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IOT BASED SMART IRRIGATION SYSTEM BY USING ARTIFICIAL INTELLIGENCE

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ABSTRACT: Regarding Agriculture Monitoring based on land or crops in the modern agricultural system, networking technology has been crucial. Since farmers can control their activities even more readily than before, it is possible to make choices even when farmers are not present. This also applies to water management in irrigation systems. The Internet of Things (IoT) keeps track of real-time data analysis from every agricultural crop that is gathered by sensors and devices. The agriculture is required rather than traditional farming since better resource management benefits farmers and eventually raises the Gross domestic product of the nation. Where agriculture is predominately centered on the unorganized sector, are ineffective and frequently result in needless water waste. A system that can offer an effective and deployable solution is therefore required. Using data on soil moisture, the automatic irrigation system we present in this study can water fields on its own. The goal is to conserve water and only provide it to the crop when it absolutely needs it. Utilizing artificial intelligence and the Internet of Things, irrigation system control via smartphone is now possible. An intelligent system that selectively irrigates crop fields only when necessary, depending on the weather and current soil moisture levels is created by the system's prediction algorithms, which analyze historical meteorological data to identify and forecast rainfall patterns and climatic changes. With an accuracy rate of 80% during testing in a controlled setting, the technology effectively addresses the issue. All aspects of agricultural production need to include technology. Given the increasing demand and poor crop supply, there is a need to enhance agricultural production. The paradigm and framework for the irrigation system are suggested in this essay. In this paper, we present a smart irrigation system using solar powered and ESP-32 microcontroller. The idea of the Internet of Things has been used. Using the soil sensor, the irrigation system measures the soil's temperature and humidity before watering the plants accordingly. Additionally, the system will send an information with all pertinent plant information, such as temperature and humidity, anytime the plants are being watered. The idea that we've employed is quite straightforward and easy to apply. Both manpower and time will be saved.

Index Terms – Smart Irrigation, Internet of Things (IoT), Artificial intelligence,

1. INTRODUCTION

1.1 ABOUT THE PROJECT:

A smart irrigation system based on water is added to the soil or land during irrigation to support plant development. Rainfall could not always be enough to supply the plants with the water they need to develop, depending on various factors such as area, season, and climate. Most irrigation systems perform database systems resulting in predicting soil moisture. Delivering precise soil-based water estimates and making soil parameters of plans and productivity of crops. Farmers can use scientific techniques such as various irrigation systems and a balanced quantity of herbicides and fertilizers to increase crop output. Crop production is determined by the availability of water, land, rainfall, meteorological conditions, and other factors. More extensive databases for crop and meteorological factors are now accessible. However, the agricultural industry lags significantly behind other sectors utilizing farm data in decision-making.

The requirements of the parameters of sensors, environment, and the function of indigenous institutions in irrigation management contain quantities of data. Furthermore, in regular and sufficient maintenance, irrigation systems decline quickly and cease to offer the desired quality within their design life. Many irrigation systems have also had negative impacts on the environment.

The Internet of Things (IoT) based Neural Network algorithm techniques used to collect the generated data must first be identified for them to be examined and evaluated. To carry out these tasks, a significant quantity of data is necessary. This data will lose all relevance, structure, and process. Some challenges in implementing precision agriculture are linked to data management, network management, and plant health condition.

Fig. 1 Smart irrigation system

Each node receives a substantial quantity of sensor observations, adding to the complexity of the network. As the Internet is a virtual network of devices, it plays a big part in each application examined, which is the downside of typical internet usage. The expertise necessary for a farmer to use agricultural technology efficiently is above that of a conventional technique. In most conditions, the end users will only have a basic understanding of precision agriculture. However, their expertise is insufficient to convert a technology for uniform crop production into a precise agriculture technology.

1.2 OBJECTIVES:

The project focuses on these objectives, which are:

- To measure field temperature periodically by deploying sensor.
- To make use of solar power which could be generated even in remote areas.
- To decide the need to provide irrigation to the crops based on soil moisture data.

1.3 SCOPE OF SMART IRRIGATION SYSTEM:

Using sensors like moisture, rain, etc., it is simple to control the water supply for irrigation by assessing the state of the soil and climate. Intelligent sensors that measure soil moisture then use the results to automatically irrigate fields with less human involvement.

2. LITERATURE REVIEW

Ahmed et al., In this work, automated security and irrigation control systems with wireless messaging capability. Our work's primary goals are to optimize efficient water usage, reduce losses, and offer security. Operating two pumps keeps the necessary water level in the field and throws extra water during hard, heavy rains.

Ajayi et al. Proposed automated security and irrigation control systems with wireless messaging capability. Our work's primary goals are to optimize efficient water usage, reduce losses, and offer security. Operating two pumps keeps the necessary water level in the field and throws extra water during hard, heavy rains.

Akanksha et al., The amount of these qualities is expressed using metrics like the Water Quality Index (WQI) and Irrigation WQI, which are used to calculate the overall water quality (IWQI). By obtaining real-time data on water properties, this study suggests a network architecture to automatically decide whether water samples are suitable for drinking and irrigation.

Alghazzawi et al., The four steps of the method are preprocessing, feature extraction, classification, and segmentation. Before images are converted to RGB format, the noisy photos are first removed. The R band is then assigned to the feature extraction step. The specified attributes are then input to the classifier to evaluate whether an image is normal or aberrant. For classification, an Optimal Probabilistic Neural Network (OPNN) is employed. The PNN classifier is improved using the artificial jelly optimization (AJO) algorithm.

Alharbi et al., The greenhouse makes planting more straightforward, which has several advantages for agriculture. Gas sensors and soil pH sensors are frequently employed in agricultural modeling. These sensors may be used for a variety of IoT-integrated farm applications. The suggested model's hardware architecture and operation are covered in the technique. Additionally, numerous agricultural evapotranspiration models are described. The Penman-Monteith equation examines essential issues, such as congestion control.

Amin et al., employing the Internet of Things (IoT), the cloud, ambient computing, edge computing, artificial intelligence, and agricultural robotic systems, the tracking, analysis, and processing of numerous processes and services in real-time. Additionally, by employing automated systems and removing human interference, these technologies can improve farm productivity and match future expectations by making agricultural operations more intelligent and resourceful.

Anand et al., Imbalance the agriculture, including standing water and weed patches, interfere with farming operations, resulting in incorrect utilization of the farmland and upsetting agricultural planning. Modern agricultural techniques might be more effective by monitoring fields and crops using Internet of Things (IoT)-enabled intelligent technologies. Remote sensing using Unmanned Aerial Vehicles (UAVs) is an effective method for gathering detailed photographs of farms.

Angelin Blessy and kumar Due to the efficient use of resources and generation of yields, it is crucial and necessary to civilization. Practical methods are required to monitor moisture levels, improve water use, and boost yields. This article discusses cutting-edge methods for combining IoT and artificial intelligence in agricultural irrigation systems. This browser presents the different parts, modern irrigation system, many comparative metrics, and its needs.

Assaf. R and I. Ishaq, over time, the amount of rainfall has decreased, and springs are becoming drier. As a result, the irrigation system is one of the most frequently employed in agriculture. The kind of soil, its fertility, its moisture content, its humidity, and its temperature are just a few of the many variables that should be considered when determining how much water should be supplied to the plant when employing an irrigation system. To automate the watering schedule for the plants, our suggested irrigation system takes these considerations into account.

Assaf. R and I. Ishaq Palestine is a fertile nation whose economy mainly depends on agriculture. In Palestine, rain is essential for agriculture, but as time has passed, the amount of precipitation has decreased, and springs are drier. As a result, the irrigation system is one of the most frequently employed in agriculture. The kind of soil, its fertility, its moisture content, its humidity, and its temperature are just a few of the many variables that should be considered when determining how much water should be supplied to the plant when utilizing an irrigation system.

Badrun et al., The irrigation industry may benefit from the Internet of Things (IoT) innovative solutions, which can enhance irrigation management and lower operating infrastructure maintenance costs. The incapacity of stakeholders to transform available data into full, reliable information that can be used in decision-making is one of the most significant issues with intelligent irrigation systems.

Bhat S. A and N. -F. Huang., develop in precision agriculture because it has the capacity to evaluate massive volumes of data and crucial abstract information, which enables agricultural practitioners to comprehend farming operations and draw solid judgments.

3. EXISTING SYSTEM

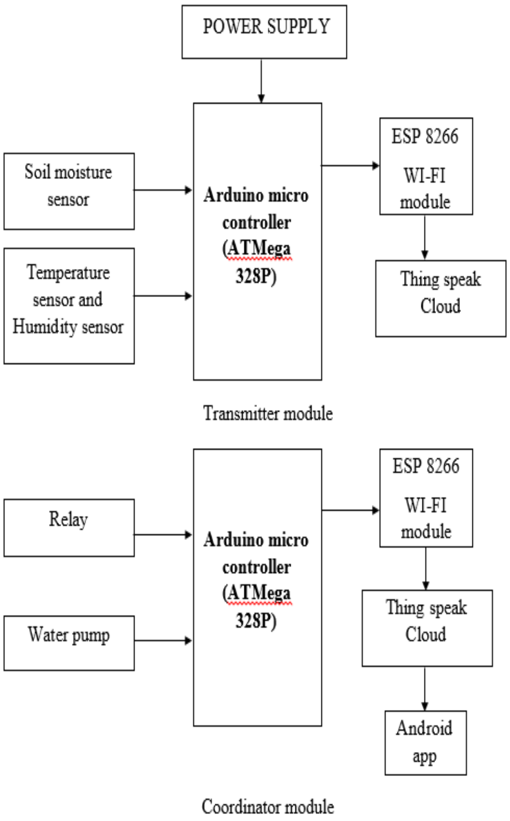


Fig. 2 Block Diagram of Existing System

3.1 EXPLAINATION OF EXISTING SYSTEM:

The microprocessor of the transmitter module reads the moisture content of the soil and ambient variables like temperature and humidity. Every 30 seconds, these values are transmitted to the cloud through the internet. Graphs are used in the Thing talk cloud to display the logged data. An alarm message is provided to the farmer when the sensor values exceed the threshold. A farmer can activate the water motor by using an Android application to operate the relay attached to the coordination module online. A second signal telling the farmer to stop the engine is issued when the appropriate environmental criteria are fulfilled.

To test the system's dependability, a potato plant is used as an experiment. The water needs of the potato plant are 500-700mm per day. As a result, the cloud analytics are configured for soil moisture in the 300–600 range. It is discovered that the system is effective and that water is pumped into the field as needed. The farmer receives a warning message if the soil is dry.

The suggested irrigation system offers an effective and dependable solution. It is simple to study the data and learn how much water is needed at what intervals throughout the day thanks to constant updates on soil conditions and environmental factors. Additionally, the technology can effectively manage water and assure a higher agricultural output in arid areas with insufficient rainfall by accurately watering the crops. The method reduces human involvement. It enables the farmer to access the data from anywhere and learn about the crops and environment around them, operate the water pump, and keep an eye on the field.

4. PROPOSED SYSTEM

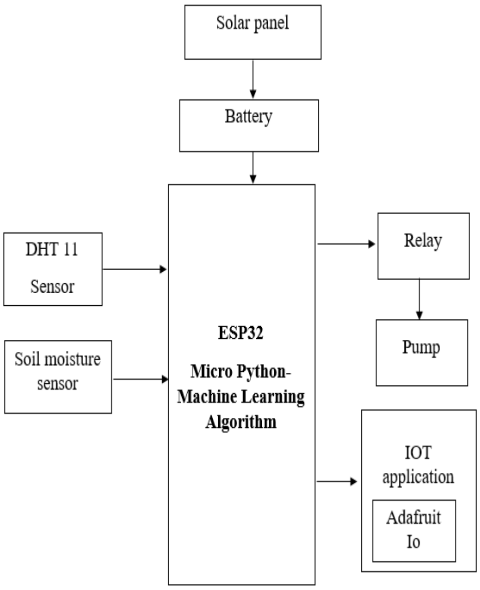


Fig.3 Block Diagram of Proposed System

4.1 EXPLAINATION:

A server or laptop computer, among other electronic equipment, are electrical loads that are powered by the power supply. The solar panel accept the sun rays converting to electricity and storage the battery. This circuit receives power from the battery. A power supply's primary job is to convert electrical current from a source to the proper voltage, current, and frequency needed to power a load. The relay works on the principle of electromagnetic field induction, the relay act as one of the controllers. By opening and stopping the flow in response to the signal from the sensor and supplied through the controller, a water pump regulates the flow of water. If the root depth will reach high, the pump will be on OFF State otherwise the pump is kept in ON. Always the relay controlling on the pump. DHT 11 sensor to measure both humidity and temperature. This sensor operating voltage is 3V to 5V, the sampling rate of the DHT11 is 1Hz.

In order to accomplish this, we began by selecting the sensors that would be utilized to realize the model, starting with the soil moisture sensor, which indicates the amount of soil moisture present, and moving on to the temperature/humidity and rain sensors. The Arduino board is first programmed to control the sensors in a way that permits the gathering and distribution of the various pieces of data in real time when the sensors are connected to it. In order to teach them to be able to predict when to start or stop pumping, we made sure the data was saved and aggregated over several months using methods based on machine learning.

5. HARDWARE REQUIREMENTS:

5.1 POWER SUPPLY

In contrast to a primary or disposable battery, which is delivered fully charged and discarded after use, a type of electrical battery known as a rechargeable battery, storage battery, secondary cell, or accumulator can be charged, discharged into a load, and recharged several times.

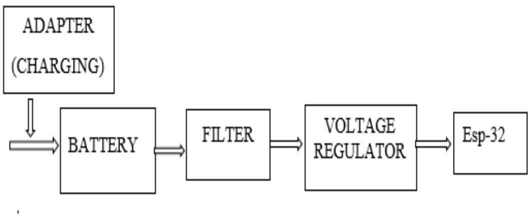


Fig. 4 Power Supply Block

5.2 VOLTAGE REGULATOR

A voltage regulator is a device designed to automatically maintain a constant voltage. A voltage regulator may employ negative feedback or a simple feed-forward design. It could use an electromechanical mechanism or electrical components. Depending on the design, it could be used to regulate one or more AC or DC voltages.

Fig.5 Voltage regulator

5.3 JUMPER WIRES

In order to analyse circuit problems or to swap circuits, jumper wires are typically used to carry electricity between two places in an extremely circuit.

Fig. 6 Jumper wires

5.4 SOLAR PANEL

In solar energy, the sun is the source. Solar panels, also known as "PV panels," are machines that use the sun's light, which is composed of small energy particles called "photons," to produce electricity that may be used to power electrical appliances.

Solar panels can be used for a broad variety of other things in addition to producing electricity for residential and commercial solar electric systems, including remote power systems for cabins, telecommunications equipment, remote sensing, and more.

Fig. 7 Solar panel

5.5 LEAD ACID BATTERY

A lead acid battery's negative electrode is made of porous or spongy lead. Lead can grow and dissolve more readily because it is permeable. The positive electrode is composed of lead oxide. Both electrodes are immersed in an electrolytic solution of sulfuric acid and water. In the case that the two electrodes come into contact because of the physical movement of the battery or variations in electrode thickness, a membrane that is chemically permeable but electrically insulating keeps them apart. This membrane also protects against electrical shorts that pass through the electrolyte.

Fig. 8 Lead acid battery

5.6 DHT 11 SENSOR:

The ratio of relative humidity measures how much moisture is present in a gas, which could be a mixture of water vapor, nitrogen, argon, or pure gas, for example. The two types of sensors can be identified based on how they calculate humidity. They are what they are: a relative humidity sensor and an absolute humidity sensor. The DHT11 is a digital temperature and humidity sensor.

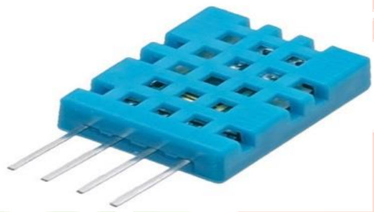


Fig. 9 DHT 11 Sensor

5.7 RELAY MODULE:

In automatic control circuits, relays automatic switches are widely employed to manage high currents with low current signals. The input voltage range for the relay signal is 0 to 5V.

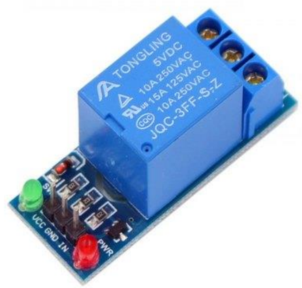


Fig. 10 Relay module

5.8 WATER PUMP:

The basic purpose of a pump, which is defined as a common mechanical device, is to push a gas that would normally flow through a pipeline. These are also used to compress gases so that wheels don't have to be inflated with air. Pumps pressurize the liquids to pull them in and release them throughout the exit by using mechanical energy. The primary energy sources for pumps include wind power, human power, electricity, and engines.

Fig. 11 Pump

6. INTERNET OF THINGS (IOT)

6.1 INTRODUCTION

The internet of things, or IoT, is a network of interconnected computers, mechanical and digital equipment, objects, animals, or people who may exchange data across a network without needing to interact with other people or computers.

The Internet of Things (IoT) ecosystem consists of web-enabled intelligent devices that use embedded systems, such as processors, sensors, and communication technology, to collect, send, and act on the data they receive from their surroundings.

6.2 ESP32 WIFI MODULE (IOT HARDWARE)

The ESP32 designation refers to the Expressive Systems chip. This provides Wi-Fi connectivity for embedded devices, as well as dual-mode Bluetooth connectivity in some versions. ESP32 is essentially only a chip, but the maker also usually refers to the modules and development boards that make use of this component as "ESP32."

Fig. 12 ESP 32 Wi-Fi module

The Ten Silica Xtensa LX6 microprocessor, which has dual-core and single-core variations, is used in the ESP32 device and has a clock frequency of more than 240 MHz.

6.2.1 ESP 32 pinout

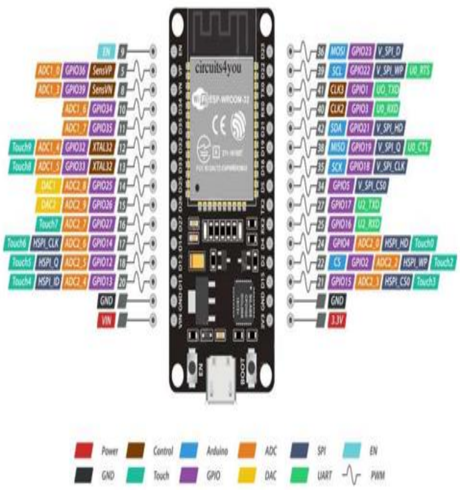


Fig. 13 ESP 32 Pin configuration

6.2.2 ESP32 Peripheral features

1. 10 Capacitive sensing GPIOs
2. 3 UART interfaces
3. 18 Analog-to-Digital Converter (ADC) channels
4. 3 SPI interfaces
5. 2 I2C interfaces
6. 16 PWM output channels
7. 2 I2S interfaces
8. 2 Digital-to-Analog Converters (DAC)

7. SOFTWARE REQUIREMENTS

7.1 Node MCU ESP 32 Micro python Programming:

7.1.1 *Micro python*:

A compact and effective version of the Python programming language is called micro python. It is designed to work on microcontrollers in restricted conditions and provides a tiny portion of the standard Python library. It is totally Python compatible, thus there are no inherent problems when moving your code from a desktop to an embedded machine. Micro In addition to the core Python libraries, Python also comes with supplementary modules to efficiently access and interact with the low-level hardware. Micro Python is a complete Python compiler that includes a run-time interactive prompt (REPL) for running commands. For an interactive user experience, the REPL offers paste mode, auto-indent, tab completion, history, and tab completion.

7.1.2 *Micro python Boards*:

For each of the below-listed microcontroller boards, Micro python has a specific firmware.

The firmware may be downloaded and flashed from the Micro python's official repository:

- ESP 32 Module
- pyboard v1
- STM32 Nucleo and Discovery Boards
- pyboard D Series
- Espruino Pico
- Raspberry Pi Pico
- TinyPICO
- Wi Py Module

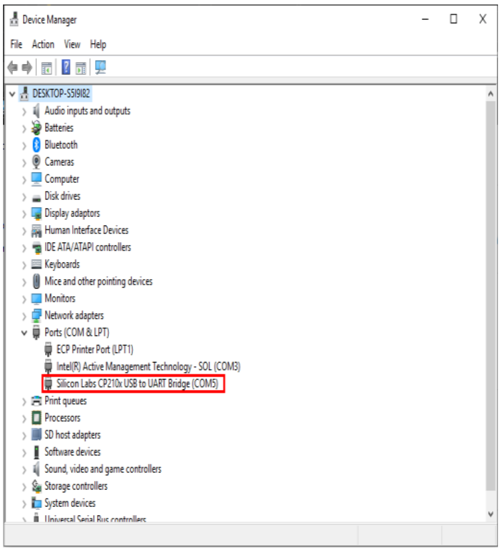
7.1.3 *ESP 32 Micro python Programming*:

The ESP 32 must be flashed with Micro Python firmware before being programmed with the Micro Python API.

1. ESP 32 Wi-Fi Module firmware flashing using the Micro Python firmware
2. ESP 32Wi-Fi Module Programming Using the Micro Python Programming Language

STEP 1: Install CP2102 Driver:

An FTDI Serial Programmer is part of the ESP 32-12E module.

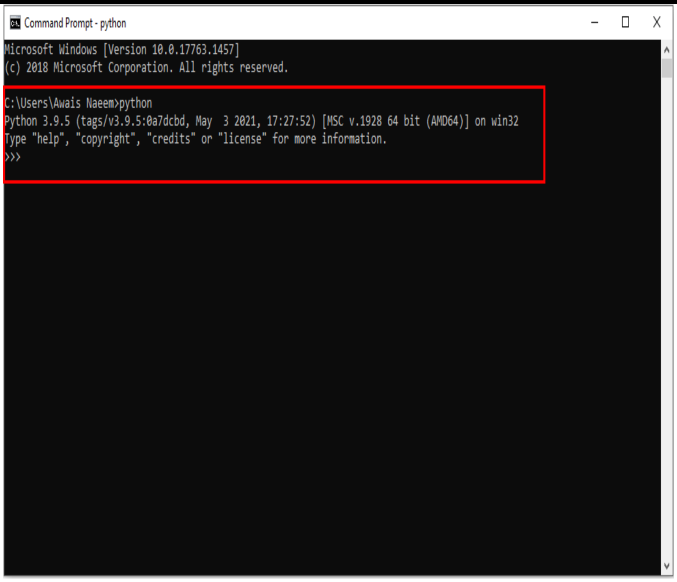


STEP 2: Install Python Essentials for Windows:

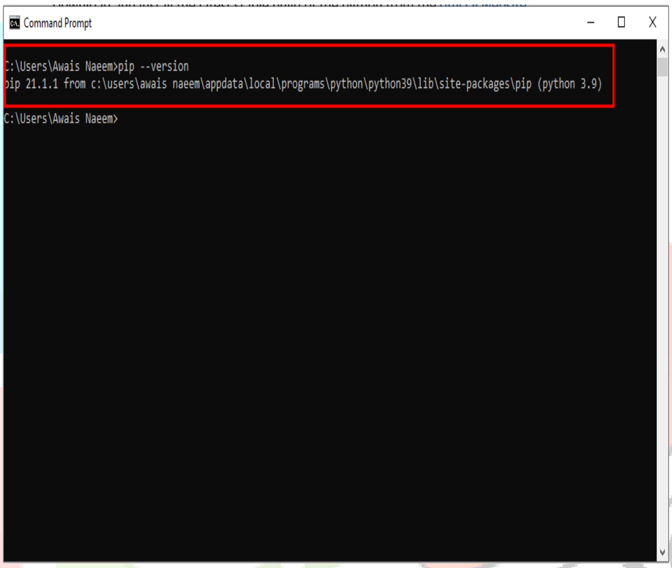
The most recent stable version of Python can be downloaded and installed from the official website.

Fig. 14 Python Download and Install in Windows

If Python was properly installed, the following line in Windows Terminal should open an interpreter and identify Python at the command prompt:



Python is pre-packaged with "Pip Package Manager" if you obtained it from official sources. Using the following command, make sure that "pip" is installed alongside Python:



You can proceed if your system recognizes both "pip" and "python." If not, you can download the programmed once again. Make sure that your system has successfully loaded and identified both of these before continuing.

STEP 3: Install esptool:

- Using the pip package manager, install the esptool on Windows by typing pip install esptool.
- After the installation is finished, use the following command to check whether the esptool was installed successfully.

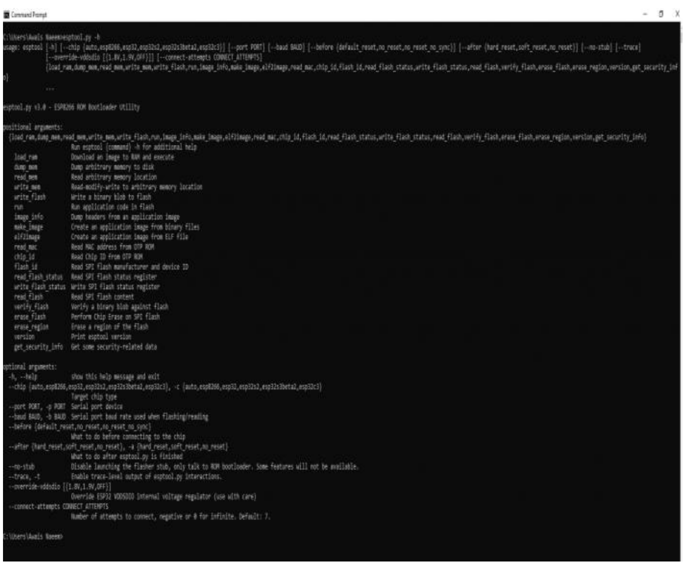


Fig. 15 Micro python Firmware Flash in ESP8266 using esptool (Windows)

7.1.4 *Micro python Firmware REPL*:

I'm going to utilize the REPL that is built into the Micro Python Firmware to create and flash a program that will blink the onboard LED.

I must use a specific serial port to communicate with the ESP 32 in order to accomplish this. I'll be using the Windows-based Putty terminal emulator and serial console program for this.

You must first download and install Putty from its official website. Once it is installed, you can use a dedicated serial port (such as COM5) to communicate serially to access the REPL:

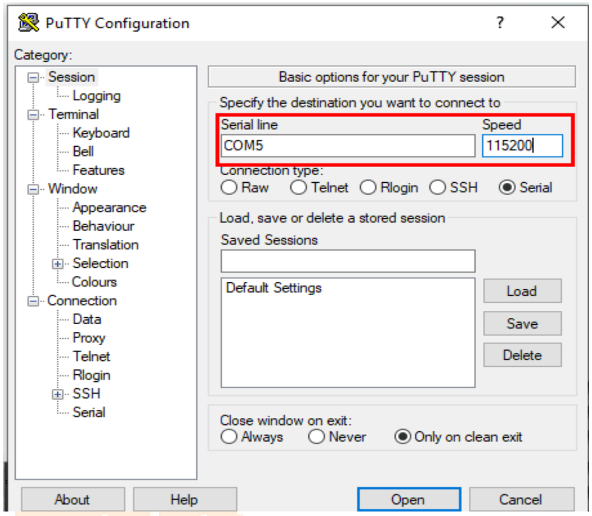


Fig. 16 Settings on windows

To issue commands on the REPL after the connection has been made, you must hit the RST button on the ESP 32:

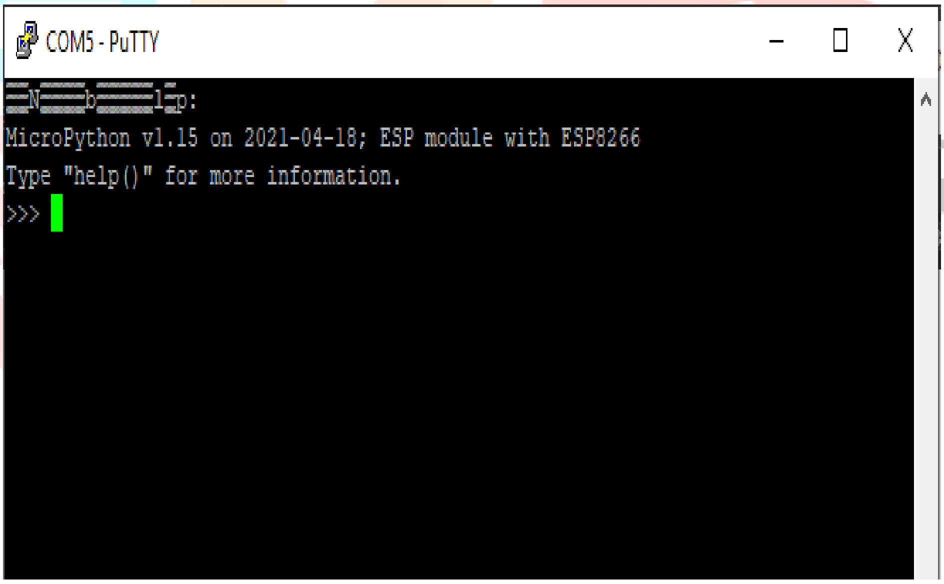


Fig. 17 Micro python REPL in Windows

7.2 THONNY IDE:

Thonny IDE is a fantastic starting point for learning Python and even Micropython. This IDE is also pre-installed on the Raspberry Pi and has a large user base.

Integrated development environments (IDEs), which bundle common tools like code editors, compilers, and debuggers into a single software program, increase the productivity of computer programmers. An IDE already provides the environment, so users do not need to install the language's compiler or interpreter on their machines.

Step 1: Install Thonny IDE

For Windows

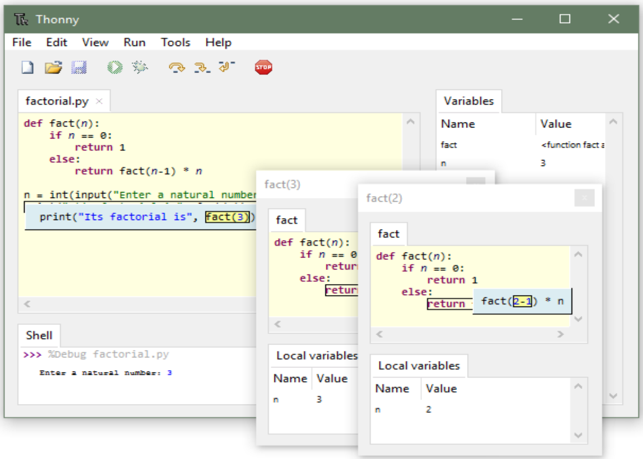
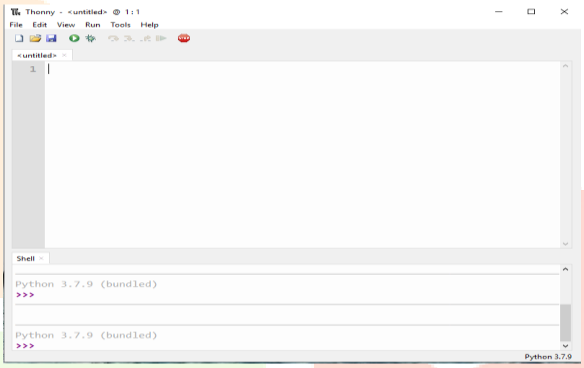


Fig. 18 Thonny Installer for Windows

Once the IDE has been installed, run it by running the installer with administrative rights. The user interface should be as follows:



Step 2: Organize Thonny IDE

You must choose the proper interpreter within the Thonny IDE in order to upload the mini-Python application to the esp8266 wifi device.

Go to **Run->Select Interpreter…**

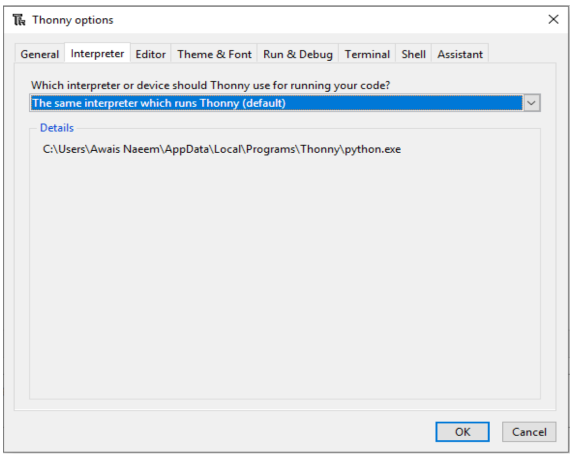


Fig. 19 Thonny Interpreter Window

Choose Micro Python (ESP8266) from the dropdown menu, and then from the Port dropdown menu, choose the proper Serial Port (COM for Windows):

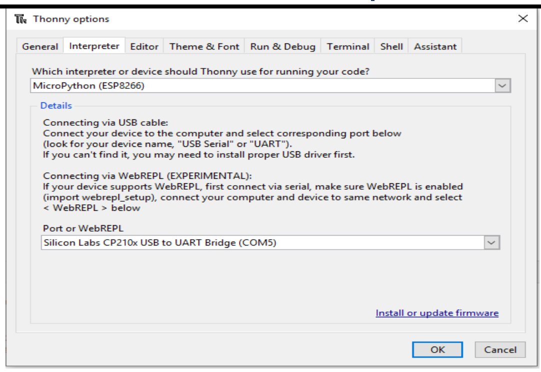


Fig. 20 Micro python Interpreter and COM Settings for ESP8266

When you click OK, you'll see that the flashed firmware is connecting the Thonny IDE to the ESP32 board.

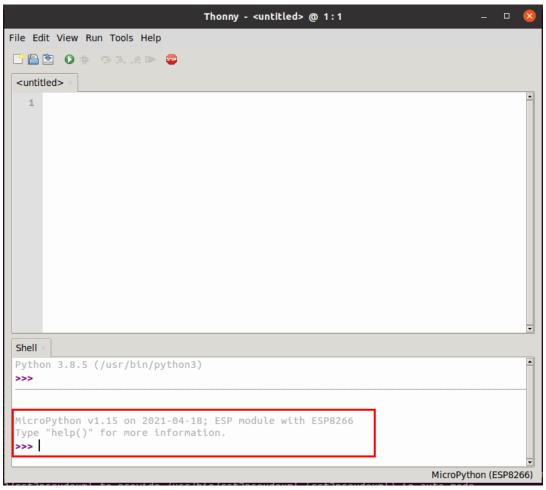
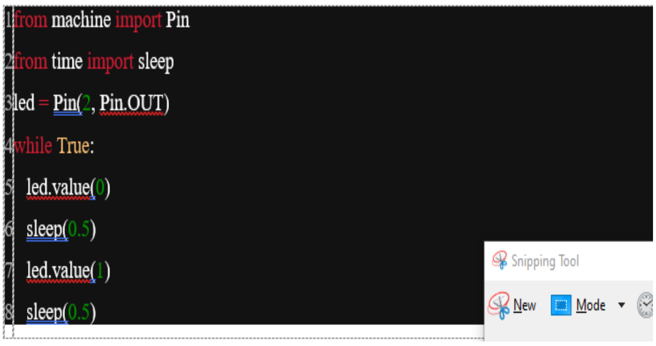


Fig. 21 Thonny IDE Connection Establish with esp32

Step 3: Upload First Micro python Script using Thonny IDE

Following the establishment of the connection, you can enter commands into the REPL window or create a specific micropython script that will be loaded into the esp32 wifi module.



Paste the script below into the "untitled" file and save it as "main.py" in the Micro Python Device:

You should click the 'Stop' button to modify the application. To view the effects of changes after updating the software, save it and then 'Run' it.

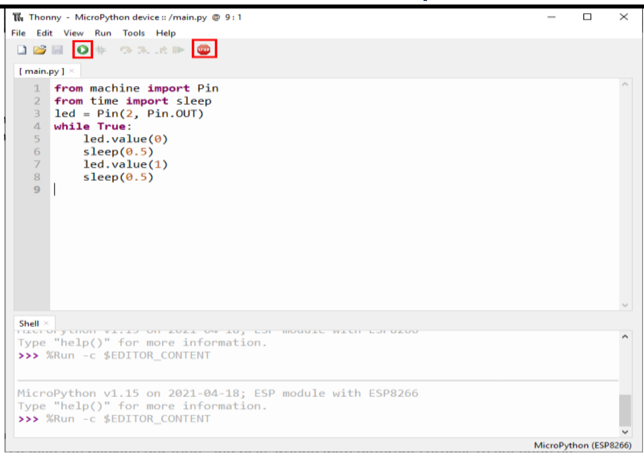


Fig. 22 Thonny IDE Script

7.3 ADAFRUIT IO

The platform Adafruit IO was created by ADAFRUIT IO to show, react to, and interact with the data from your project. Adafruit additionally keeps your data secure (ADAFRUIT would never sell or give your data away to another firm) and private (data feeds are private by default).

The esp32-s2 is an affordable, all-in-one, option for connecting your projects to the internet using our IOT platform, ADAFRUIT IO.

For more information and guides about ADAFRUIT IO, check out the ADAFRUIT IO basics series.

7.4 SOFTWARE DESIGNING

7.4.1 *PROPOSED ALGORITHM*:

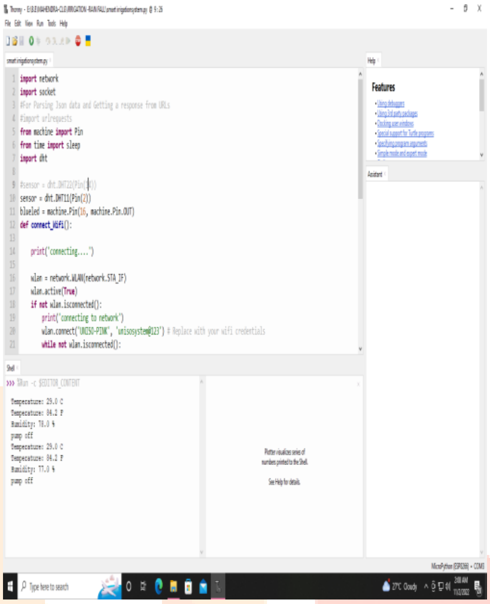
```
# Complete project details at https://RandomNerdTutorials.com

from machine import Pin

from time import sleep

import dht

sensor = dht.DHT22(Pin(14))

#sensor = dht.DHT11(Pin(14))

while True:

  try:

    sleep(2)

    sensor.measure()

    temp = sensor.temperature()

    hum = sensor.humidity()

    temp_f = temp * (9/5) + 32.0

    print('Temperature: %3.1f C' %temp)

    print('Temperature: %3.1f F' %temp_f)

    print('Humidity: %3.1f %%' %hum)

    except OSError as e:

    print('Failed to read sensor.')

  import network
```

```
import socket
#For Parsing Json data and Getting a response from URLs
import urequests
from machine import Pin
from time import sleep
import dht
#sensor = dht.DHT22(Pin(14))
sensor = dht.DHT11(Pin(14))
blueled = machine.Pin(2, machine.Pin.OUT)
def connect_Wifi():
  print('connecting....')

    wlan = network.WLAN(network.STA_IF)
    wlan.active(True)
    if not wlan.isconnected():
        print('connecting to network')
       wlan.connect('UNISO-PINK', 'unisosystem@123') # Replace with your wifi credentials
        while not wlan.isconnected():
            pass
    print('Connected') # Print connected once connected
def get_data():
    response = urequests.get("https://www.metaweather.com/api/location/2295386/")
    data = response.json()
    return data
while True:
  try:
     sleep(2)
    sensor.measure()
    temp = sensor.temperature()
    hum = sensor.humidity()
    temp_f = temp * (9/5) + 32.0
    print('Temperature: %3.1f C' %temp)
    print('Temperature: %3.1f F' %temp_f)
    print('Humidity: %3.1f %%' %hum)
    if (temp > 35):
        blueled.off()
        print("pump on")
    else:
```

```
        blueled.on()

        print ("pump off")

  except OSError as e:

    print('Failed to read sensor.')
```

8. RESULTS AND DISCUSSION

The below the figure represents smart irrigation system using python and development tool is Thonny.



The soil moisture sensor senses the how much of water content in soil, temperature value and humidity value using the DHT-11 sensor. These values are predicted help of sensors updated in python (Thony) to run the coding to get the result. The humidity and temperature values are continuously monitoring and updated in python to cross the certain condition the motor will ON and OFF states. The status of the motor depends on temperature and moisture values.

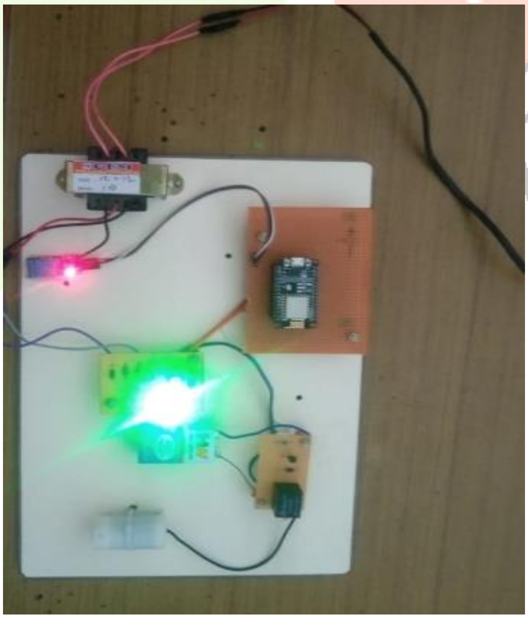


Fig. 23 Prototype of smart irrigation

The above the figure represents the overall prototype of smart irrigation system.

Table 1 Condition for on and off water pump

S. No	Sensor value	Motor status
1	Temperature >35 and humidity<55	Motor ON
2	Temperature <35 and humidity>55	Motor OFF


TEMP
32.3
Value
HUMIDITY
45
Value
81
Value
PUMP ON OFF


TEMP
31.8
Value
HUMIDITY
45
Value
78
Value
PUMP ON OFF


TEMP
31.8
Value
HUMIDITY
45
Value
81
Value
PUMP ON OFF

9. CONCLUSION

Internet of Things will help to enhance smart irrigation based on the solar power. With the use of sensors and the Internet of Things, we can forecast the temperature, humidity, and soil moisture level. IoT technology and information recording in Python with fuzzy logic may be used to monitor and operate irrigation systems. When predators are used, crop damage is decreased. IoT works in several facets of farming to increase productivity, water management, crop monitoring, and soil management. Mobile IoT applications retain sensor data and provide alerts to worried farmers. It also reduces the need for human labour, makes agricultural methods simpler, and promotes smart farming. In addition to these benefits, smart farming may expand the market for farmers with a single touch and little work. We are able to anticipate the temperature, humidity, and soil moisture content thanks to sensors and the Internet of Things. To monitor and manage irrigation systems, IoT technologies and information recording in Python, may be employed. Crop damage is reduced when predators are utilized. IoT improves productivity, water management, crop monitoring, and soil management in several aspects of farming. Additionally, it facilitates smart farming, simplifies agricultural practices, and eliminates the demand for human labour. In addition to these advantages, smart farming might easily and quickly increase the market for farmers.

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