an electrical signal (digital analog signal).

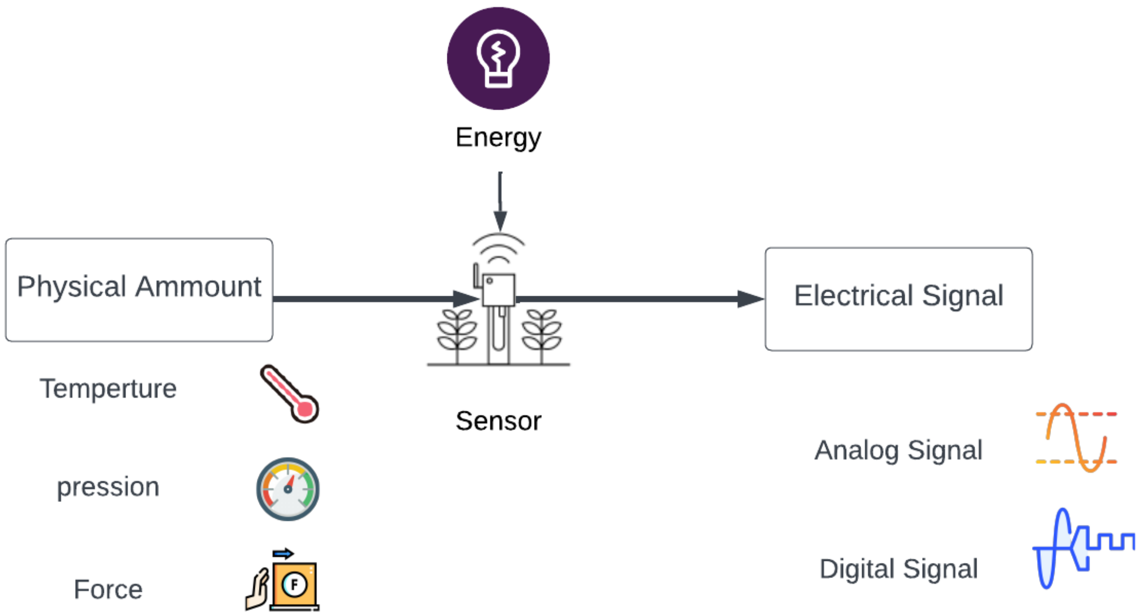


Figure II- 2: Sensor Definition

- **Types of output :**

Sensors and their conditioners can also be classified by type of output:

- **Analog Sensor :**

An analog sensor is used when the information can take any potential value between two specified value limits. The signal from analog sensors can be of the following types:
Output voltage or output current.

- **Digital Sensor :**

We then speak of a digital sensor because the information provided by the sensor allows the computer to divide a binary number by bits. The following types of signals may be present in the output of digital sensors:

TOR (all or nothing), pulse train, sampling [9].

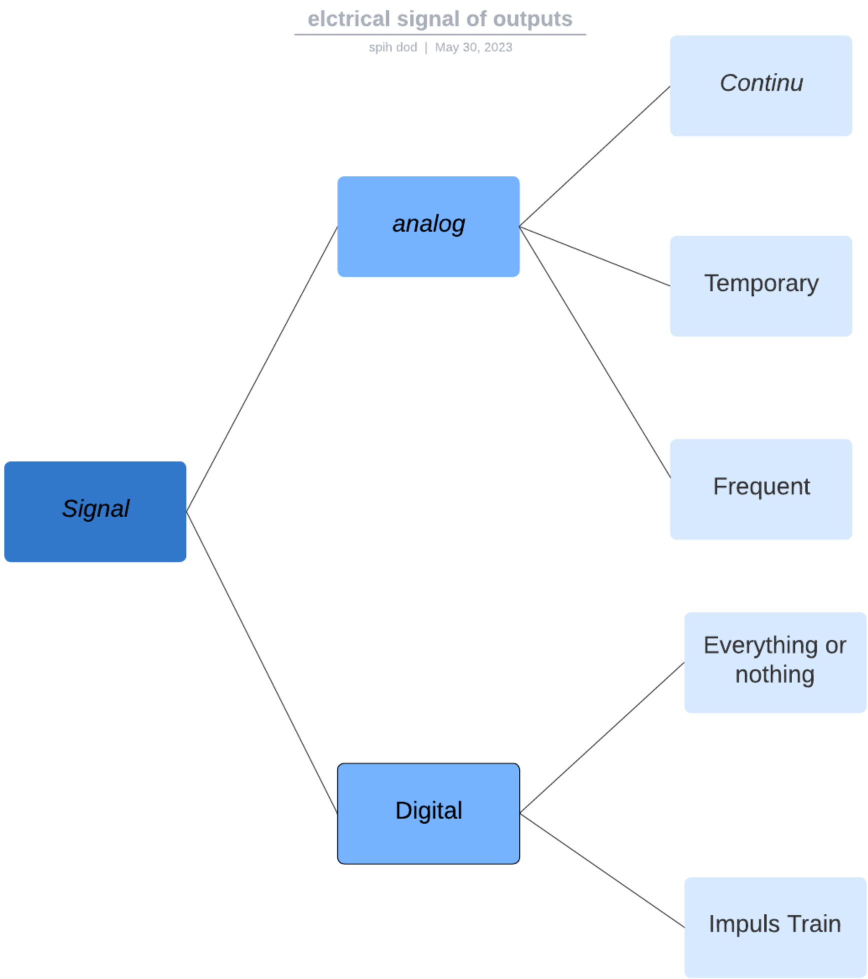


Figure II- 3 : Output electrical signal.

- **Classification of sensors:**

There are two types of sensor classification:

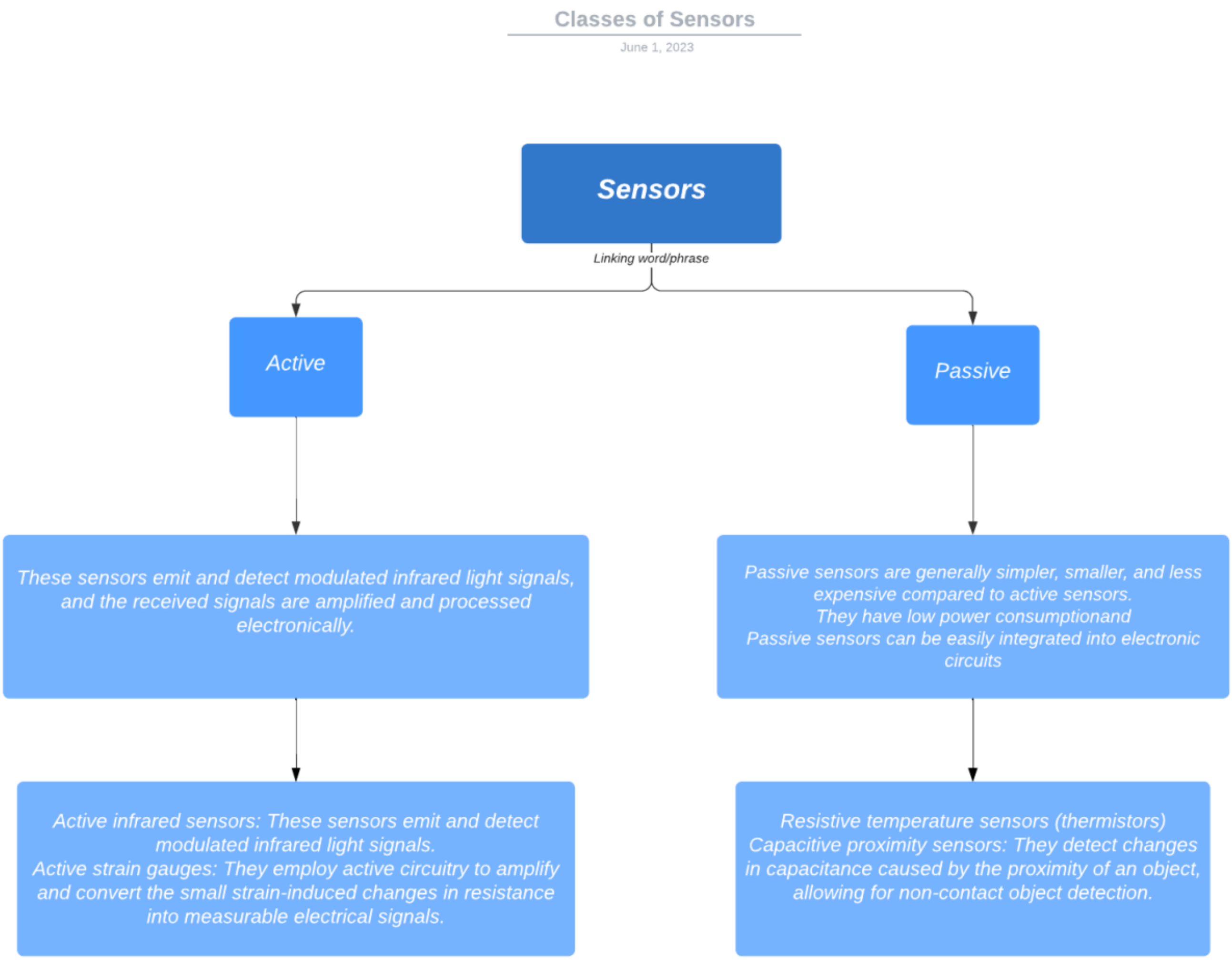


Figure II- 4: Classification of sensors

II. 2. 2. 2. 1 Air temperature and humidity sensor (DHT 22):

- **Description**

The DHT22 is a digital Temperature and Humidity Sensor. Most beginner Arduino projects involve the acquisition of environmental data - such as weather stations. These typically use the cheap and inaccurate DHT11 sensor module, which normally only measures temperature, and humidity is only indirectly dependent on the environment. Therefore, if you want accurate measurements, it is better to use a DHT22 sensor [10].

Figure II- 5: DHT 22**.**

- **Characteristics :**

Model	**DHT 22**
Power supply	3.3-5,5 VDC
Output signal	Digital signal
sensitive element	Polymer capacitor
Operating range	Humidity0-100%HR;temperature -40~80C°
Frequency Measured max	2Hz (2 measurement per second)
Humidity hysteresis	+-0.3%RH
Detection period	Medium:2s
Dimensions	Small size14*18*5.5mm;big size 22*28*5mm

Table II -1: **Characteristic of DHT22** [10].

II. 2. 2. 2. 2 Capacitive Soil moisture SensorV2.0 :

- **Description**

For our PCB, we will use capacitive Soil Moisture sensor version 2.0, there is two Versions of soil moisture Sensors Version 1.2 and version 2.0.

There is no difference Between Version's but there's differences in the same version some have missing crucial components and some don't work as intended we used the best Soil moisture type with on real time values changes and with a timer that doesn't consume that much of voltage (TLC5550):

This sensor works in a different way than the traditional sensor .By measuring the charging and discharging time, we can determine the degree of the moisture of the Soil [11].

Figure II- 6: Capacitive Soil Moisture Sensor V2.0

- **Advantages :**

- It is made of corrosion-resistant material, which gives it an excellent service life.
- On-board voltage regulator chip.
- Applications: garden plants, smart agriculture.

- **Implementing the right capacitive soil moisture sensor :**

In our journey to choose which capacitive soil moisture sensor is the suitable and the best performing for our network of sensors .we decided that these are the indicators we choose from:

- **Resistance connection :**

The outlined part of the circuit the picture below is used to convert the waveform signal from the sensor into a constant voltage that can be read by other hardware

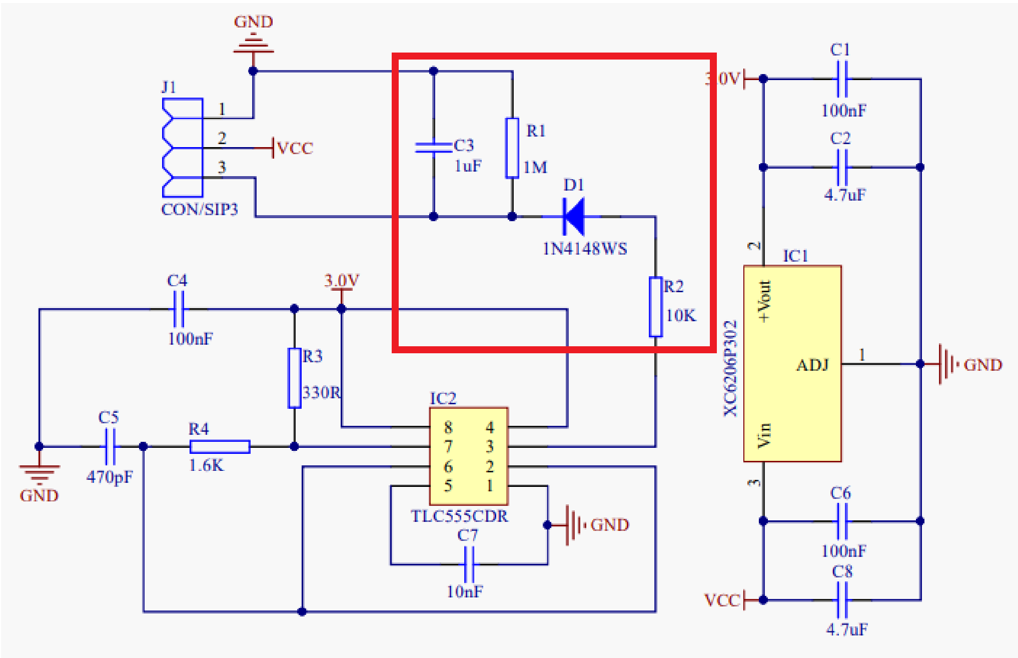


Figure II- 7: schematic of the capacitive soil moisture sensor.

In some soil moister sensors the 1 mega ohm resistor is not connected in two sides (the analog output and the ground

This means that the sensor becomes extremely unresponsive and the measured value changes only very slowly [24]

So in order to not face this problem we conducted connection between components and here is the result:

1- Test connection between GND and R4

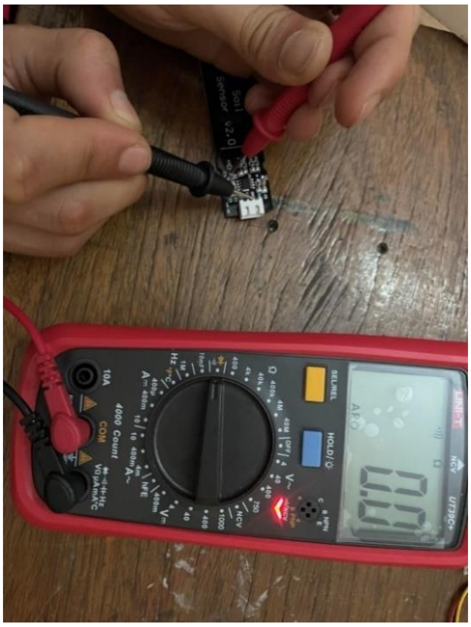


Figure II- 8: Test connection between GND and R4

2- Test connection between R4 and C4 :

Figure II- 9: Test connection between R4 and C4

The length of the area that can measure soil moisture is 6 cm. this capacitive soil moisture can resist longer than the usual other kinds of the sensors it can resist being exposed to water and other natural effects for longer.

- **Characteristics :**

Model	**Capacitive Soil Moisture Sensor V2.0**
Operating voltage	3.3V-5.5V CC
Output voltage	0V-3.0V CC
Operating current	5mA
Interface	PH 2.54-3P
Size	98x23x4mm
Pin	Analog signal output, GND, VCC

Table II- 2: Characteristic of Capacitive Soil Moisture Sensor V2.0 [11].

II. 2. 2. 2. 3 Distance Ultrasonic Sensors (Level):

- **Description**

The ultrasonic sensor (also often called sonar or ultrasonic range finder) determines the distance of an object in the same way as the

The HC-SR04 distance sensor generates a narrowband signal at a frequency of 40 kHz and picks up the reflected signal (echo). Based on the propagation time of sound to and from the object, the distance in centimeters from the obstacle can be determined quite accurately [12].

Figure II- 10: HC-SR04 Level Sensor

- **Characteristics :**

Model	**HC-SR04 Level Sensor**
Operating voltage	5.5 V CC.
working current	15 mA
Working frequency	40 Hz
Measuring angle	15 degrés
Dimensions	45 * 20 * 15 mm

Table II-3 : Feature of HC-SR04 Level Sensor [12].

II. 2. 2. 3 Relay

- **Description**

A Relay is a switch, an electromagnetic switch it allows electrical current to flow through a conducting coil that opens or closes a switch It also protects the circuit current With a control relay users do not need to manually turn the switch to isolate or change the state of an electric circuit. Currently control relays play a crucial role in today's electronic devices. They are electronic parts that power electronic parts such as motors, power plants, power supply systems, transistors, and many more. [13]

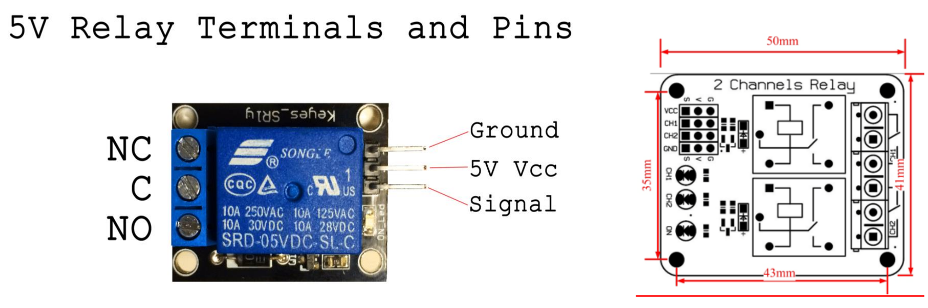


Figure II-11: Relay Module

- **Characteristics :**

Model	**Relay**
Operating voltage	Inside the relay is a 120-240V switch which is connected to an electromagnet.
relay outputs	- NC: Between120-240Vnormally closed - NON:Between120-240Vnormally open - C:Common
Trip current	5mA
Relay input	- DC+:positive power supply(VCC) - DC-:negative power supply (GND) - IN1 :can be high or low level control relay - IN2: can be high or low level control relay
Module Size	50x26x18.5mm (LxLxH)

II. 2. 2. 4 Nokia 5110 LCD display

- **Description**

We used a Nokia 5110 type LCD display with eight LED, SCLK, MOSI, D/C, RST, SCE, GND and VCC connectors connected to ESP32 boards for displaying different measured sizes and other useful information [14].

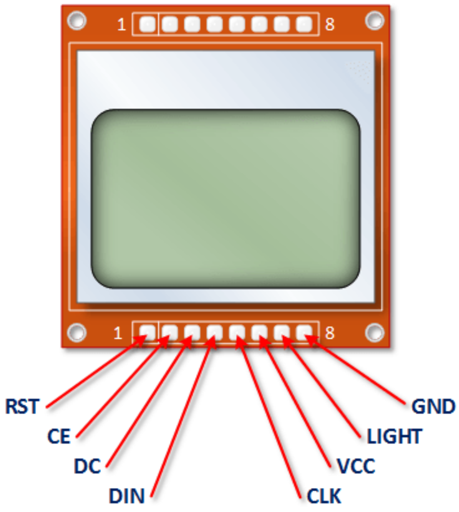


Figure II-12: Nokia 5110 LCD display

- **Characteristics :**

Model	**Nokia 5110 LCD display**
Operating voltage	2.7V ~ 3.3V
Operating current	≤ 600μA
Resolution	48*84 pixel
Dimension	43.6 (mm)* 43.1 (mm)
Color display	Blue with black text

Table II- 5: Feature of Nokia LCD display

II. 2. 2. 5 Water Pump:

Water Air Operated Double Diaphragm pump

- **Description and operating principles :**

The diaphragm pump, a form of positive displacement pump, is called a "reciprocating" pump because it uses a piston to cycle back and forth to exert intermittent pressure on a double diaphragm fluid which is used to compress air. Compressed air from front to back is directed between the two sides of the diaphragm pump using a pneumatic valve. Diaphragm pumps can handle a variety of viscous liquids as well as liquids containing suspended solids [15].

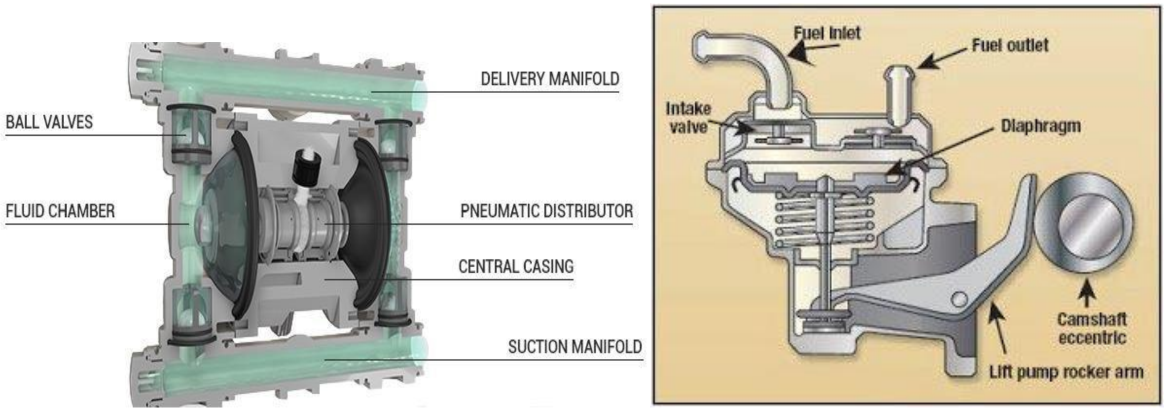


Figure II-13: the components of a diaphragm pump

- **Advantages of diaphragm pumps :**

- Manages even strong liquids which have high-level solid content

- They hold the ability to prime themselves

- ***Disadvantages:***

- They have little pulsation which may lead to the device damage
- These pumps are persuaded not to push very accurately at their base section

Figure II- 14: New MINI Aquarium DC Diaphragm Pump 3m 12V 1.5-2 L/Min

- **Characteristics :**

Model	**water diaphragm pump**
Operating voltage	6-12(V)DC
Debit	1-3 (l/Min) (approx.)
Operating current	0.5-0.7 to (The power should be more than 6W)
Water temperature	up to 80 C°
Lifetime	2500 h (max)
Pump size	40mm * 90mm * 35mm

Table II- 6: Water pump feature.

II. 2. 2. 6 Solar panels:

- **Description**

Solar panels are a device that converts solar energy into electrical energy using photons.

Solar panels are used in remote power and remote sensing systems, this energy can be used to generate electricity or be stored in batteries or thermal storage

Figure II- 15: Solar Panel 120mAh Mini Silicon Solar Cells DIY Epoxy Plate

Advantages of Solar Energy	Disadvantages of Solar Energy
Renewable Energy Source	Cost
Reduces Electricity Bills	Weather Dependent
Diverse Applications	Solar Energy Storage is Expensive
Technology Development	Associated with Pollution

Advantages and disadvantages of Solar Energy

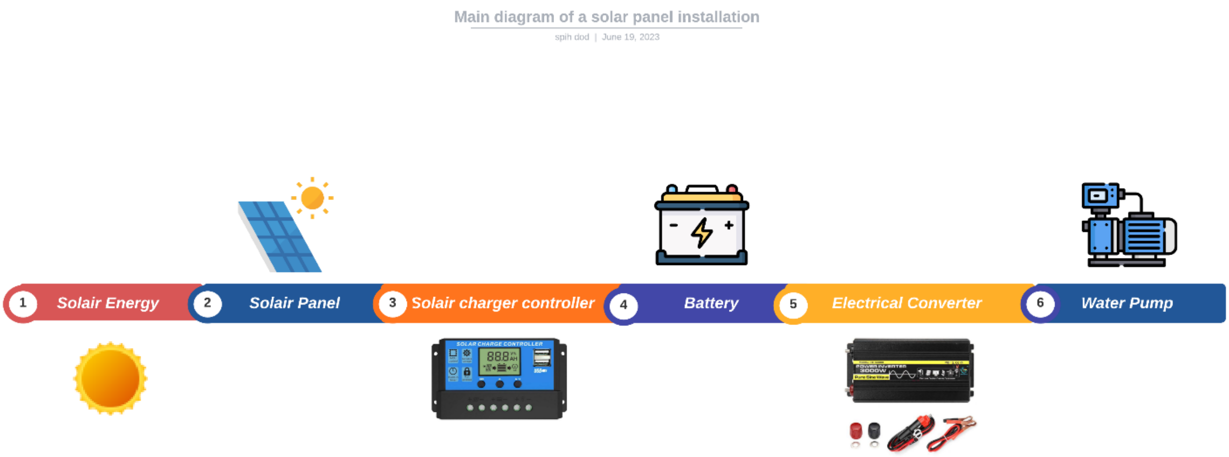


Figure II- 16 : Main diagram of a solar panel installation

- **Characteristic :**

Model	Solar panels
Operating voltage	DC 5.5 (V) - High conversion rate, high yield - Excellent low light effect
	- Suitable for running and charging a pump and small DC batteries
Operating current	0.15 (A)
Power	0.85 (W)
Material	Monocrystalline Silicon
size	85x60x3mm

Table II-7: Feature of Mini Silicon Solar Cells Panels [16].

II. 2. 2.7 Solenoid valve:

- **Definition of Solenoid valve :**

A solenoid valve (SV), an electromechanical device, controls the gas or liquid flow by changing position of valve when an Electric current is passed through a solenoid coil. It is well known that solenoid valves find use in wide range of industries such as automobile industry, aerospace industry, nuclear power plant industry, and agricultural industry [17].

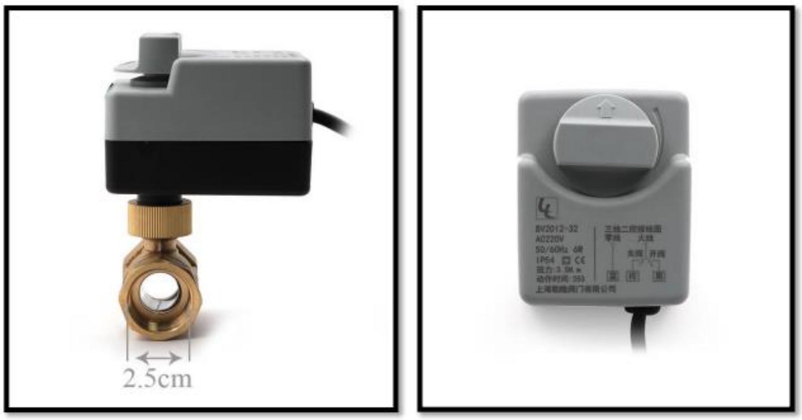


Figure II- 17: Solenoid valve bv2012 32 1

- **Specifications :**

  - Caliber: DN20 6 points G3/4"
  - Flow hole diameter: 17mm
  - Internal thread diameter: 25mm
  - Drive voltage: 220VAC
  - Power consumption: 6VA (only in the process of valve opening and closing)
  - Valve body pressure: 1.6MPa
  - Allowable pressure difference: ≤0.4MPa
  - Applicable medium: cold water, hot water or 50% ethanol solution
  - Opening and closing time: open 25 seconds, close 25 seconds
  - Applicable medium temperature: 0-95°C
  - Applicable ambient temperature: 0-65°C
  - Connection method: G internal pipe thread
  - Body material: bras [17].

- **Advantages :**
  - Low energy use
  - Remotely operated
  - Compatible with AC and DC voltages.
- **Disadvantages :**
  - The potential for the coil to need replacing during its lifetime
  - The need for the control signal to remain during its operation.

II. 3 Software Part:

During our production, we relied on different software and environments:

Arduino IDE, the first we used to program and configure ESP 32 for the proper functioning of our application.

Easy EDA, We used a trial and test platform before starting on the real platform [PCB].

Python to taste and adjust and note evolution results online from soil sensor (soil moister sensor) and Temperature and humidity sensor (note results online by curve), and Preparation (creation of a special account, website) to see soil moisture values, temperature and air humidity, watering history, remote control.

II.3.1 Programming (ARDUINO IDE):

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. [18]

II.3.2 Easy EDA:

Easy EDA is an easier and more powerful online PCB design tool that allows electronics engineers, educators, students, makers, and enthusiasts to design and share their projects. This is a design tool integrated LCSC components catalog and JLCPCB PCB service that helps users to save time in making their ideas into real products. [19]

II.3. 3 VSC Editors:

VSC is a programming editor open source developed by Microsoft with the Electron Framework, for Windows, Linux and macOS, you can program in dozens of languages it's supported by most programmers Features.

II. 4 Conclusion

In this chapter, we have presented a detailed study about the main components used in our project regarding the design of an Automatic Smart Irrigation System Upgrade. We presented the characteristics of ESP 32 and its advantages and operations , and we also presented the characteristics and classification of the sensors and their different types and we talked about the elements used such as the pump and the type used and the internal component, the relay and the OLED display, as well as the software used.

Chapter III:

Implementing the Irrigation system

III. 1 Introduction

The world faces multiple challenges today the most significant is water resource management water scarcity threatens crop growth and food security this thesis focuses on an efficient smart Irrigation System

In this Chapter, we explain our smart Irrigation System and the solution we came up with to both home garden owners and large to medium farmland owners based on wireless communication for long to medium Ranges. Powered by Rechargeable lithium-ion batteries and solar panels designing and making circuit boards.

The Simulation Results and Real life application are not the same, a lot of unexpected difficulties can appear so to complete the prototype a test from farmers is necessary there are more than 1.1 million farmers in Algeria and this system can be helpful for them and a great way to develop irrigation on the country since most farmers use rainfall rather than irrigation developing the agriculture will have massive positive impacts on the economical aspect.

III. 2 Proposed Irrigation System

Today all farmers and agriculture enthusiasts around the world have water control shortage problems in our project we tried to make a good solution to this problem for both large-scale farm owners and home garden owners.

For large to medium-scale farms and green spaces we made a smart system that controls and monitors the growth and the right amount of watering needed to grow with a real-time responsive dashboard that shows all the data needed for growth with a network of sensors communicating and sending data to the cloud every second.

For home garden owners that want to save time, we made a smart monitoring solution to water plants when not in the home to do it the system tracks the moisture of the plants when it’s low the pump automatically waters the plants until the moisture percentage is fulfilled

Every plant has the right amount of moisture percentage so we made it suitable for the owner to choose whatever percentage the water flow stops at this can be managed on the website dashboard.

III. 2.1 Home garden irrigation System:

for this system, we optimized a PCB with a microcontroller, in this case, an ESP32 to program the circuit board we used the DHT 22 and a soil moisture Sensor to capture the humidity and temperature of the air and most importantly to measure the soil moisture all the data get sent to the cloud from the cloud into a user-friendly dashboard that the home garden owner can control we designed the PCB using Easy EDA:

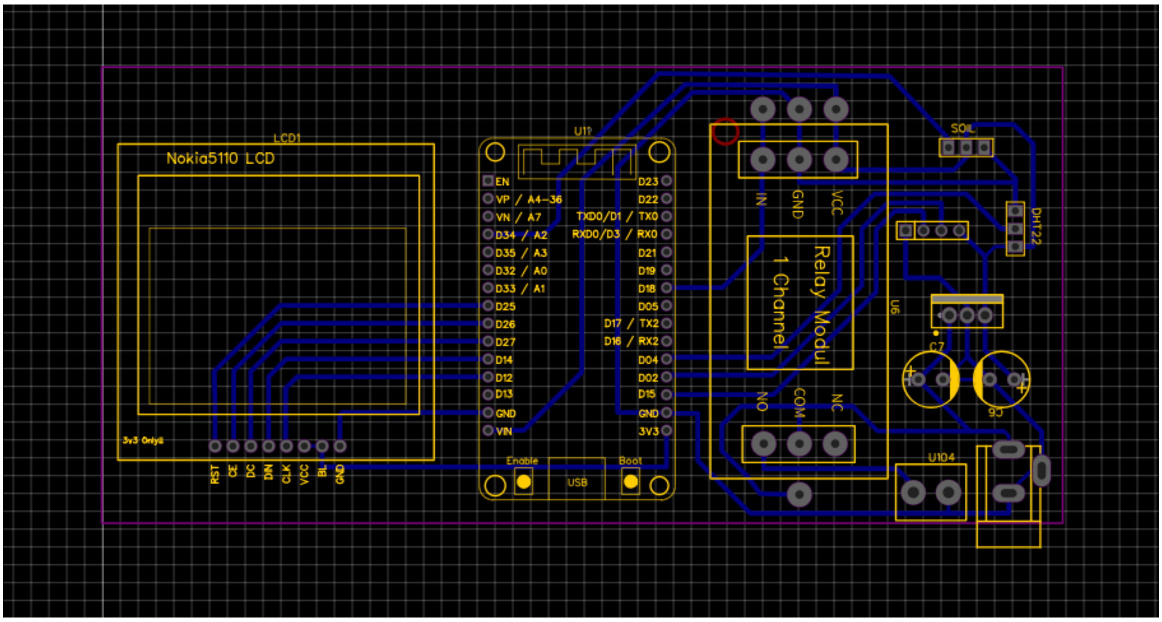


Figure III-1: 2D image showing the Copper connections in the PCB

The 3D model will be like this:

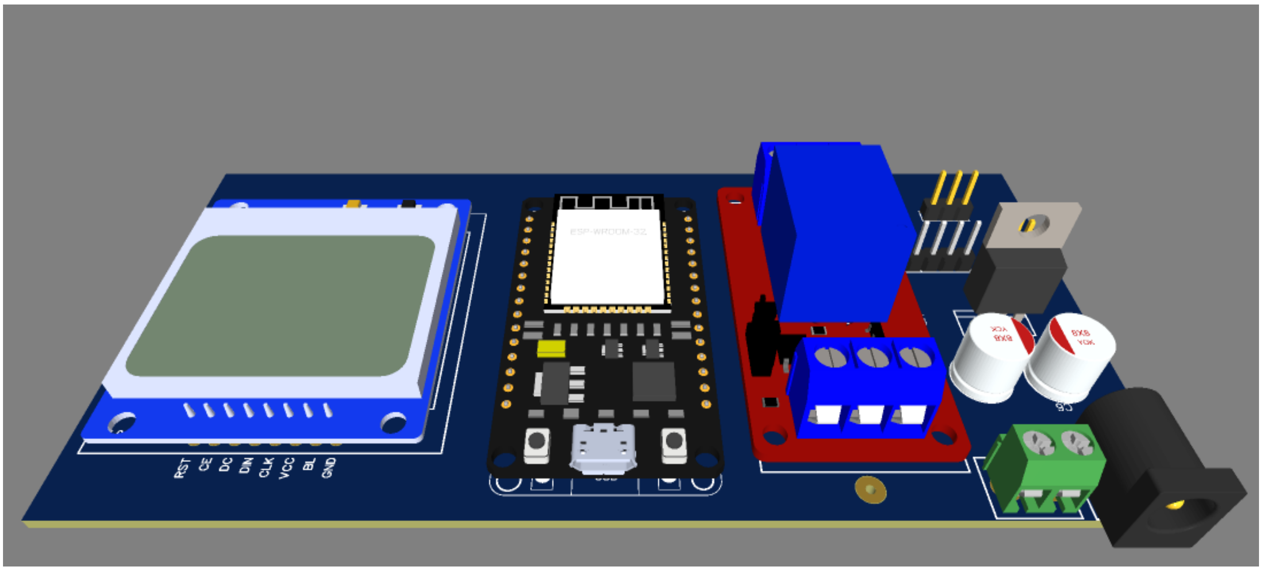


Figure III-2 3D model for the PCB components

III. 2.1.1The steps of making a PCB:

Step 1: Designing the PCB:

For the design we used EASY EDA, we made the copper layer and the spaces between each line for the components.

Step 2: Review the design by the engineer:

After we finished the PCB design we sent a copy for the engineer to inspect the final schematic.

Step 3: Printing the PCB Design:

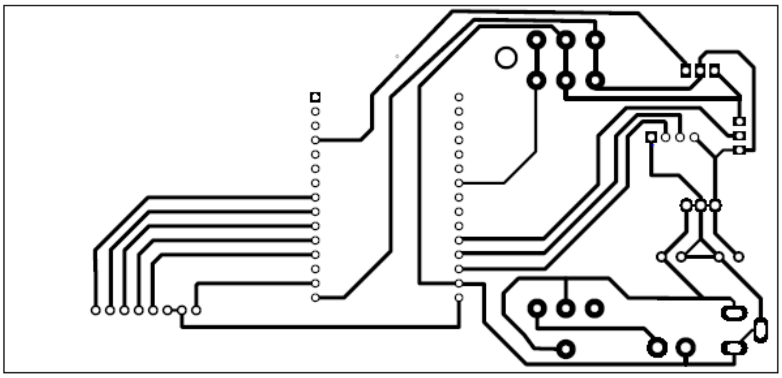


Figure III-3 printing the home garden circuit connections

Step 4: Printing the Copper for the Interior Layer:

We cut a suitable epoxy plate, after removing the protective film from the epoxy plate, the resin is on the surface. This resin has the property of changing when exposed to Ultra Violet (UV) radiation, it is said to be photosensitive, and then we set a timer for a period not exceeding three minutes

Figure III 4 : PCB chemical etching

Step 5: Etch the Inner Layers or Core to Remove Copper:

The most important part is the Etching of the inner layer to form the circuit copper traces and remove non-essential copper this step will determine the quality of the PCB and its life span for our PCB we used chemical etching using sodium hydroxide.

Figure III-5 : PCB chemical etching

Step 6: Layer Alignment:

In our case we only made one layer PCB the alignment spacing between copper traces is very important to insure no possibility for a short circuit

In general, there are multiple methods for layer alignment methods:

- Optical alignment system: vision system alignment cameras
- Software-assisted layer aliment: PCB software today have integrated feature that allows a precise alignment for an easy manufacturing experience
- Auto algorithmic alignment: using algorithmic and robots to align (more precise)

Step 7: Drilling:

In the design every hole for the components is visible when the copper layer is made then we drill holes for each component pin.

Figure III-6: Drilling the PCB

Step 8: Solder Mask Application:

When we place the components in their right place we then solder every pin in their right place

Step 9: Electrical Reliability Test:

After we finish making the PCB we test each copper connection and component with a

Multimeter to ensure that all copper connections are working fine.

Step 10: Finishing the PCB:

The final step is to polish the PCB and make sure everything is working fine testing the final PCB by uploading a program to its CPU and assure that the main purpose of this PCB is working.

Upon completing the circuit board printing process, this is the resulting appearance of the board:

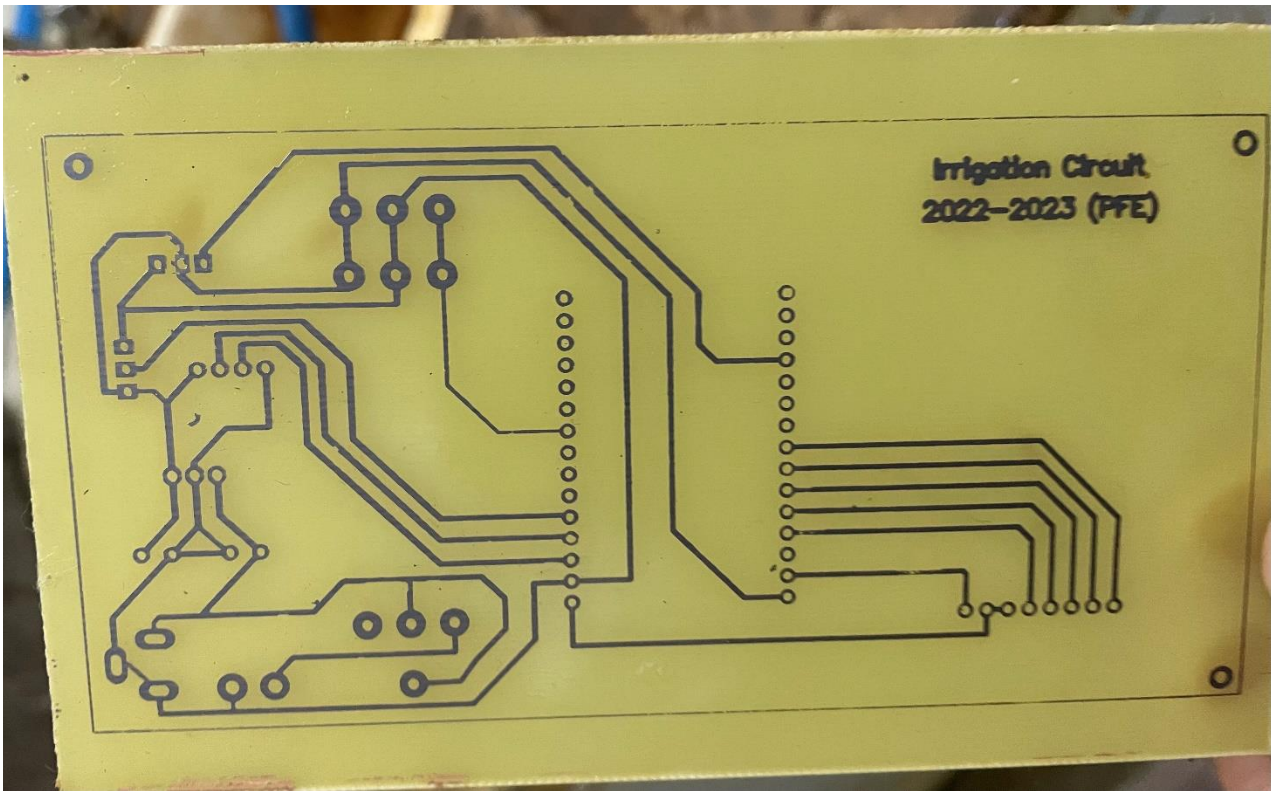


Figure III-7: final polished PCB

This circuit is a one-layer circuit with copper links between the components:

Its 13cm×7cm after we printed the circuit now we placed and soldiered the components

On their slots we used a 5V relay to control the 12V water pump with a 12V power supply port for the option of using AC Voltage (with a converter) and another port for using a 9V DC battery both can satisfy the needs of the PCB.

To display the Information the sensors Send We used a Nokia a5110 and the user can also see the information on the dashboard on our Website.

The converter we used we made it with 2 capacitors of 10µF each and a Regulator of 12 V

After the completion of assembling and testing all the components, the end result appears as follows:

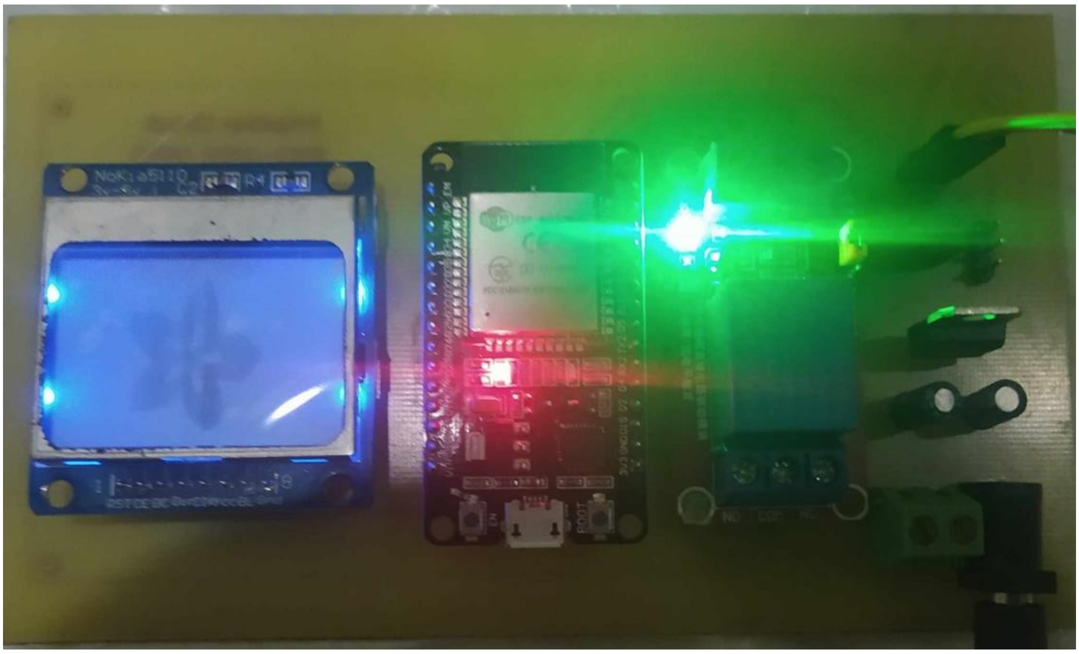


Figure III -8 : Final PCB with components soldered

III. 2.1.2 3D Model Case for the PCB

Every PCB needs some kind of protection against nature damage like water dropping on the circuit or someone could get injured if he touches the exposed copper with his hands even though

The voltage and the current that’s running in the circuit are very low but protection is a priority so we made and designed a 3D printed Case to protect the circuit from damage to the Designee circuit we used multiple Software mainly SOLID WORKS and AUTODESK FUSION 360

Both of this software are best in the market for designing 3D complicated shapes.

AUTODESK FUSION 360 combines both 3D model designing for 3D printers and circuit PCB designing, fusion 360 uses CAD, CAM, and CAE (computer-aided design, computer-aided manufacturing, computer-aided engineering). Which makes it all in one solution

For our home garden, we designed this case:

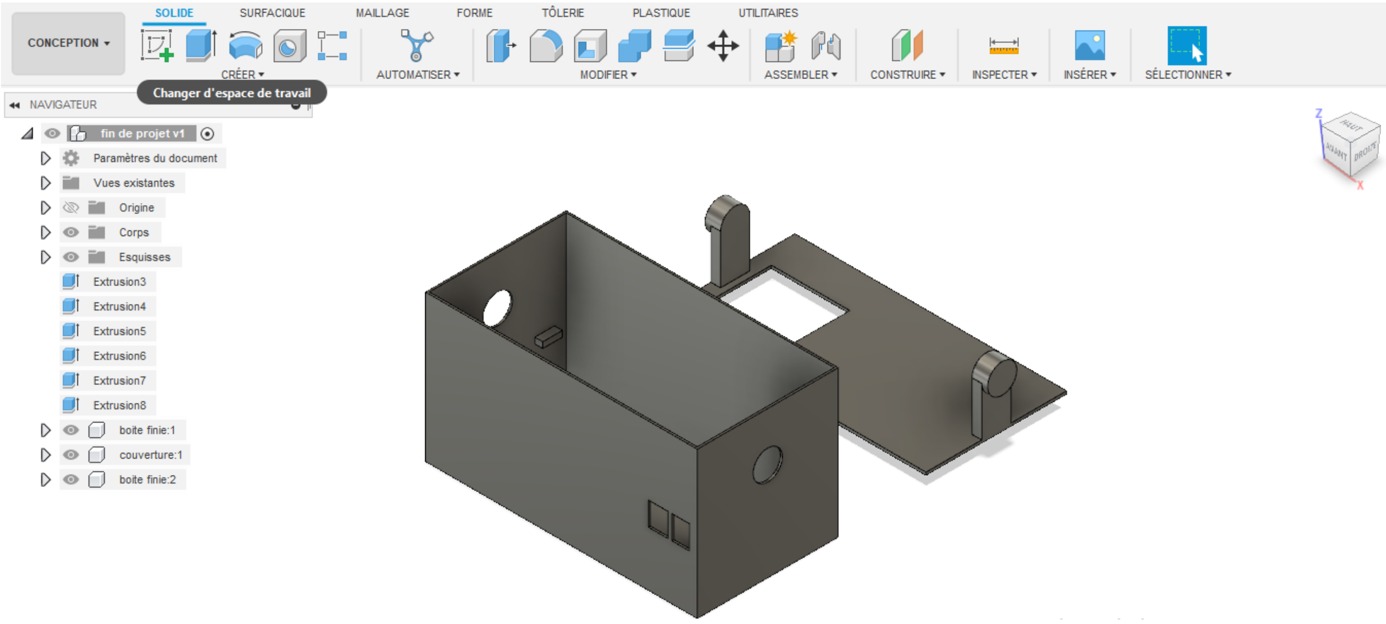


Figure III-9: Autodesk fusion 360 3D model for a protection case

The large farm PCB case:

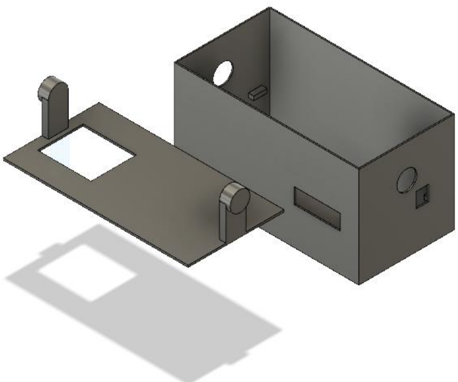


Figure III-10: 3D model for farmland protective case

Small Network PCB Case: we designed it so it can have an upper cover that can be closed using screws

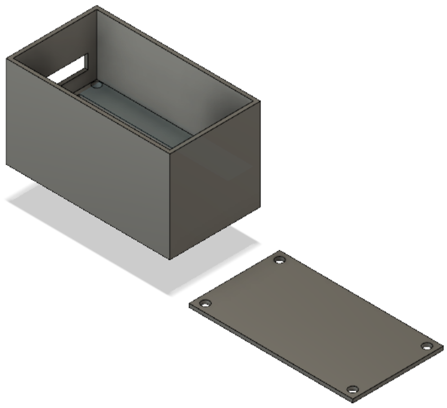
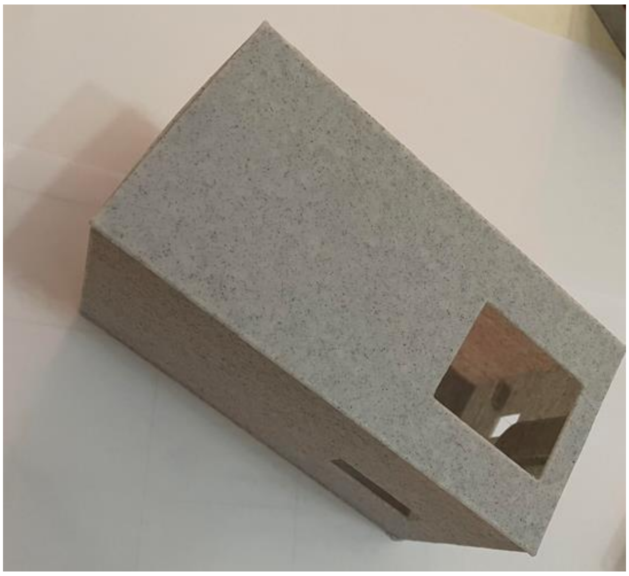


Figure III-11: 3D model for a network PCB case



All these models were made using a 3D printer the material that was used was the filament

Upon completing the printing process, the final product of the cases takes on this appearance.:

We designed so it exactly fits the PCB and its input/output ports and a hole for the oled display to be placed on it . the dimensions are 13cm L by 6cm W by 7 cm H.

The walls are 1.75 mm thick for a stability

For small cases, this is the final shape:

For small cases, this is the final shape:

IFigure III -12: 3D printed cases

Now the most important part is sending the data to our dashboard in real-time to truly distant monitor the water flowage and the moisture of each plant to do that we programmed a website with an interactive dashboard using VSC editor (html.CSS.JavaScript.PHP)

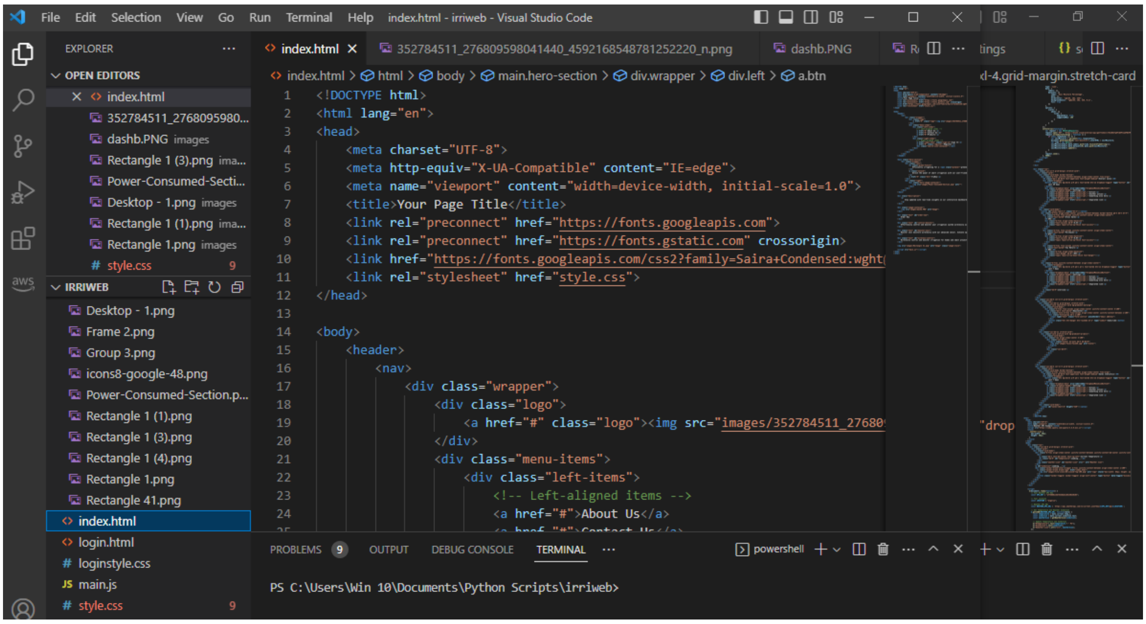
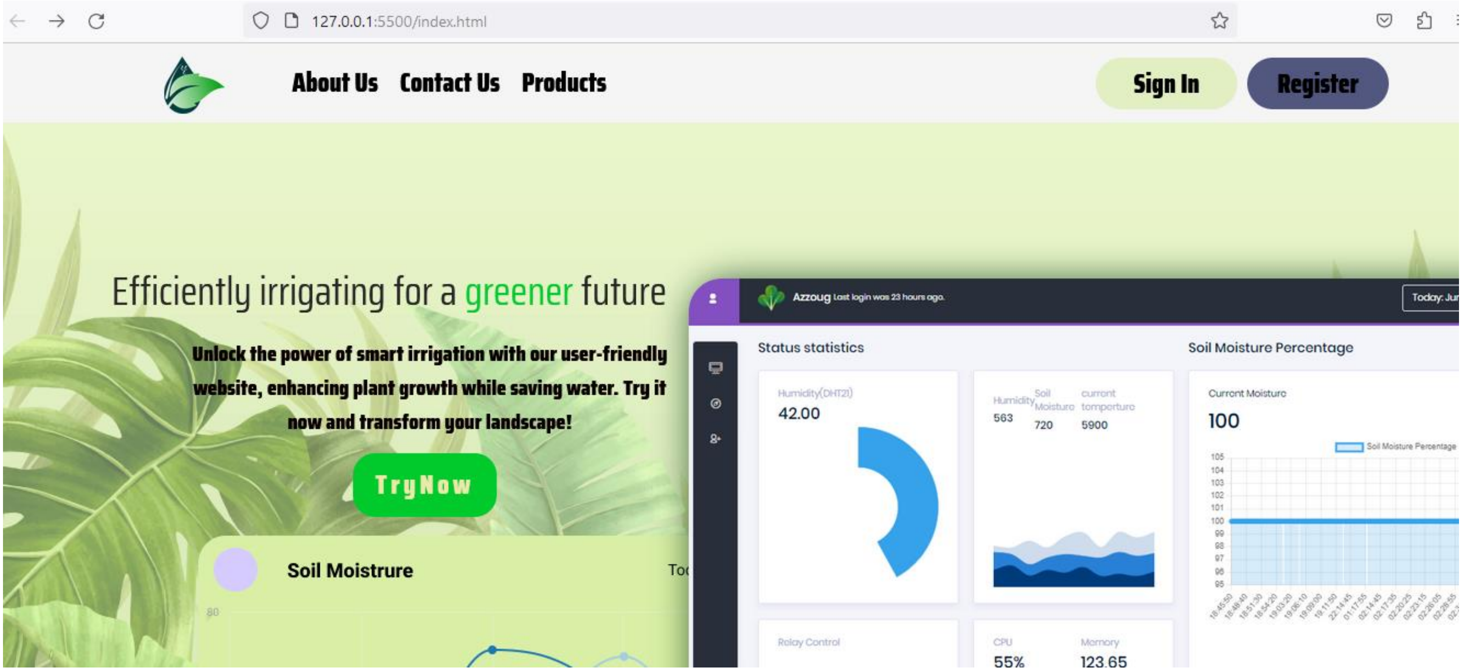


Figure III -13 : The development of the Dashboard in VSC

The appearance of the landing page on the website resembles the following design.



The website is user-friendly with clear instructions and visuals with a simple Sign-in page:

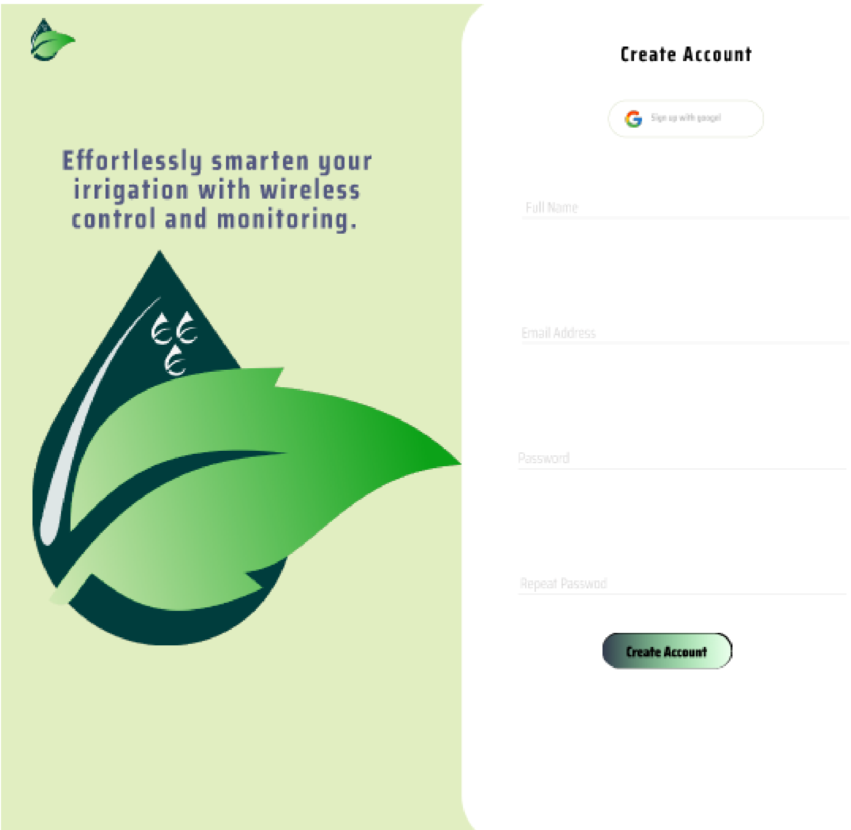


Figure III -14: Our website landing page and its Sign up page

We designed a logo that describes our work domain our logo is simple and eye-catching

Figure III -15: The project Logo

Our dashboard has many widgets and command buttons to control the Pump there are moisture charts and humidity charts also real-time tempter degrees with future predictions it's easy to use and to get used to.

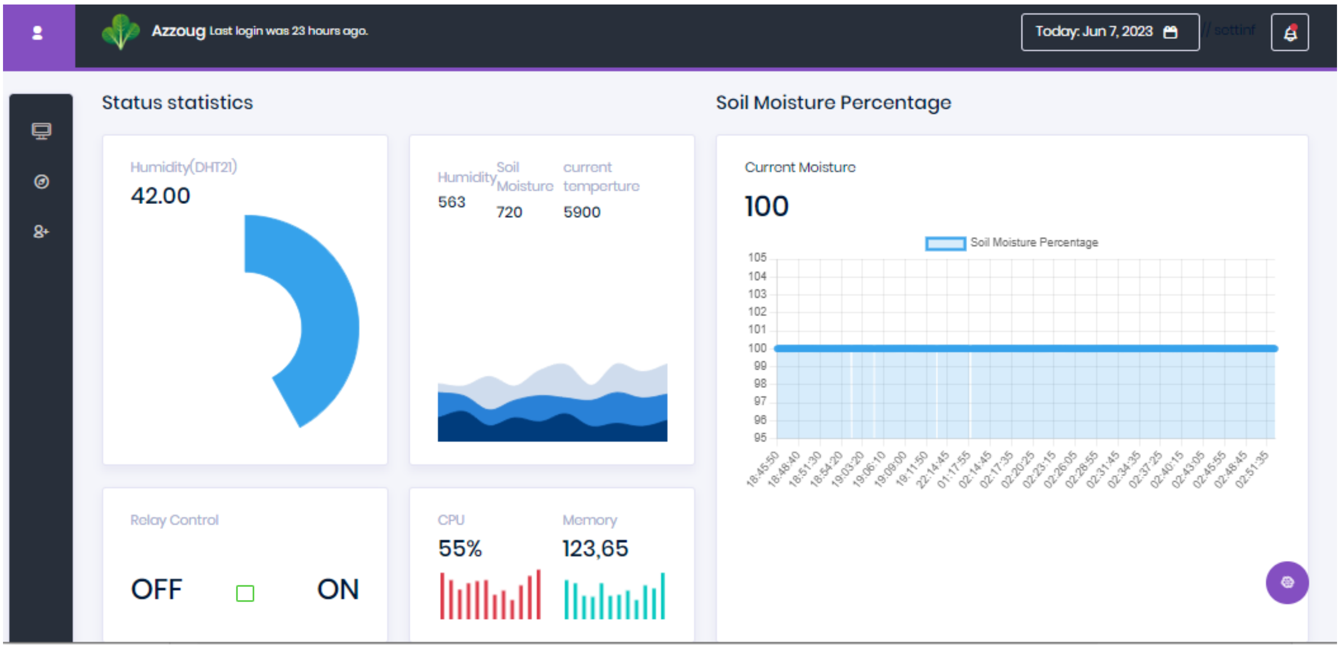


Figure III -16: The Responsive dashboard

The data gets sent from the microcontroller to the cloud.

III. 2.1.3 The Cloud:

Using a cloud service for a project like this will improve the effectiveness and data analysis which will result in a better experience for the farmers and garden owners

There are multiple services for using a cloud in our Irrigation System for example:

- Amazon IOT Core
- Microsoft Azure IOT
- Blynk Cloud

We integrated the cloud by using APIs to send data from Blynk to our website with some CSS HTML javascript, we created Responsive charts that update every second with the exact value of sensors and also made buttons to control the solenoid Valve and the water pump. This is The main line to be able to get values from blynk:

```
request.open('GET',
'https://blynk.cloud/external/api/get?token=XZ4TuFFlsGD_2ZBHS-
HS4keqwVlPVeK1&V3');
```

The desired outcome for the home garden irrigation system is to achieve a final structure that resembles the following:

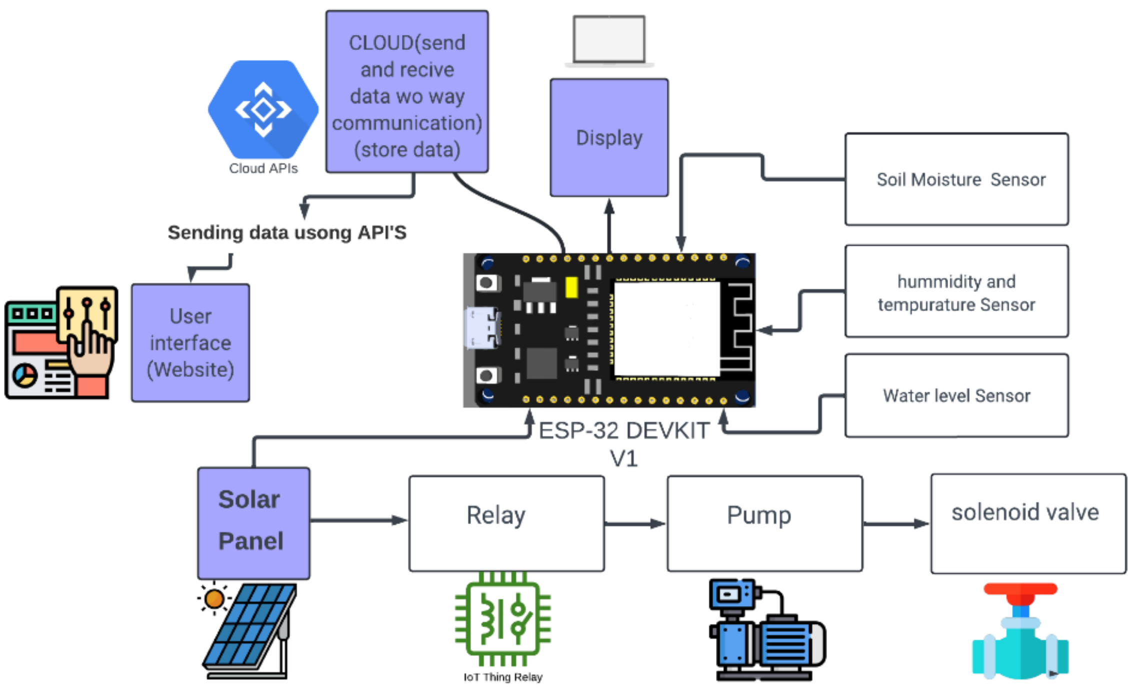


Figure III -17: The functional work structure of the home garden Irrigation system

III. 2.2 large to medium scale farms Irrigation system

The large-scale farm owners the ones who do it for commercial and their main goal we made a sufficient solution to monitor and control the growth of their green spaces and houses, we made a Network of sensors that communicate with each other's to capture the moisture for large scale green spaces all this communication doesn't need wifi or Bluetooth so it can be made in areas that don't have any Wi-Fi or cellular coverage this all possible because of the antenna integrated into the PCB. The range that the network can cover is up to 250 meters with no obstacles (open field) with multiple PCBs at the same time we can cover a large area of land which will allow us to control the irrigation from far away with no cellular.

III. 2.2.1 ESP-NOW:

ESP-NOW is a protocol that allows communication between multiple ESP boards ESP-NOW uses a vendor-specific action frame to transmit ESP-NOW data. The default ESP-NOW.

Esp-Now is a kind of connectionless Wi-Fi communication protocol that is defined by Espressif. In ESP-NOW, application data is encapsulated in a vendor-specific action frame and then transmitted from one Wi-Fi device to another without connection. CTR with CBC-MAC Protocol (CCMP) is used to protect the action frame for security. ESP-NOW is widely used in smart lights, remote controlling, sensors, etc. [1]

III. 2.2.2 Making a Multi Communication between ESPs:

ESP-NOW is a lightweight and efficient protocol for direct communication between ESP8266/ESP32 devices, offering advantages such as low power consumption, high throughput, and simplified implementation. However, its limited compatibility, lack of built-in security features, and scalability constraints should be considered when deciding whether to use it for a specific project.

In our assembly we used ESP-32 DEVKIT V1 as a data receiver from multiple ESP-32 Senders to achieve that we need to figure out the Mac Address for the ESP-32 Receiver we used Arduino (IDE) and compiled this code:

```
##include <WiFi.h>
void setup() {
  Serial.begin(115200);
  Serial.println();
  // Print MAC address
  Serial.print("MAC Address: ");
  Serial.println(WiFi.macAddress());
}
void loop() {
}
```

In the serial monitor the Mac Address is displayed for our ESP-32 Receiver the Mac Address is:

MAC: C0:49:EF:69:B2:D8

After we figured out the Mac Address for our ESP-32 Receiver the protocol for ESP-NOW needs only the Mac address for one ESP then the other ESP sends data to that one Address

The Receiver needs to be configured to receive data from other ESPs. Simultaneously, the data received by the ESP-32 SENDER is displayed on the cloud in real-time every 1 second. The ESP-32 Receiver also transmits data to the cloud.

In the code executed for the ESP-32 Receiver, we extensively use the <esp_now.h> library for the protocol to work. The code receives soil moisture data every 1 second. The amount of data that can be sent is limited to 250 bytes per second, and the data transmission frequency depends on the distance between the sender and receiver. In our example, we tested it at 35 meters and achieved 100% data exchange. The protocol has the potential for more capabilities, but for now, that's all we need.

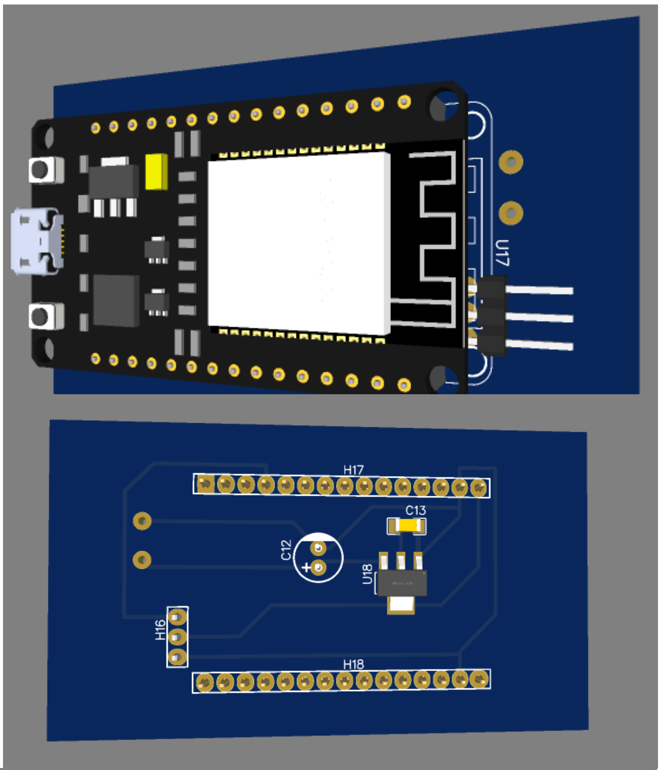
We configured one-way data transmission between two ESPs (RECEIVER-SENDER), and the outcome was a successful test. We received accurate data on the cloud.

Our goal is to establish a network of communication between ESPs (Senders to Receiver) using multiple ESPs. We utilized one ESP32 DEVKIT V1 as the receiver and six other ESPs of the same module as senders. Each ESP sender is integrated with a soil moisture sensor on a PCB. The PCBs were designed using EasyEDA and Autodesk Fusion 360. The sender PCBs are also equipped with a 5V lithium battery, and resin is applied to the PCBs to protect and isolate the circuit in case of water exposure, as well as to improve performance in harsh conditions.

In our project, we designed and manufactured five small PCBs, each with its antenna, and one main PCB that receives data from the other PCBs and transmits it to the cloud and our dashboard.

The small PCB design:

We printed 5 similar copies of this PCB each sending Data to one main PCB the main PCB is designed like this:



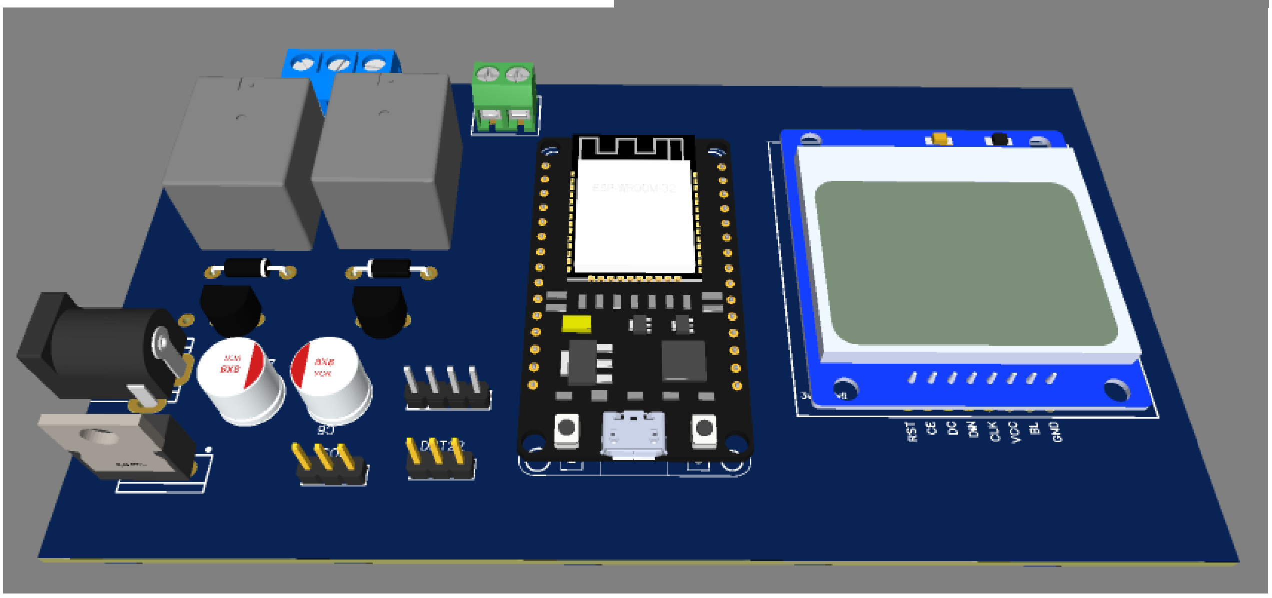


Figure III -18: 3D Model for the farmland PCBS

This PCB is Responsible for communicating with other small network PCBs and sending data to the cloud.

This is the ultimate configuration of the circuit for the farmland, showcasing its final design.

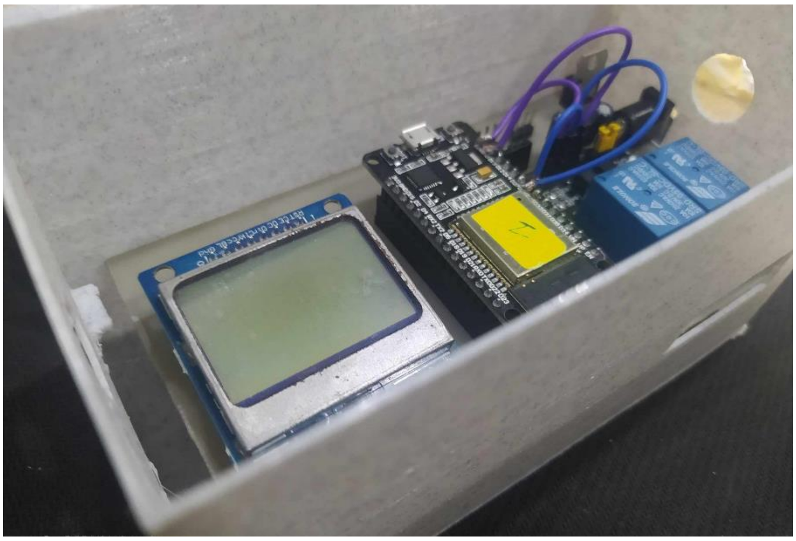


Figure III-19: The final product for the farmland Assembly main receiver PCB

The network's visual representation is depicted as follows:

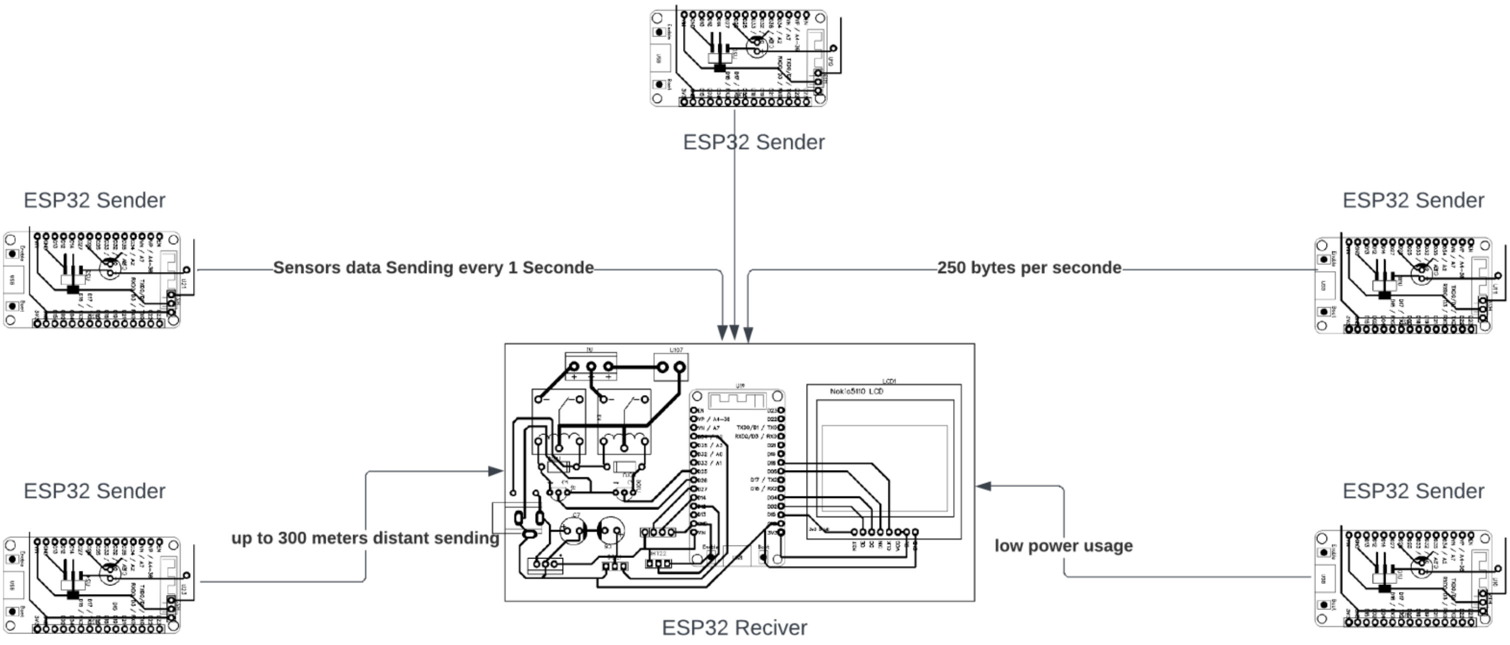


Figure III -20 : The wireless network with multi sensors communication

I. 3. 2. 1 Our PCBS setup power consumption:

Components	Voltage(V)	Current(ma)
Small sending PCB	3.7V	300ma
Main PCB(home garden)	4.2V	550ma
Main PCB Receiver (network)	4.3V	620ma

Table III-I : Measured PCB power consumption

One of the parts we focused on in our project is power consumption we attend to make it as practical and efficient as it can be we used lithium-ion rechargeable batteries have a longer time than typical nickel batteries and have high capacity compared to other types but yet to get as much efficient as we can we made some PCBS consume less power when it's not needed for example when it's raining or expected highly to rain we put the network on sleep mode only the important components and function are working such as the processor chip and the data transmission function, by doing the life span of the batteries will increase significantly for more optimal use we have automated this power consumption structure to the expected weather conditions.

According to the ESP32 Datasheet, the ESP 32 have 5 power consumptions modes those are:

- Normal power consumption mode: the CPU is working the ESP is sending and receiving
- Light sleep mode: the CPU is working but the wireless communication is disabled.
- Deep sleep: the CPU is paused and can be woken up by a timer or a button to wake up
- Hibernation. The CPU is down the RTC memory is disabled only certain GPIO are working
- Power off: the ESP is turned off

[20]

The normal consumption mode is not that efficient especially when using a DC battery it lowers the life of the battery our best solution is to use a deep sleep mode with a timer to wake it up whenever we need to transmit data between ESP or to send data to the cloud.

To achieve this we need a good module of the ESP-32 like the ESP-32 DEV KIT V1 with some coding in the Arduino IDE editor we can use the low consumption option and integrate it with our network. And we can use multiple waking-up methods:

```
case ESP_SLEEP_WAKEUP_EXT0 : Serial.println("Wakeup caused by external signal using RTC_IO"); break;
    case ESP_SLEEP_WAKEUP_EXT1 : Serial.println("Wakeup caused by external signal using RTC_CNTL"); break;
    case ESP_SLEEP_WAKEUP_TIMER : Serial.println("Wakeup caused by timer"); break;
    case ESP_SLEEP_WAKEUP_TOUCHPAD : Serial.println("Wakeup caused by touchpad"); break;
    case ESP_SLEEP_WAKEUP_ULP : Serial.println("Wakeup caused by ULP program"); break;
    default : Serial.printf("Wakeup was not caused by deep sleep: %d\n",wakeup_reason); break;
```

In our case, a timer is more efficient because we only need our PCBS running once every couple of minutes the moisture and temperature values don't change that much every couple of minutes this will have a great impact on the efficiency of our setup network.

Light sleep measurements:

To know the effect of using Deep sleep mode on our microcontroller we measured the power consumption values of the ESP in this mode with a millimetre in two cases the ESP32 alone and then with a working PCB with multiple components:

Component	Current (ma)	Power consumption (MW)
Home garden PCB	3ma	0.1 milliwatt
Large farms PCB	5ma	0.15 milliwatt
Single small PCB (esp-now)	0.9ma	0.3 milliwatt

Table III-II: Deep sleep power consumption measured

The deep sleep mode is very effective for IoT projects it turns off the CPU and only keeps the parts of the chip that can be turned on again

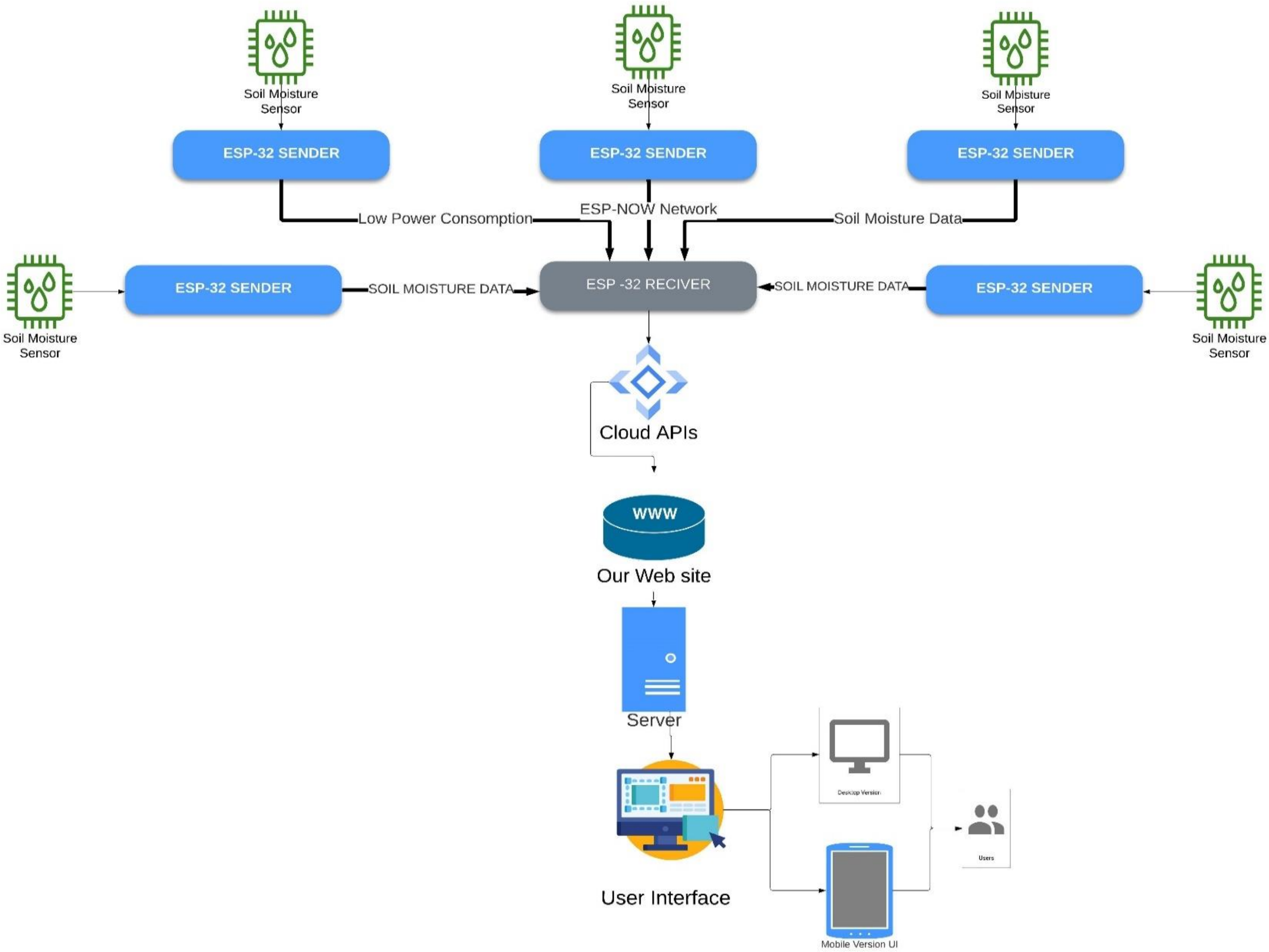


Figure III -21: The network communication information journey

III. 2.2.3 Circuit protection from water damage:

Our PCB have a high chance of getting impacted by water even the 3D printed cases are designed for protection but water still has a chance of reaching the circuit boards, this would be devastating to the system and will result in a short circuit destroying the circuits to avoid this problem and assure no water touches the circuits we covered the circuits with clear nail polish.

Nail polish can be a great circuit isolator due to its non-conductivity and it’s cheaper than other options like resin epoxy a small bottle of nail polish can isolate multiple PCBs.

III. 3 Testing and validating the full assembly of the Advanced Irrigation system in real farmland:

To finalize our work and introduce it into the world we asked a farmer permission to use his land to embody the project on the ground we first set up multiple small soil moisture PCB'S on different locations 100 meters apart using the Network communication we were able to send data between multiple PCBS all sending moisture data to one main Receiver which sends the data to the cloud

Figure III -22: Embodying the System in the farm

The solenoid valve worked as the soil moisture condition was set

```
if (moisturePercent < 10.0) {
    // If the valve is not already open, open it and update the flag
    if (!isValveOpen) {
      openValve();
      isValveOpen = true;
```

When the soil is dry and indicates low values the valve automatically opens and stays open until the soil is wet. For some time determined by the plant or tree type.

```
} else {
    // If the valve is currently open, close it
    if (isValveOpen) {
      closeValve();
      isValveOpen = false;
    }
  }
```

Then to close it after a while, if the valve is already open and the moisture and time conditions are set the valve will automatically close.

The valve can also be opened manually by either the dashboard switch or the integrated vane switch.

Figure III-23: Demonstration of the solenoid valve in function seamlessly connected to the board.

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The figure showcases a solenoid valve connected to the main farmland PCB, illustrating the integration of the valve within an agricultural irrigation system. The farmland PCB serves as the central control unit, regulating the operation of the solenoid valve to control the flow of water. Additionally, the farmland PCB displays humidity and temperature data on an OLED display and sends all the collected data to the cloud. This setup enables precise and automated management of water flow, as well as comprehensive monitoring of environmental conditions for efficient irrigation in farmland applications. Controlling the water flow can be done by partially opening the solenoid valve and leaving it half open this way is more suitable when watering different plants at the same time.

Figure III-24: The small PCB and the integrated sensors capturing data and transferring data

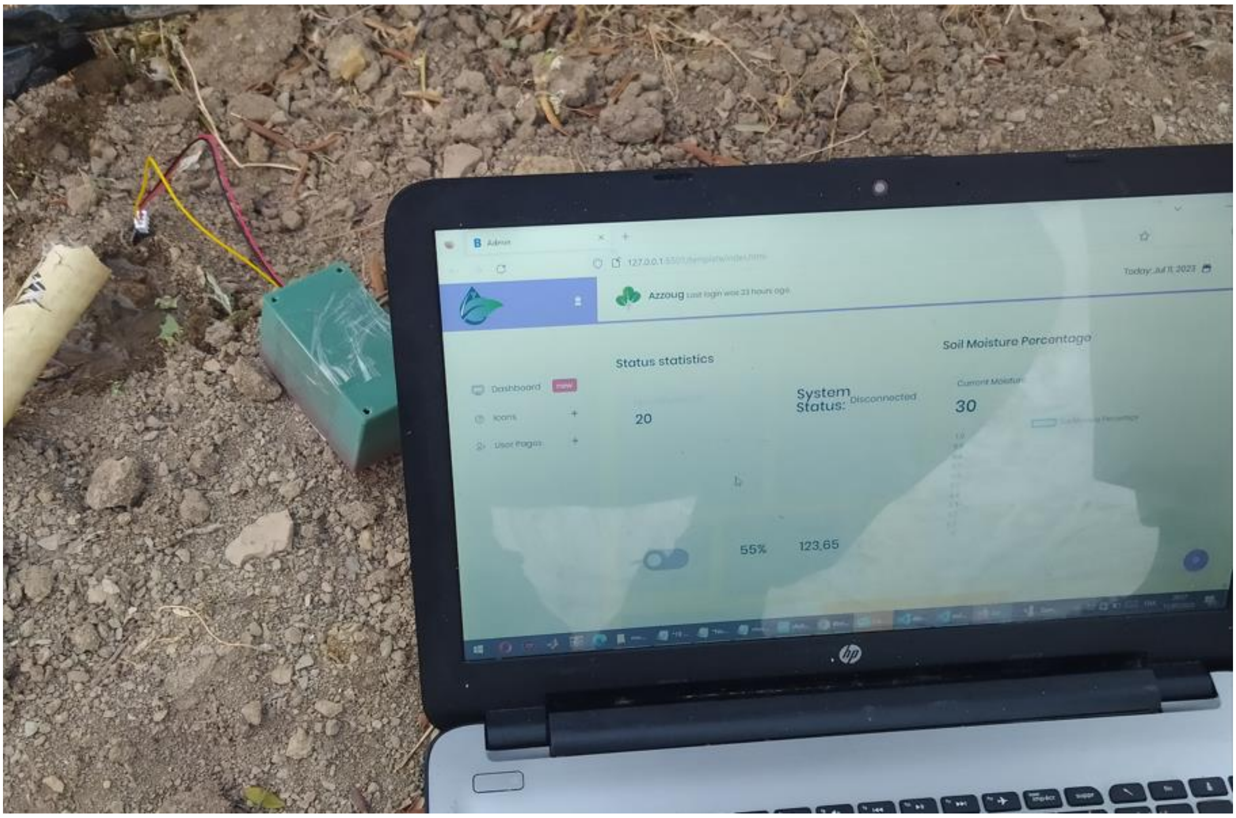

Figure III-25: the small PCB getting Water to the plant Besides the Dashboard

The captivating photo showcases the integration of soil moisture sensors with the small PCBs in the agricultural setup. These sensors, equipped with ESP-NOW communication technology, efficiently capture and transmit soil moisture values to both the Main farmland PCB and the cloud. The website connected to the system leverages this data to analyze and interpret the soil moisture readings in real-time. With this insightful information, the website determines the optimal course of action, intelligently opening or closing the solenoid valve as needed. This advanced system, enabled by ESP-NOW communication, ensures precise irrigation contro.

A video has been prepared to visually demonstrate the system's functionality in a practical farm environment. This QR code is a link to the Video:

Link:

https://drive.google.com/drive/u/1/folders/1QlANj8_pWqsw35az_-H4kWgk2iAbCa-0

III. 4 The home garden System:

implementing the System for home garden plants was much easier to set up because we used the home garden PCB to open and close the 12 V motor we don't need a lot of water flow for homegrown plants we first configured the moisture sensor to the right wet and dry values the sensor detects the dielectric permittivity of the soil. The DHT on the other hand is much easier to configure for humidity and temperature

To determine the right values we first have to convert the soil moisture readings of the raw sensor into a range of 0 to 100% to do that we used this

```
int dryValue = 2550; // Sensor reading when the soil is completely dry
int wetValue = 1100; // Sensor reading when the soil is completely wet
float moisturePercent = 0.0;

void setup() {
  Serial.begin(9600);
}

void loop() {
  sensorValue = analogRead(analogInPin);

  moisturePercent = 100.0 - ((sensorValue - wetValue) / (float)(dryValue - 
wetValue)) * 100.0;

  if (moisturePercent < 0.0) {
    moisturePercent = 0.0;
  } else if (moisturePercent > 100.0) {
    moisturePercent = 100.0;
  }
```

After multiple tests with dry and wet soil, we configured the right values and automatic algorithmic conditions for the pump to turn on and off based on the moisture values and also manually on the dashboard the System was ready to go.

After a while, the System has been proven to be time-saving for our friend Benaldjia who can now water his plants while at work or on vacation without worrying about his plants lacking water or having bad conditions

The Nokia 5110 Displays The Sensors Value on Real time With Pump status

Figure III-26 : Nokia 5110 Displaying Sensor values

III. 4.1 Cost

For the smart irrigation system production cost is an important aspect of its success not only the system saves water it also saves electricity bills by using the deep sleep mode (partially off) the system cost is very affordable more explanation of the financial stats is on the BMC.

III. 5 Conclusion

In this thesis, we got deeper into finding a solution for the crisis of water resource decline and the importance of smart Irrigation System. Our Irrigation system has been proven to be a Reliable Solution for monitoring and saving water under harsh weather conditions the efficiency has not been impacted, optimizing a communication network that doesn't need cellular coverage with such a great price for manufacturing such a System and the need on the market for such a product increases every day with global warming and natural disaster, and the farmer that uses it now said it has been very grateful now he doesn't have to be always there when watering his farmland he also suggested if we can make a model for even longer distances

The benefits are more clear with propel in the industry giving their feedback on the system our next step is to make it cover longer distance so even places in very rural areas can use the system all the time and make it available in quantities farmers

Final Conclusion

In this thesis, we developed a wireless smart Irrigation System the system proved to be a game changer to the agriculture, integrating the wireless sensor network communication revolutionized landscaping and will improve plant health.

Our ultimate goal is to enable any farmer that wants to use save time and money to use our smart Irrigation System it will make it easier for the farmer to distant monitor the Growth of the farm and enhance water conservation by preventing overwatering and also benefits others by preserving the valuable resource of Water.

There is always room for advancements and innovation on this field our next step is to further enhance the accuracy of the sensors and try to develop sensors that can go deep into the roots. We will try to use the system in different types of soil to determine which parameters an d conditions that should change in the system and also base the amount of water on other factors at the moment we are integrating a System based on predictive Analytics using machine learning to use the future Weather Conditions to enhance the plant watering time and quantity and longer distances of monitoring especially in the Desert.

In conclusion, this System provides a promising a wireless solution to the challenges to the old Irrigation Methods. We have made a great step forward in this field and raising awareness it has an endless potential For Greener Future improving productivity in landscaping.

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