VIETNAM NATIONAL UNIVERSITY

UNIVERSITY OF ENGINEERING AND TECHNOLOGY

ASSIGNMENT REPORT

Major: Electronics and Telecommunications Engineering Technology

Subject: IoT and Application

INDOOR PLANT WATERING SYSTEM

GROUP 11

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Abstract:

Indoor plants have become increasingly popular in recent years, as they not only add a touch of nature to our homes and offices, but also provide numerous benefits to our health and well-being The only problem is - those plants need watering to survive, and if you forget to pay attention to them for a while you may need to start over. So instead of staying ever vigilant, we decide to choose the topic “Indoor Plant Watering System”, which creates a setup that will let you both monitor the amount of moisture in your plants soil, and automatic water your plants.

Introduction:

The system is built on the idea of a smart potted plant using IoT technology. We planned and perfected the system in a time and only using one type of plant for the demo, which is the aloe vera. The goal of the system will be to care for indoor plants when the owner is away from home for a long period of time. The system will help the plants meet the required amount of water and update the plant's situation to the user via Blynk Platform. Although the system only includes a small node in the idea, this is a development for a bigger system in the future.

I. System overview:

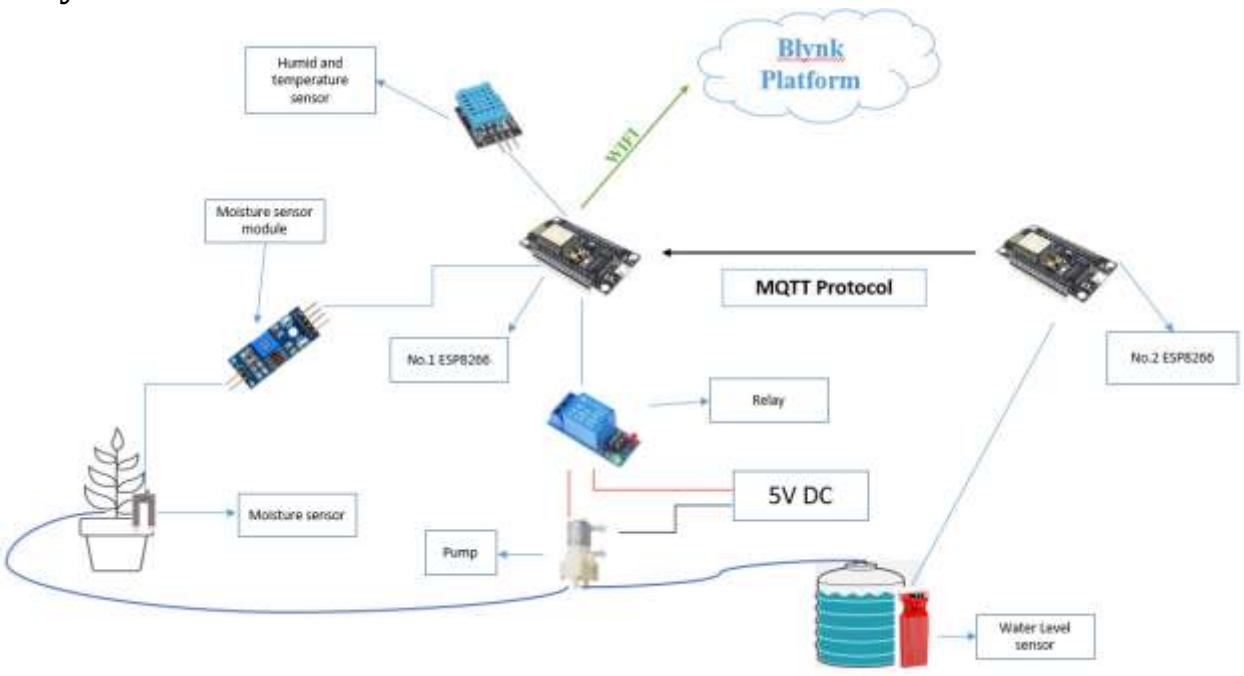


Figure 1 : System Architecture

Operation mechanism: The image depicts a smart plant watering system with two ESP8266 microcontrollers, labeled as No.1 ESP8266 and No.2 ESP8266.

No.1 ESP8266 is responsible for reading data from a moisture sensor module to assess the soil moisture level, collecting data from a humidity and temperature sensor to monitor environmental conditions, and controlling a pump (via a relay) to water the plant based on the gathered data.

On the other hand, No.2 ESP8266 monitors the water level sensor inside a water tank or reservoir to check the water supply's level.

Both microcontrollers use the MQTT protocol to communicate with each other and the No.1 ESP8266 uses Wi-fi to communicate with the Blynk platform, a cloud service for controlling IoT devices, to check the plant's status.

1. System analysis

Input:

- Sensor parameters: temperature, humidity, soil moisture, water level (of the tank)

Output:

- Relay controls the pump
- Relay controls lights
- Signal when the tank runs out of water

Data needs to be displayed and stored:

- Parameters from the sensor
- Water level of the tank

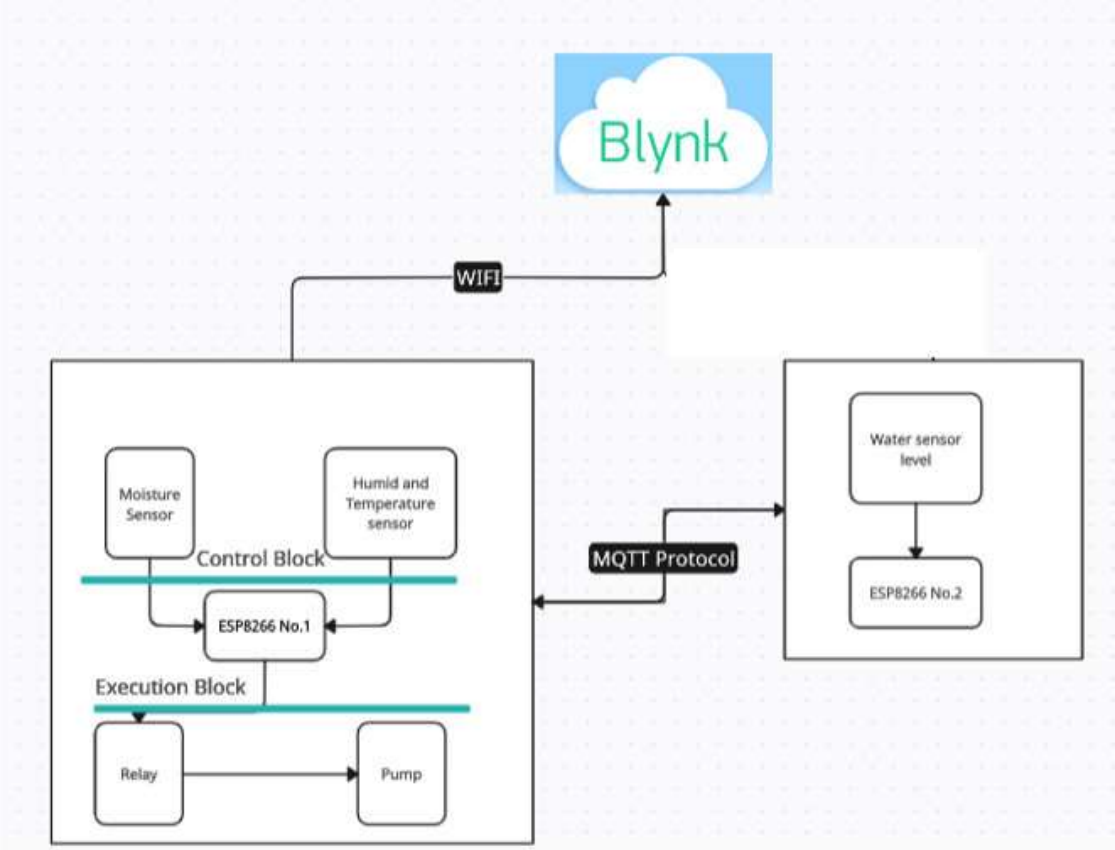


Figure 2: System block diagram

1.1 Control Block:

a. NodeMCU ESP8266

Figure 3: ESP8266 NodeMCU

ESP8266 is a microcontroller with integrated Wifi technology with multi-platform compatibility characteristics and is often used in IoT systems. In the ESP8266 system acts as an entrance microcontroller it connects to the screen, the LoRa module to receive parameters from the sensor and display it to the screen, the ESP8266 is also connected to the Blynk IoT platform to control the system over the Internet.

NodeMCU ESP8266 Specifications & Features:

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

Table 1: NodeMCU Development Board Pinout Configuration:

Pin Category	**Name**	**Description**
Power	Micro-USB	**Micro-USB:** NodeMCU can be powered through the USB port
	3.3V	**3.3V:** Regulated 3.3V can be supplied to this pin to power the board
	GND	**GND:** Ground pins
	Vin	**Vin:** External Power Supply

Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Applications:

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

b. DHT11–Temperature and Humidity Sensor

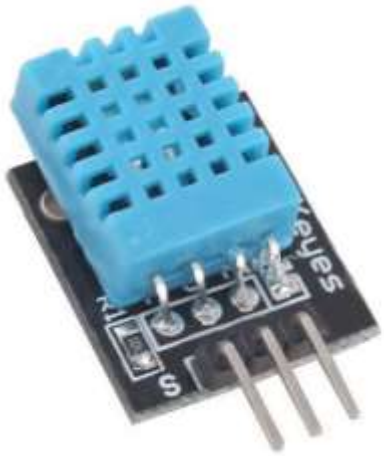


Figure 4: DHT11

The DHT11 is a commonly used **Temperature and humidity sensor that** comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data.

How Does a DTH11 Sensor Work?

If you remove the sensor's casing, you will find an NTC thermistor and a humidity sensing component inside.

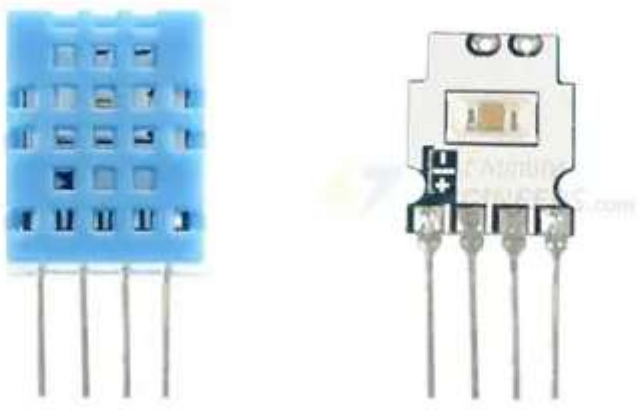


Figure 5: DHT11 (Inside)

The humidity sensing component has two electrodes with a moisture-holding substrate (usually a salt or conductive plastic polymer) in between. As the humidity rises, the substrate absorbs water vapor, resulting in the release of ions and a decrease in the

resistance between the two electrodes. This change in resistance is proportional to the humidity, which can be measured to estimate relative humidity.

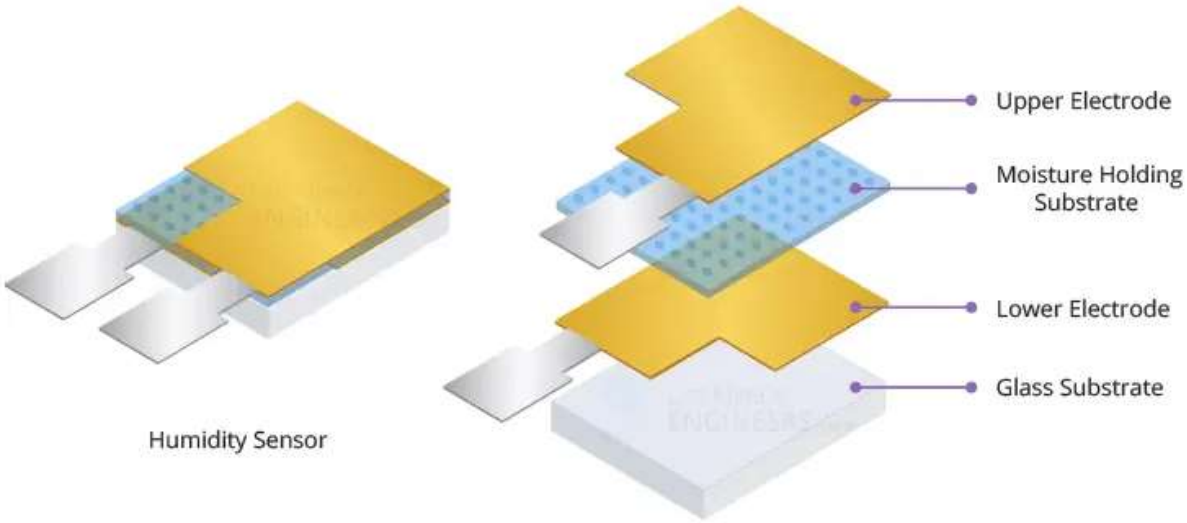


Figure 6: DHT11 Architecture

Table 2 : DHT11 Pinout Configuration:

DHT11 Sensor module		
No	Pin Category	Description
1	Vcc	Power supply 3.5V to 5.5V. With a 5V power supply, the sensor can be placed up to 20 meters away. With 3.3V supply voltage, the sensor can be placed just 1 meter away; otherwise, the line voltage drop will cause measurement errors.
2	Data	Outputs both Temperature and Humidity through serial Data
3	Ground	Connected to the ground of the circuit

DHT11 Specifications:

- Operating Voltage: 3.5V to 5.5V
- Operating current: 0.3mA (measuring) 60uA (standby)
- Output: Serial data
- Temperature Range: 0°C to 50°C
- Humidity Range: 20% to 90%
- Resolution: Temperature and Humidity both are 16-bit
- Accuracy: ±1°C and ±1%

Applications:

- Measure temperature and humidity
- Local Weather station
- Automatic climate control
- Environment monitoring

Connection diagram:

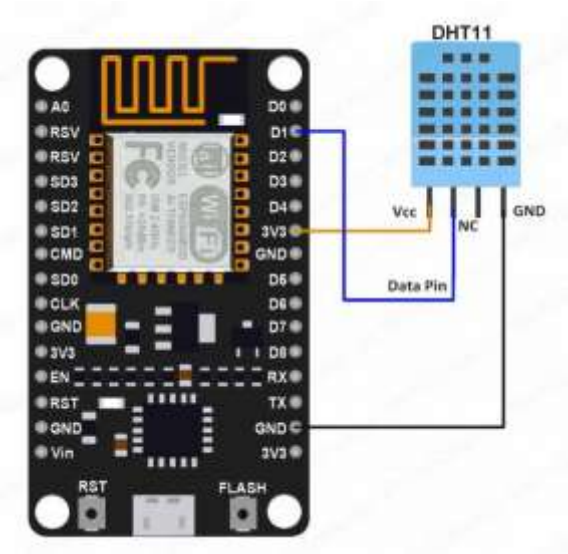


Figure 7: Connection diagram of DHT11

c. Soil Moisture Sensor

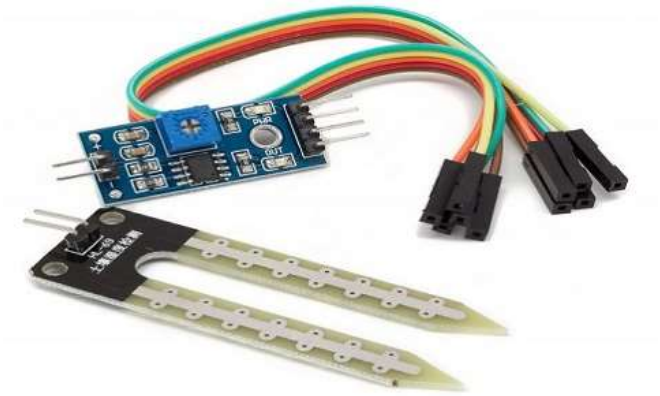


Figure 8: Soil Moisture Sensor

The Soil Moisture Sensor is commonly used in automated watering systems, smart gardens, and other applications. It helps determine the moisture level of the soil using a probe and provides analog or digital values through corresponding pins to communicate with a microcontroller for various applications.

How Does a Soil Moisture Sensor Work?

The soil moisture sensor operates in a straightforward manner.

The fork-shaped probe with two exposed conductors acts as a variable resistor (similar to a potentiometer) whose resistance varies with the soil's moisture content.

This resistance varies inversely with soil moisture:

- The more water in the soil, the better the conductivity and the lower the resistance.
- The less water in the soil, the lower the conductivity and thus the higher the resistance.

The sensor produces an output voltage according to the resistance, which by measuring we can determine the soil moisture level.

Table 3**:** The Soil moisture pinout configuration:

Soil Moisture Sensor		
No	Pin Category	Description
1	Vcc	Power supply 3.5V to 5.5V, analog output will vary depending on the voltage supplied to the sensor.
2	A0	Analog output, generates analog output voltage proportional to the soil moisture level, so a higher level results in a higher voltage and a lower level results in a lower voltage.
3	Data	Digital output, indicates whether the soil moisture level is within the limit. D0 becomes LOW when the moisture level exceeds the threshold value (as set by the potentiometer), and HIGH otherwise.
4	Ground	Connected to the ground of the circuit

Soil moisture sensor Specifications:

- The required voltage for working is 5V
- The required current for working is <20mA
- Type of interface is analog
- The required working temperature of this sensor is 10°C~30°C

This module also includes a potentiometer that will fix the threshold value, & the value can be evaluated by the comparator-LM393. The LED will turn on/off based on the threshold value.

Applications:

- Agriculture
- Landscape irrigation
- Research
- Simple sensors for gardeners

Connection diagram:

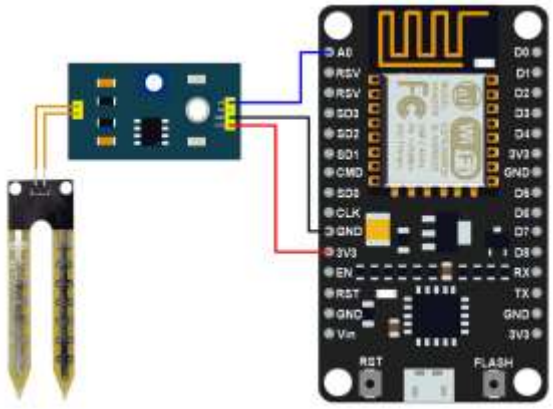


Figure 9 Connection Diagram of Soil moistrure Sensor

d. Water Level Sensor

Figure 10 Water Level Sensor

Water level sensors detect the level of liquids and other fluids and fluidized solids, including slurries, granular materials, and powders that exhibit an upper free surface.

How does the water level sensor work?

The operation of the water level sensor is fairly simple. The power and sense traces form a variable resistor (much like a potentiometer) whose resistance varies based on how much they are exposed to water.

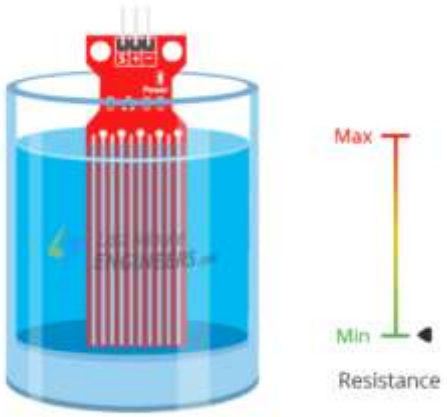


Figure 11: How water level sensor work

This resistance varies inversely with the depth of immersion of the sensor in water:

- The more water the sensor is immersed in, the better the conductivity and the lower the resistance.
- The less water the sensor is immersed in, the poorer the conductivity and the higher the resistance.

The sensor generates an output voltage proportional to the resistance; by measuring this voltage, the water level can be determined.

Table 4: Water level sensor Pinout Configuration

Water level sensor		
No	Pin Category	Description
1	Vcc	Power supply 3.5V to 5.5V.
2	Signal	Is an analog output pin that will be connected to one of your Arduino's analog inputs.
3	Ground	Connected to the ground of the circuit

Soil moisture sensor Specifications:

- Operating voltage: DC3-5V
- Operating current: less than 20mA
- Sensor Type: Analog
- Detection Area: 40mmx16mm
- Operating temperature: 10℃-30℃
- Humidity: 10% -90% non-condensing

Connection diagram:

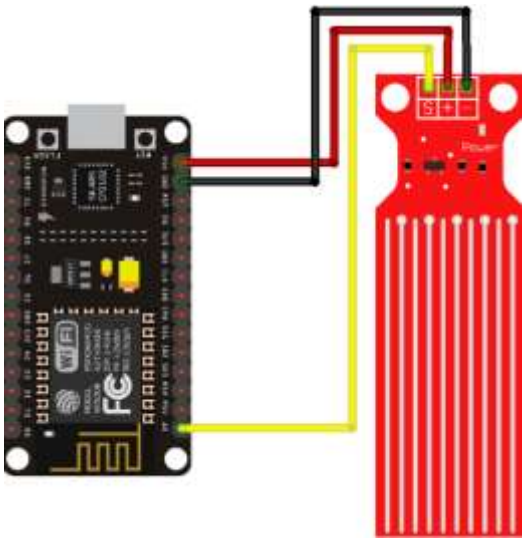


Figure 12: Connection Diagram of Water level Sensor

1.2 Execution Block

a. Single-Channel Relay

Figure 13: 5V Single-Channel Relay Module

Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises of components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

Table 5:Single-Channel Relay Module Pin Description

Pin Number	Pin Name	Description
1	Relay Trigger	Input to activate the relay
2	Ground	0V reference
3	VCC	Supply input for powering the relay coil
4	Normally Open	Normally open terminal of the relay
5	Common	Common terminal of the relay
6	Normally Closed	Normally closed contact of the relay

Single-Channel Relay Module Specifications

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

b. Water Pump

Figure 14:Water Pump MB385

The R385 Water Pump 12VDC is a compact-sized water pump. It is used for pumping water and fluids, with a maximum pumping capacity of approximately 1-2 liters per minute. It is suitable for various small-scale designs that require a small pump, such as pumping water in fish tanks, irrigating plants, attaching to a nozzle for handwashing devices, or for applications that involve spraying or atomizing fluids.

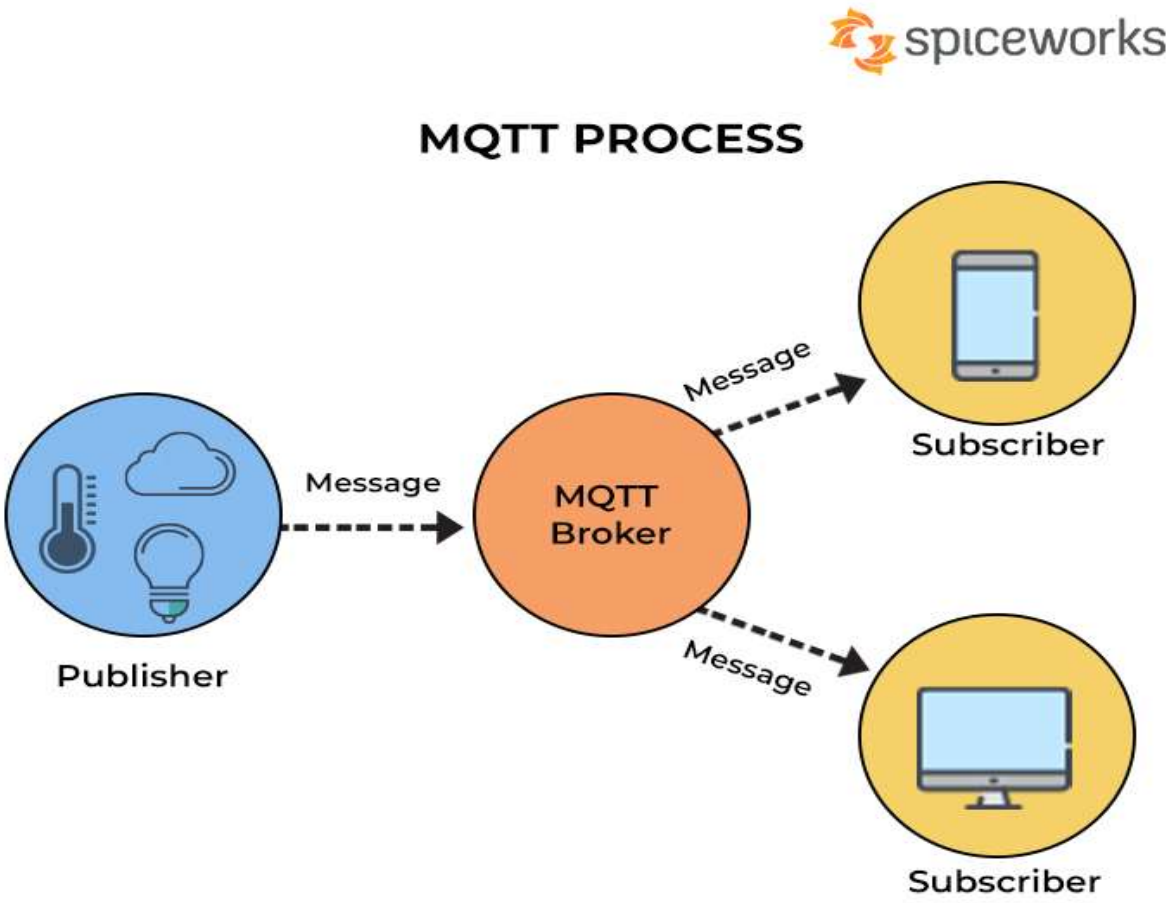
Water Pump Specifications:

- Supply voltage – 6V to 12V
- Quiescent current: 0.6A - 2A
- Power: 5-12W
- Operating Temperature: Up to 80 degrees Celsius
- Pump Flow Rate: 1-2 liters per minute

1.3 Communication protocols used in the systems

a. MQTT protocol

MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol designed for constrained devices and low-bandwidth, high-latency, or unreliable networks. It is commonly used for connecting small and resource-constrained devices to the internet and is widely used in the Internet of Things (IoT) industry. MQTT is based on a publish-subscribe messaging model, allowing devices to publish messages to a broker and subscribe to receive messages from the broker. It is known for its simplicity, efficiency, and reliability in delivering messages between devices.



In this system, we use MQTT communication for 2 ESP devices to connect with each other. ESP 8266 no 2 will act as a publisher to send water level data and communicate with ESP number 1 through MQTT protocol. ESP no 1 will act as a subscriber to receive water level data in the tank.

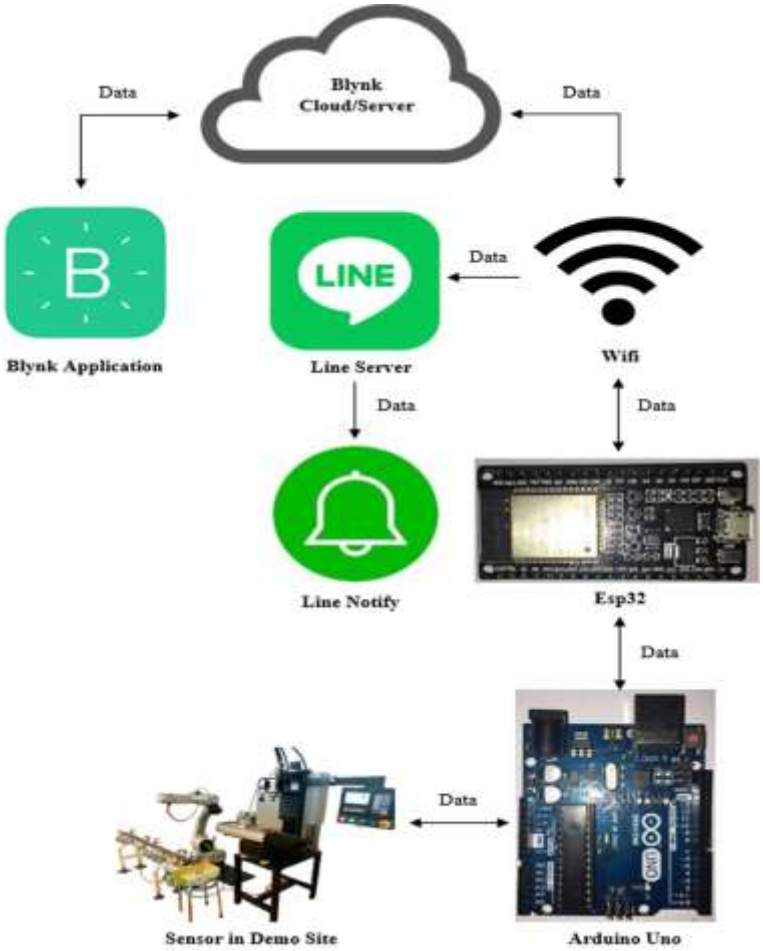
b. Wi-fi network

A Wi-Fi network is a type of local area network that uses high-frequency radio waves to provide wireless connectivity to devices. It allows devices such as smartphones, laptops, tablets, and other electronic devices to connect to the internet and communicate with each other without the need for physical wired connections. Wi-Fi networks are commonly used in homes, businesses, public spaces, and other areas to provide convenient and flexible internet access.

In order to send data to the Blynk platform, the ESP 8266 no 1 use this technology.

1.4 Blynk Platform

Blynk is a platform that provides a drag-and-drop mobile app builder for IoT (Internet of Things) projects. It allows users to easily create custom mobile applications to control and monitor their connected devices, such as Arduino, Raspberry Pi, ESP8266, and other microcontroller-based projects. Blynk provides a user-friendly interface for building IoT applications without the need for extensive coding knowledge, making it accessible for hobbyists, makers, and developers to create their own IoT solutions.



II. Algorithm Flowchart:

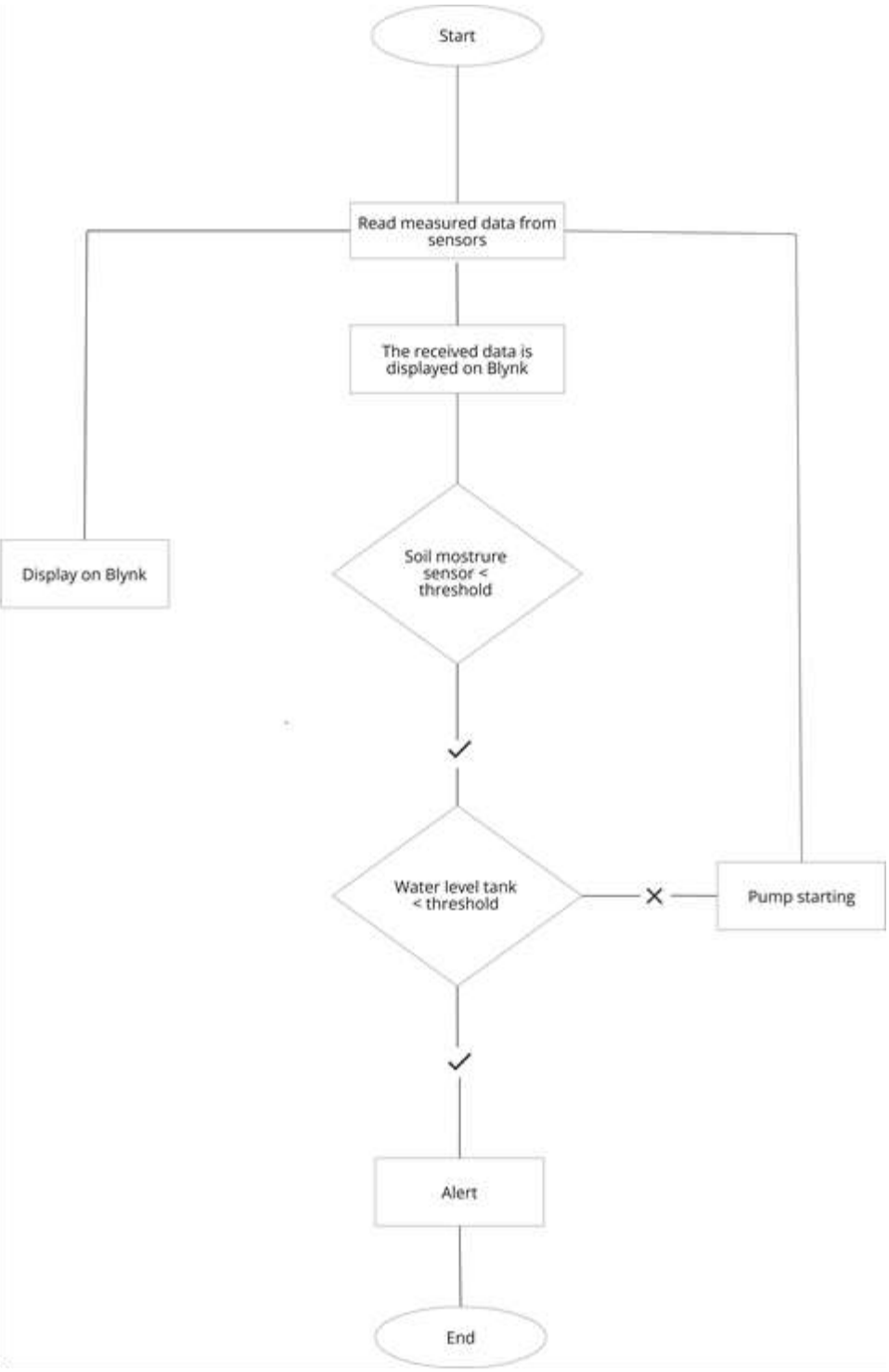


Figure 15: Algorithm Flowchart

Starting system:

+) ESP8266 No.1 communicates with the temperature sensor (DHT11) communicating via digital pin, the sensor will return the humidity value (%) and temperature (Degrees Celsius).

+) For the soil moisture sensor, they communicate with the ESP8266 No.1 via the analog pin of the ESP8266 board, we will set a humidity threshold suitable for the plant being used. In this Project, we use the aloe vera.

+) After receiving the data from sensors, ESP8266 No.1 sends displayed data to Blynk Platform via wifi.

Figure 16: Blynk Platform

+) The Water Level sensor will be plugged in ESP8266 No.2 via analog pin and return the current water level of the water tank, ESP8266 No.2 (As a Node) transmits the data which are about the tank's water level status to the ESP8266 No.2 (As a GateWay) by MQTT protocol. We will set a suitable threshold for the water level.

+) After receiving information about the water level status of the water tank, ESP8266 No. 1 will simultaneously check the soil moisture and water level of the tank. If the soil sensor is below the threshold and the water level sensor is above the threshold, the relay will close and the pump will start pumping (for a pre-programmed time period). In the remaining case, if both values are below the threshold, the relay will open and the pump will not operate.

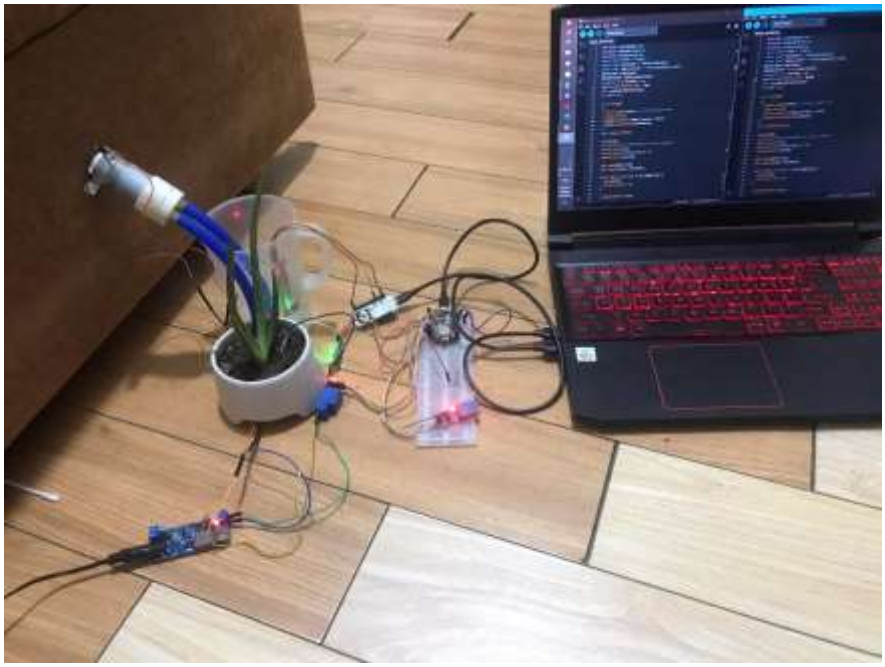


Figure 17: System Deployment

III. Result evaluation

In terms of reading sensor data, we see that the soil moisture sensor data has quite high accuracy (up to 85 ± 2%), the accuracy of the humidity and temperature sensors is quite low (The difference can be up to 4 degrees Celsius, for air humidity it can be up to 20-30%), Finally, about the water level sensor, the sensor returns a relatively accurate ADC value based on that to convert to water level value.

When we use the MQTT protocol to transfer data from ESP8266 number 2 to ESP8266 number 1, the latency of the protocol is quite low. Protocol latency depends heavily on the quality of the network.

When the plant needs to pump water, the pump will automatically pump within 3 seconds with the amount of water pumped per second being 20ml (total 60ml). The time between the first pumping and the second pumping is about 2 days (For days with high air humidity) and about 1 day (For days with low air humidity).

IV. Conclusion

The Indoor Plant Watering System report would highlight the successful development of a system that addresses the need for automated plant care, particularly when owners are away from home for extended periods. It would emphasize the system's ability to monitor soil moisture levels, environmental conditions, and water supply, and to automatically water the plants as needed. This report would likely touch upon the accuracy and reliability of

the sensors used, the effectiveness of the communication protocols, and the overall performance of the system. It may also discuss potential future developments and improvements for the system.

V. Work Assignment

Student ID	Full Name	Assigning of work
20021601	Nguyễn Quang Vinh	• System design • Implement communication between 2 esp8266 • Make connections to Blynk Platform
20021598	Vũ Huy Tùng	• System design • Prepare components • Programming and testing sensors
20020091	Nguyễn Như Phúc	• System design • System optimization