UNIVERSITÉ ANTONINE

Faculté d'Ingénierie en Informatique, Multimédia, Systèmes,

Réseaux et Télécommunications

Baabda – Liban

Environment monitoring for a smart economic irrigation system

Rapport de Projet de Fin d'Études (PFE)

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I would also like to express my gratitude to all the friends and colleagues who have given me their moral support throughout my journey. It was nice to meet them, work in groups and overcome difficulties together.

ABSTRACT

In the current time, probably one of the greatest problems that is facing the word is the shortage of water, and agriculture is one of the big sectors that demands water for irrigation purposes. The project shows how the irrigation method can be handled in a smart way using an IOT system. The objective of this project is to help conserving water by automatically providing plants with the necessary amount of water for a specific period of time and during unrainy days, thus a smart irrigation system using IOT technique is built to solve this problem, with the ability to monitor the weather and forecast, also, the system will sent notifications to the user in case of turning ON and OFF the pump, moreover, the system is eco-friendly thus it is supplied with solar power and batteries.

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Introduction

Agriculture is considered as the source of life, as it is the main basis of food and other raw materials, also it plays a vital role in the growth of country's economy. Irrigation is the process of applying controlled quantities of water to plants at needed intervals. Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Irrigation process is usually used in areas where rainfall is irregular or dry times. There are many types of irrigation systems, in which water is supplied to the entire field regularly. On the other hand, water is an essential element for life sustenance, there is a need to avoid its undue usage, and one of the most consumers of water is during the irrigation process. This calls for the need to regulate water supply for irrigation purposes. Fields should neither be over-irrigated nor under-irrigated.

This problem can be solved by implementing a smart irrigation system that is capable to control the weight of water used for irrigation by putting a timer for a water pump that turns ON and OFF at a specific time of the day, and the most important advantage of this smart system is the ability to monitor local weather conditions. Thus, this smart irrigation systems automatically adjust watering schedules according to the actual needs with respect to the actual weather and forecast. In this way, the big usage of water that was wasted before will be reduced and used for other purposes. Also, a temperature, pressure, altitude sensor will be used in the system to monitor the temperature at the location where the system will be available at.

Since it's an IOT based smart irrigation system, with network communication capabilities, a web page is built as a graphical user interface (GUI) with an easy user interaction page that will display the current time and date, a widget from open weather site that displays the weather and forecast for the next few days, the readings from the sensor that is connected to the system, and most importantly the time remaining for the water pump to turn ON and OFF.

The report is devised into four sections, the first chapter presents the state of the art, that contains different smart irrigation systems available in the market. The second chapter consists of a brief introduction of the system's architecture. The third chapter describes the practical part of the implemented system as well as a brief introduction on the components used in the hardware part and description of the webpage in the software part. Finally, the fourth chapter consists of a demo of the system in both software and hardware parts in addition to the future work that will be added to the system.

Chapter1 : State of The Art

1. Introduction

There exist several systems that are concerned to control the usage of water used for irrigation and the way of irrigation, and each system has its unique feature, way of working and interaction platform with the user different from the other. This chapter will present the available smart irrigation systems in the market and the feature of each system.

2. Existent systems

2.1. B-Hyve Wi-Fi Tap Timer

The B-Hyve Wi-Fi Smart Tap Timer (with Wi-Fi Hub) gives a user complete control over hose tap watering direct from a smart device. The Wi-Fi connection allows a user to make changes to the programming of the unit from anywhere, and allows the timer to receive instant weather updates. When receiving weather data, the B-Hyve will adjust watering scheduling to deliver only the required amount of water to your plants: this avoids wasting water with the added benefit of savings on bills, time, and energy [1]. The system is available in the figure 1.

Features of the product:

- Wi-Fi Connection Allows for Real-Time Weather Updates & Notifications
- Manual Watering at the Timer for Instant Tap Use
- Complete Control over Hose Tap Watering from your Smart Device
- Program the Timer by Using the B-Hyve App (Android, iOS & Web)
- Add on Additional Timers to Create Multiple Watering Zones.

Figure 1: B-Hyve

2.2. Pro-C: Smart Commercial & Residential Irrigation Systems

The Pro-C Smart Controller combines the power of Wi-Fi based irrigation management with the convenience of modular functionality into one single next-generation controller. This professional-grade controller is the ideal unit for contractors and tradies – helping to save time, save water, protect landscapes and ecosystems, and meet the demands of customers who require or desire smart irrigation systems [1]. The system is available in the figure 2.

Features of the product:

- Supports Between 4-16 Zones
- Predictive Watering Based on Real-Time Temperature, Rainfall Probability, Humidity, etc.
- Add a HC Flow Meter for System Error and Issue Notifications
- Built-In Milliamp Sensor for Troubleshooting Wiring Issues
- User Friendly Interface with Large LCD Touchscreen Display

Figure 2: Pro-C

2.3.Hydrawise Controllers: Smart Residential Irrigation Systems

The HC is a new style, full-functioning controller complete with convenient touchscreen display, multi-station standard controllers' wit optional expansion modules, and a number of additional more features to help make managing your system easier [1]. The system is shown in figure 3.

Features of the product:

- Fixed 6 & 12 Zone Models with 12 Station Expansion Module Option (To 36 Zones)
- Wi-Fi Enabled for Simple & Fast Connection to the Internet

- Predictive Watering Adjustments Based on Local Weather, Rainfall, Humidity & Wind Speed
- Optional HC Flow Meter for Real-Time Detection & Alerts
- User Friendly Interface with Large LCD Touchscreen Display

Figure 3: Hydrawise Controllers

3. Summary

This chapter outlined the existing methods and systems available in the market and which are concerned to control the water usage and smart irrigate small or big lands with different types of graphical user interface, whether having an LCD screen or via a Webpage. This is why we will propose a smart irrigation system that is capable of decrease the water usage used in irrigation also it will be able to monitor the weather and forecast so in case of rainy day, it won't turn ON the water pump. Moreover, this system will be eco-friendly system since its main power source is based on batteries and solar energy.

Chapter 2: Proposed solution

1. Introduction

This chapter includes a detailed description of the proposed system, also, it will highlight the main objective and added values of the built system. In addition, this chapter will present and describe the overall architecture of the system in its two working areas: “Hardware” and “Software”.

2. Description of the system

The purpose of this project is to build a smart irrigation system that has the ability to supply land or gardens with water for a specific period that is set previously and at a specific time of the day. The main objective of this system is to reduce the waste of water that is used for irrigation and agricultural purpose and use it in other scenarios. The added value in this system, which make it smarter is the ability to track in real-time the current weather and forecast, this will help to reduce the waste of water for irrigation in case of rainy weather, so the land will be supplied with water from water rain and don’t need more water from the user’s water tank.

The system will also contain a webpage as a graphical user interface (GUI) to interact between the system and the user, so he has the ability to monitor the weather and forecast, the readings from the sensor that is connected to the controller, and the state of the pump if it is ON or OFF. Moreover, the system will be an ecofriendly system since it is powered through batteries and these batteries will be charged by a solar panel (photovoltaic panel), and in case of low battery voltage, an email will be sent to the user. Also, the system will send an email to the user when the pump is turned ON and turned OFF or in case the controller is going into sleep mode and when it wakes up.

3. System architecture

3.1. Hardware part

This part will contain the block diagram of the system, as shown in figure 4, shows all the modules and communication that interface with the microcontroller (ESP32) and the protocol used for communication.

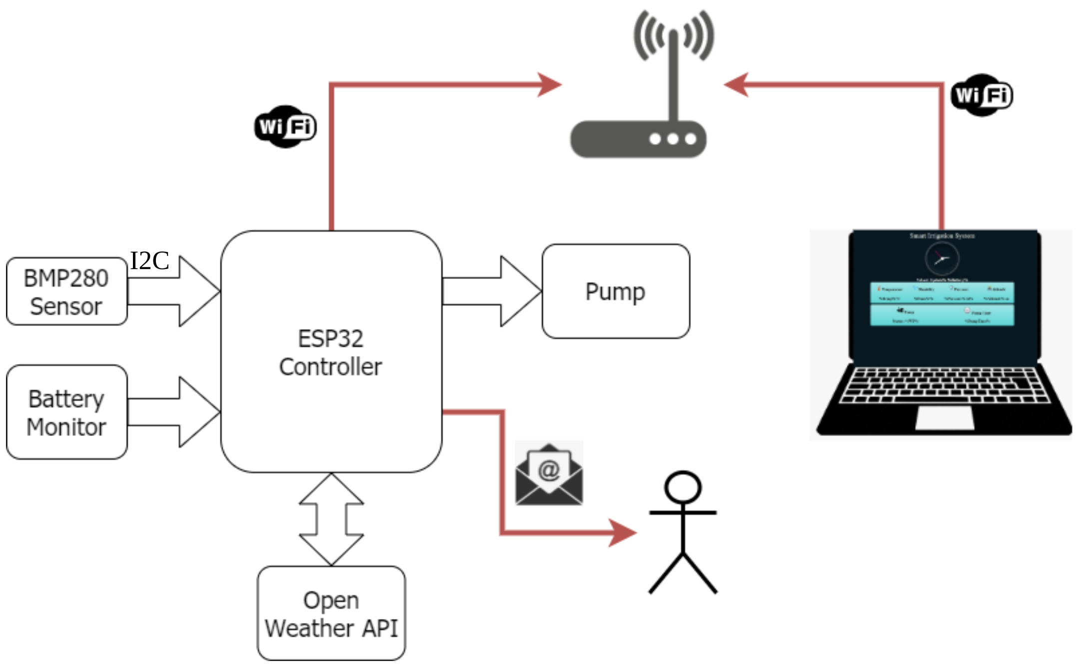

Figure 4: Block diagram

The system consists of the main microcontroller (ESP32), as the brain of the system, where all the modules and sensors are connected to it. The controller reads the data from the sensor BMP280 that is connected to it using I2C (Inter-Integrated Circuit) communication protocol, also it reads the voltage of the batteries using a normal GPIO (General Purpose Input Output) pin. The controller gets data of the current weather and forecast by sending a request to the Open Weather site, also a pump is connected to the controller as an output through a normal GPIO pin. Moreover, the microcontroller has a built-in WIFI module, thus a wireless communication is made between the controller and the user's router in order to publish the readings of the input modules and all the necessary data on a web server. Furthermore, the controller sends an email to the user at specific events for example when it goes to sleep or when it wakes up, or when the voltage of the batteries is low…

3.2. Software part

The software part of the system is represented by the web application through which the user will access and monitor the readings of the sensor, the battery level, the current weather and forecast and the states of the water pump and, the remaining time to turn the pump ON or OFF. The webpage is shown in figure 5.

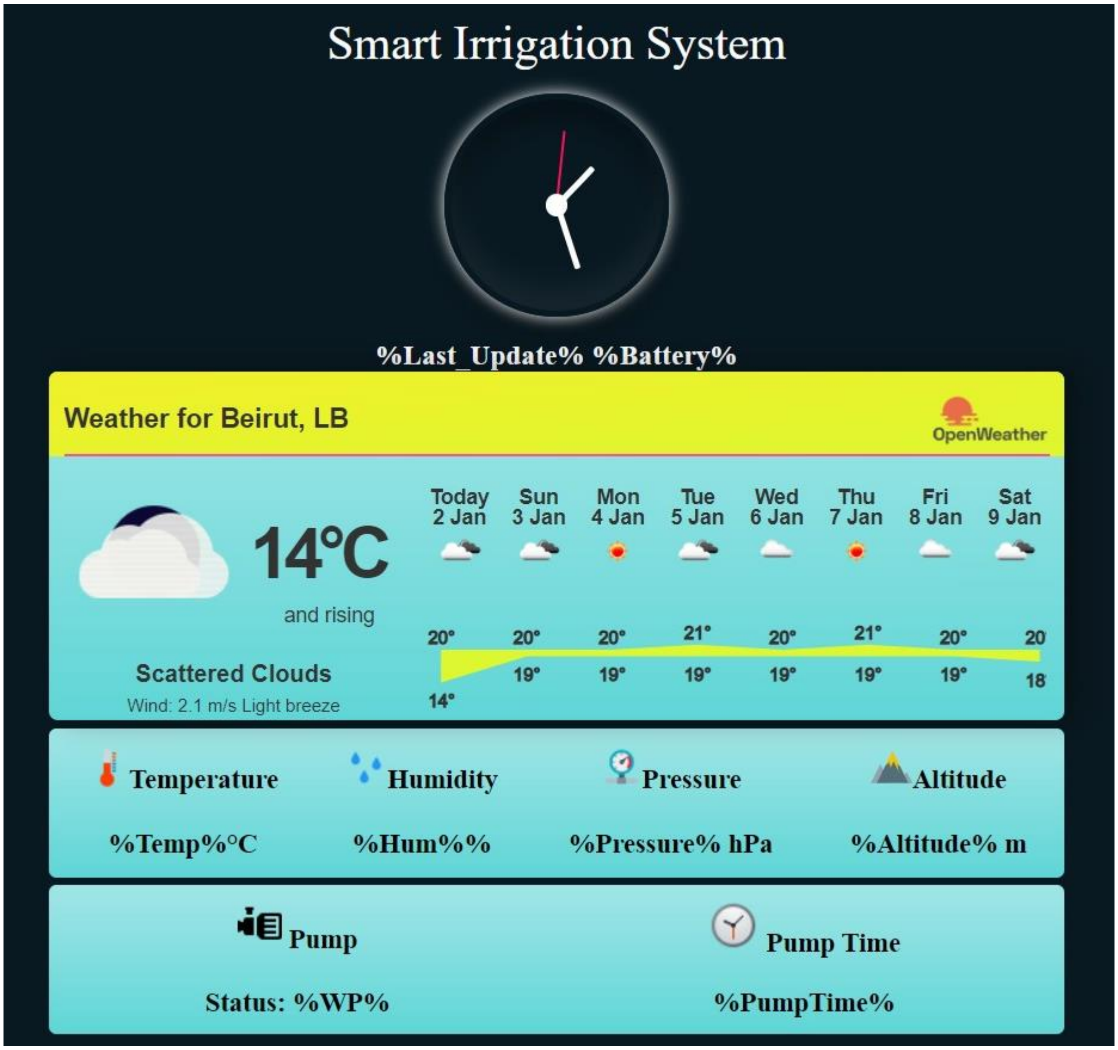

Figure 5: Webserver Template

The webserver of the system consists of a simple interactive graphical user interface (GUI) where the user can interact easily and monitor all the data that the system is reading, also, the server has an auto background update feature to the variables, so the user doesn't need to press the refresh button each time to update the values. The variables are known and updates through a specific written method by putting the name of the variable inside two percentage characters for example (%Temp%) where here the variable named Temp will update the values of the current temperature the controller is reading from the sensor and so on. Also, a widget from the Open Weather site is available that shows the current weather and forecast at a specific location that is specified before, these values are the same as the one's read by the controller from the Open Weather site.

4. Conclusion

This chapter summarized a brief description of the system as well as the architecture of the system in its both domains "Hardware" and "Software". The hardware part described the interaction between the different components of this system in order to be able to retrieve data from the BMP280 sensor, Battery level, and Open Weather site. The software section presented the webserver that is used by the system to interact with the user and monitor the data which the controller is reading.

Chapter 3: DEVELOPMENT AND IMPLEMENTATION

1. Introduction

This chapter will present a method of implementation of the system that is already defined in the previous chapter, and it will contain two sections “Hardware” and “Software”. The hardware part will contain the material and component used and at the end a simulation of the desired circuit with the way of connection. As for the software part, it will contain a flowchart for the code used in the system also a block diagram of the communication between the webserver and the controller.

2. Implementation

The main mission of building this project is the ability to reduce the usage of water used for irrigation purpose, thus this system will turn ON the water pump for a specific period, also, it will monitor the weather and forecast and this way will allow the system turn OFF the water pump when there is rain. This method is not offered in the systems available in the market.

2.1.Hardware part

This part will contain the material and components used to build the system also a simulation of the components connected will be available with the way of connection.

2.1.1. Material used:

1- ESP32

ESP32, is a series of low cost, low power system on a chip microcontroller with integrated Wi-Fi & dual-mode Bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations [2]. The ESP32 module and the pin configuration of the microcontroller are available in figures 6 and 7 respectively.

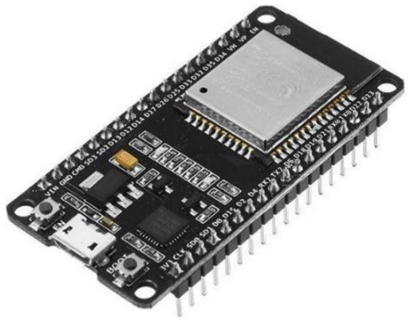

Figure 6: ESP32 module

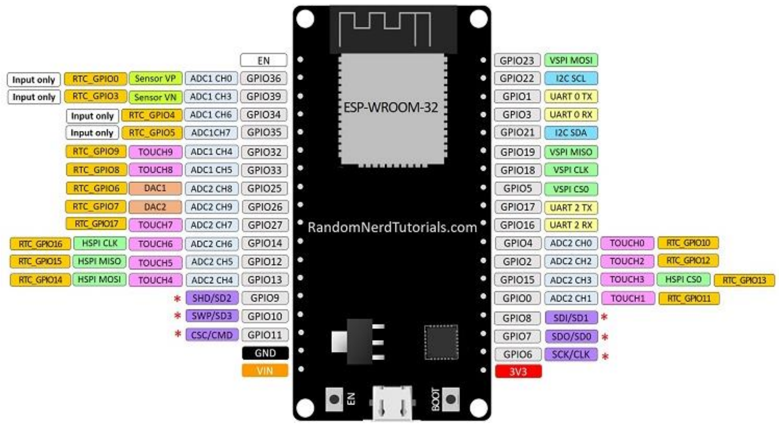

Figure 7: ESP32 pin configuration

The purpose of using ESP32 as a microcontroller of the system instead of Arduino Leonardo is that ESP32 is that it has a 12-bit ADC so the analog input voltage is very sensitive to any variation in microvolts, also the ESP32 has a built-in WI-FI module so it makes the internet connection between the microcontroller and the Webserver easier, better than using a normal Arduino board and using an external WI-FI module. Table 1 shows the difference between ESP32-8266 and Arduino UNO, and it shows that ESP32 has the best specifications between the 3 compared microcontrollers.

Table 1: Comparison between ESP32 - ESP8266 and Arduino UNO

SPECS/BOARD	ESP32	ESP8266	ARDUINO UNO
Number of Cores	2	1	1
Architecture	32 Bit	32 Bit	8 Bit
CPU Frequency	160 MHz	80 MHz	16 MHz
WiFi	YES	YES	NO
BLUETOOTH	YES	NO	NO
RAM	512 KB	160 KB	2 KB
FLASH	16 MB	16 MB	32 KB
GPIO PINS	36	17	14
Busses	SPI, I2C, UART, I2S, CAN	SPI, I2C, UART, I2S	SPI, I2C, UART
ADC Pins	18	1	6
DAC Pins	2	0	0

Since the module will work on batteries, it is important to know the power consumption, the table 2 shows the current consumption of the ESP32 module in its different states.

Table 2: Power consumption in active mode

Mode	Min	Typ	Max	Unit
Transmit 802.11b, DSSS 1 Mbps, POUT = +19.5 dBm	-	240	-	mA
Transmit 802.11b, OFDM 54 Mbps, POUT = +16 dBm	-	190	-	mA
Transmit 802.11g, OFDM MCS7, POUT = +14 dBm	-	180	-	mA
Receive 802.11b/g/n	-	95 ~ 100	-	mA
Transmit BT/BLE, POUT = 0 dBm	-	130	-	mA
Receive BT/BLE	-	95 ~ 100	-	mA

Also, in order to attenuate the power consumption of the module on the batteries, the ESP32 has a feature of deep sleep mode, so it will turn OFF all the peripherals that are available in its module, only the RTC and the timer continue to work so it will wake up after a specific period of time. The table 3 shows the power consumption of the module in its different modes.

Table 3: power consumption w.r.t. different power mode

Power mode	Description	Power consumption
Active (RF working)	Wi-Fi Tx packet 14 dBm ~ 19.5 dBm	Please refer to Table 2 for details.
	Wi-Fi / BT Tx packet 0 dBm	
	Wi-Fi / BT Rx and listening	
Modem-sleep	The CPU is powered on.	Max speed 240 MHz: 30 mA ~ 50 mA
		Normal speed 80 MHz: 20 mA ~ 25 mA
		Slow speed 2 MHz: 2 mA ~ 4 mA
Light-sleep	-	0.8 mA
Deep-sleep	The ULP co-processor is powered on.	150 μA
	ULP sensor-monitored pattern	100 μA @1% duty
	RTC timer + RTC memory	10 μA
Hibernation	RTC timer only	5 μA
Power off	CHIP_PU is set to low level, the chip is powered off	0.1 μA

2- BMP280

The BMP280 is the next-generation of sensors from Bosch and is the upgrade to the BMP085/BMP180/BMP183 - with a low altitude noise of 0.25m and the same fast conversion time. It has the same specifications but can use either I2C or SPI. For simple easy wiring, go with I2C. If you want to connect a bunch of sensors without worrying about I2C address collisions, go with SPI. This precision sensor from Bosch is the best low-cost, precision sensing solution for measuring barometric pressure with ±1 hPa absolute accuracy, and temperature with ±1.0°C accuracy [3]. The BMP280 sensor is shown in figure 8.

figure

Figure 8: BMP280 sensor

3- TP4056 – Battery charger

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component count make the TP4056 ideally suited for portable applications. Furthermore, the TP4056 can work within USB and wall adapter. Thermal feedback regulates the charge current to limit the temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The TP4056 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached [4]. The main elements of the module are shown in the figure below.

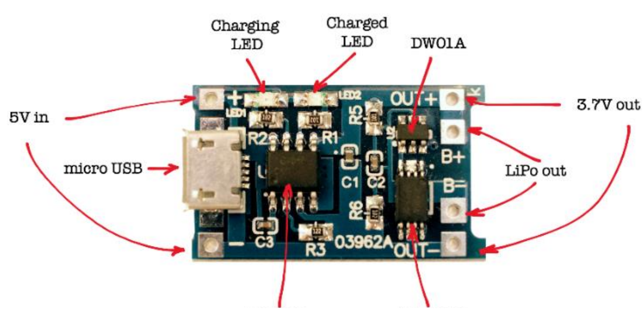

Figure 9: TP4056 module

4- Solar panel

Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads. Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing [5]. For this system, we used a 12v solar panel, as shown in figure 10, and the specifications of this panel are shown in table 4.

Figure 10: 12V solar panel

Table 4: Solar panel specifications

Specifications	Values
Peak power	5W
Maximum power voltage	18V
Maximum power current	0.27A
Open circuit voltage	22.4V
Short circuit current	0.3A
Operating Temperature	-40°C ~ +85°C

5- Buck converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS). Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step-up output current [6]. This module is used to reduce the voltage of the solar panel from 12V to 5V and boost up the current in order to charge the lithium batteries that are connected to the charger module TP4056 described previously, the buck converter is shown in figure 11.

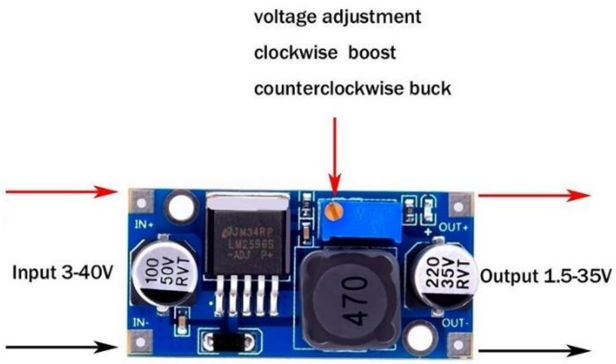

Figure 11: DC-DC Buck converter

6- Boost converter

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) [7]. Since the batteries used are lithium ion, the maximum voltage they can reach is 4.2V, from the other side, the controller (ESP32) needs 5V to power up and work normally, in this case, a boost converter is used to convert the voltage from 3.7-4.2V from the batteries to a fixed output volage 5V. The boost module used is shown in figure 12.

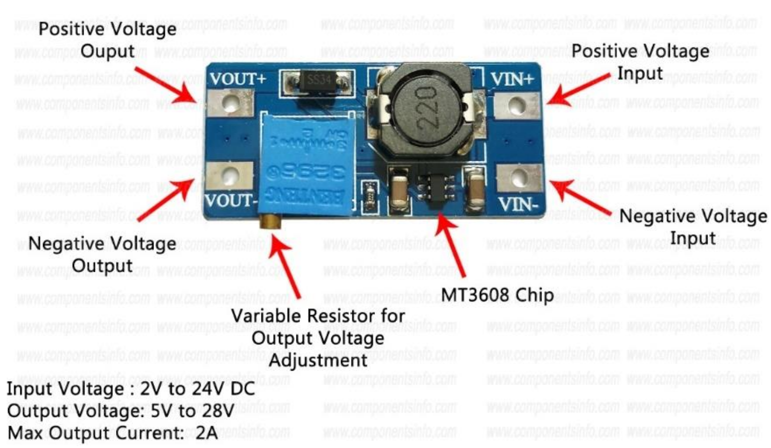

Figure 12: DC-DC Boost converter

7- Lithium-ion battery

A lithium-ion battery is a family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Lithium-ion batteries are common in consumer electronics. They are one of the most popular types of rechargeable battery for portable electronics, with one of the best energy-to-weight ratios, high open circuit voltage, low self-discharge rate, no memory effect and a slow loss of charge when not in use [8]. The lithium-ion batteries are used in the system as the main power source of the controller, and they are charged using a solar panel as described previously. The lithium-ion battery is shown in the figure 13.

Figure 13: Lithium-Ion battery-18650

8- Water pump

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into Hydraulic energy. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid [9]. The water pump is put inside a water tank and its main role is to drive the water to supply the land. The 12V mini water pump used in the system is shown in the figure below.

Figure 14: 12V water pump

9- Relay module

The relay module is an electrically operated switch that can be turned on or off deciding to let current flow through or not. They are designed to be controlled with low voltages like 3.3V like the ESP32, ESP8266, etc. or 5V like your Arduino. When electrical current is passed through a coil, it generates a magnetic field that in turn activates the armature. This movement of the movable contacts makes or breaks a connection with the fixed contact. When the relay is de-energized, the sets of contacts that were closed, open and breaks the connection and vice versa if the contacts were open [10]. The relay module is used to turn ON and OFF the pump through an external supply, since the water pump needs a high current and higher voltage than the controller can deliver, the relay is used as a control circuit. The relay module used is shown in figure 15.

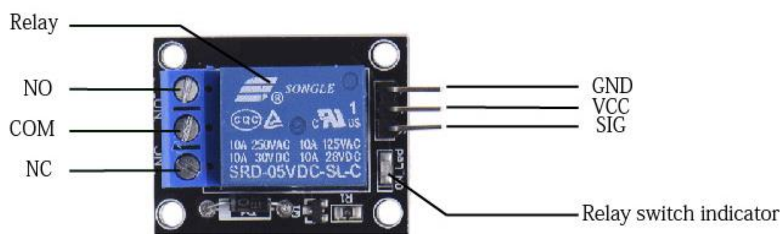

Figure 15: Relay module

2.1.2. Battery monitor concept

In order to monitor the battery voltage of the system, so that in case of low battery level an email will be sent to the user to recharge the system. The batteries voltage is between 3.7-4.2V DC and the ESP32 is a 3.3V DC level voltage, in this case a voltage divider is used to attenuate the voltage from a maximum of 4.2V to a voltage under 3.3V so the controller can read it. A voltage divider circuit is a very common circuit that takes a higher voltage and converts it to a lower one by using a pair of resistors [11]. The formula for calculating the output voltage is based on Ohms Law and is shown below.

$$\boldsymbol{Vout} = \frac{\boldsymbol{R2}}{\boldsymbol{R1} + \boldsymbol{R2}} \times \boldsymbol{Vs}$$

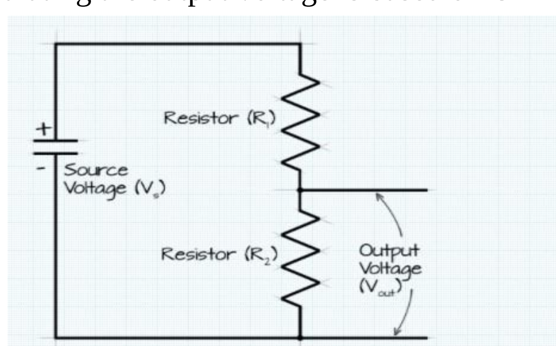

Figure 16: Voltage divider concept

where:

- VS is the source voltage, measured in volts (V).
- R1 is the resistance of the 1st resistor, measured in Ohms (Ω).
- R2 is the resistance of the 2nd resistor, measured in Ohms (Ω).
- Vout is the output voltage, measured in volts (V).

Using the voltage divider formula, stated before, and putting the corresponding values, 4.2V as Vs, 2.2kΩ for resistor R1, 4.7kΩ for resistor R2, we got 2.8V as output voltage which is under 3.3V and can be read directly by the ESP32.

2.1.3. Simulation part

The simulation part consists of connecting all the components together, the same way they will be connected in real life scenario. This simulation is made on Fritzing software.

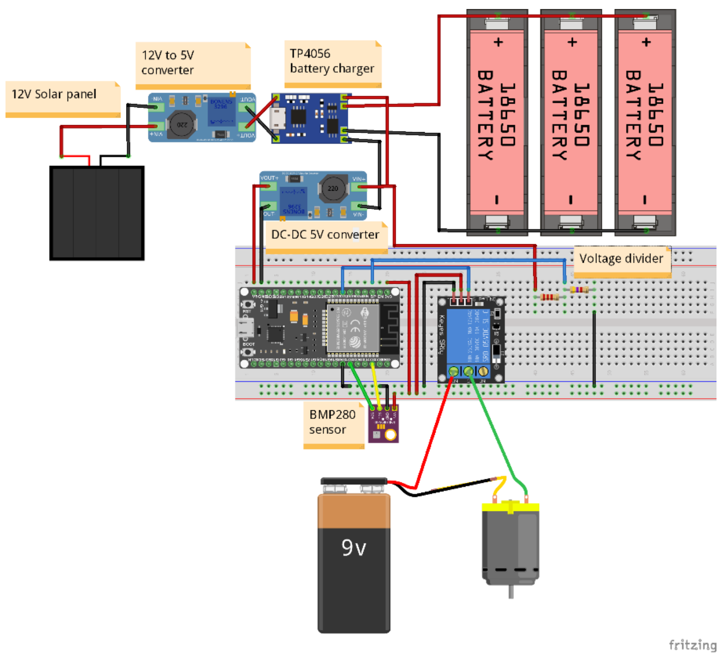

Figure 17: simulation circuit

2.1.4. Connections

The ESP32 is the brain of the system, where all the connections and communications are made. The BMP280 barometer sensor is connected to the controller via I2C communication protocol using two pins SDA (Serial Data) and SCL (Serial Clock) that are connected to pins 21 and 22 respectively on the ESP. The signal pin of the relay module, that is used to control the water pump, is connected to pin 32 of the ESP, from the other side of the relay, the positive terminal of the water pump is connected to the Common pin of the relay, and the positive terminal of the external supply is connected to the NO (Normally Open) pin of the relay, and the negative terminals of both, the pump and the power source are connected together. To supply the controller with power, three lithium batteries were used in parallel to give a higher current source to stay turn ON for a higher period of time, but since the battery's voltage is between 3.7-4.2V and the ESP needs at least 5V to work properly, a Boost converter is used to increase the voltage from 4.2V to 5V DC. In order to recharge the batteries, a charger module, TP4056, is used and it's specified to charge these types of batteries. To supply the battery charger, and make the system eco-friendly, a solar panel is used, and because of the lack of material available in the market, a 12V solar panel is used and to reduce the voltage to 5V and increase the current, a Buck converter is used, to convert the voltage from 12V or higher to 5V to be an input to the lithium batteries charger module.

2.2.Software part

This part will present a block diagram describing the process made to update the data on the webserver and a flowchart of the program that is used to make the system work properly.

2.2.1. Webserver process

The block diagram shown in figure shows the process of communication between the client (browser) and the server (ESP32) where the webserver sends a request to the controller to get the data, then the controller reads the desired data from the sensor and then it sends them in order to the webserver and then the webserver updates the displayed old values with the new values received.

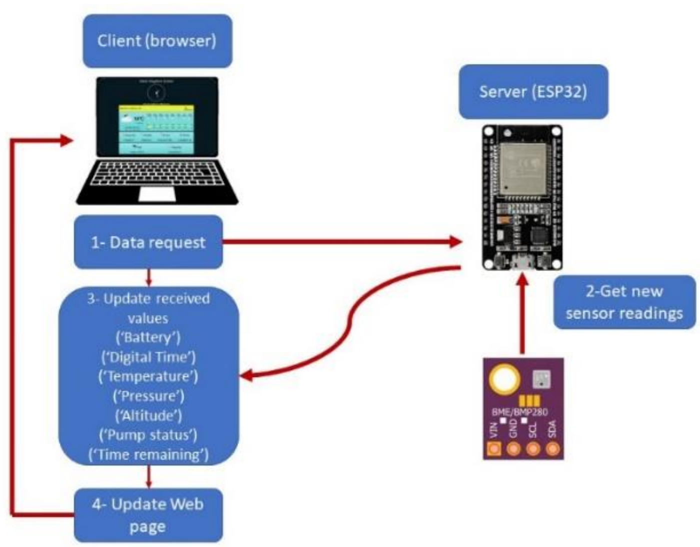

Figure 18:Communication process Block diagram

2.2.2. Flowchart

The flowchart of the system, is shown in the figure below, shows the way of processing of the controller code, how initially the system starts by a setup part to connect to the WI-FI and calibrate the sensors and then enters the main loop of the code.

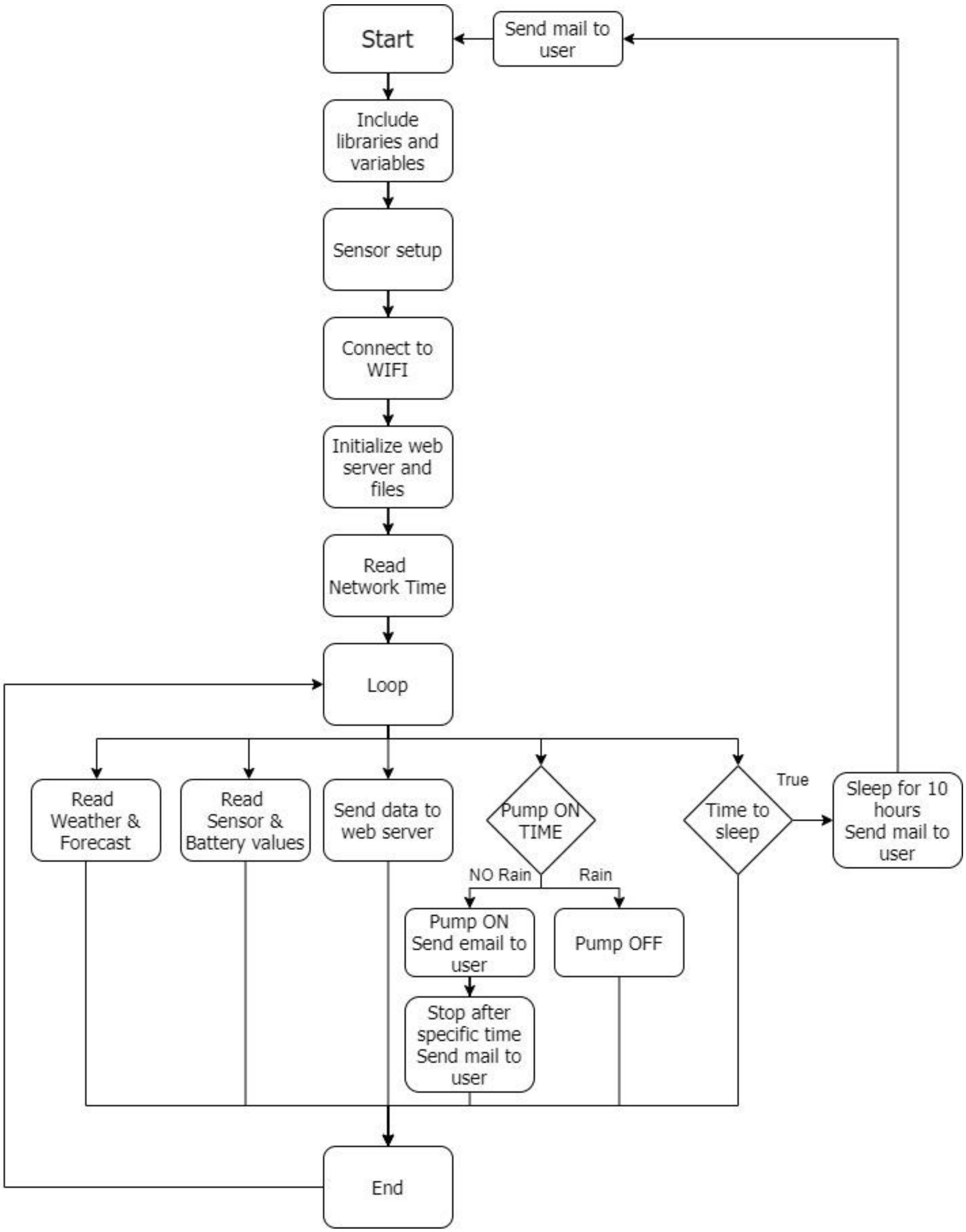

Figure 19: Flow chart

Chapter 4: Experimental evaluation

1. Introduction

This last chapter outlines an assessment of the proposed system. An experiment will be shown to test the efficiency of this system. Similarly, the additional work that we wish to complete in the future will be announced.

2. Prototype system

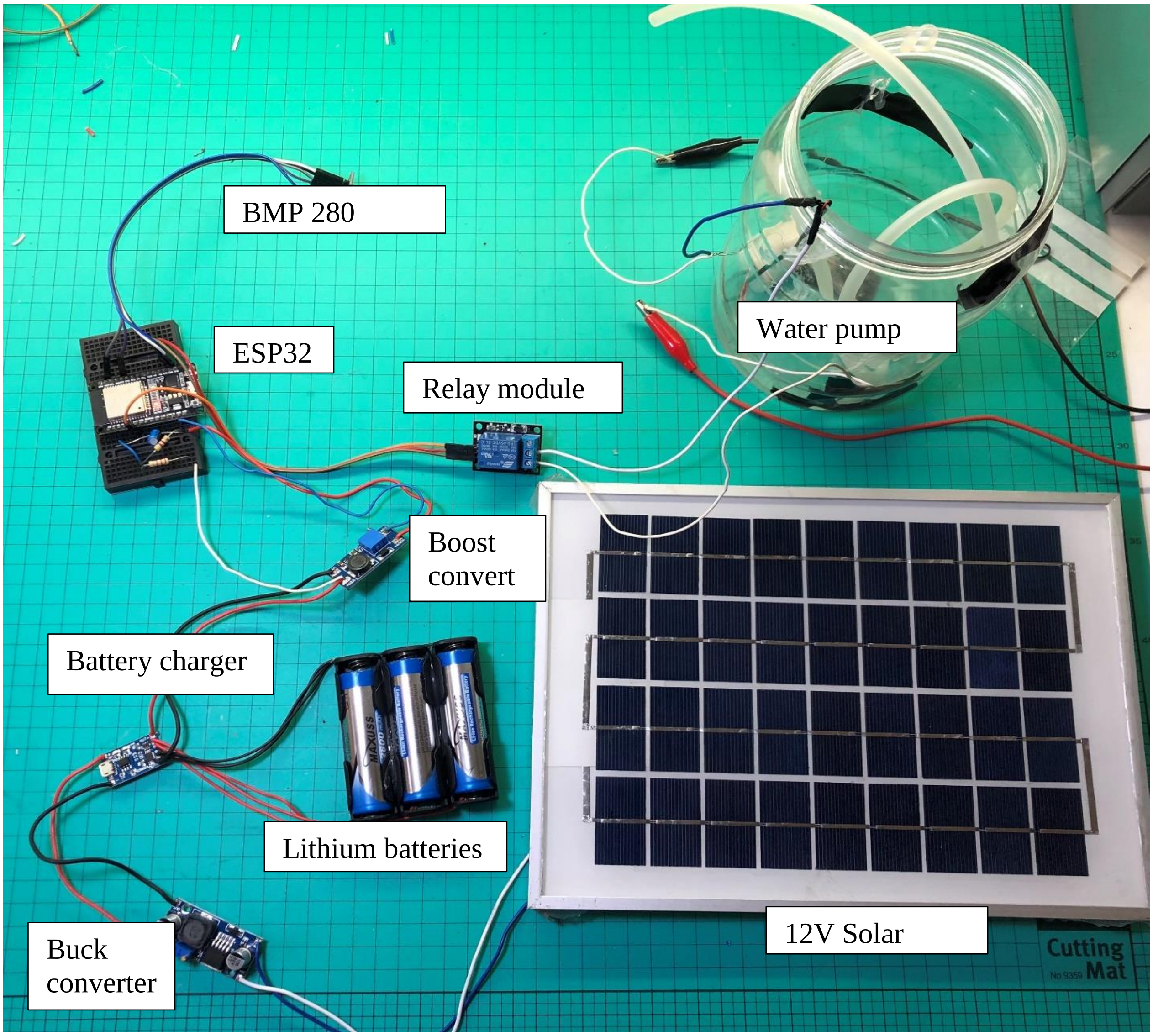

Figure 20: Implemented system

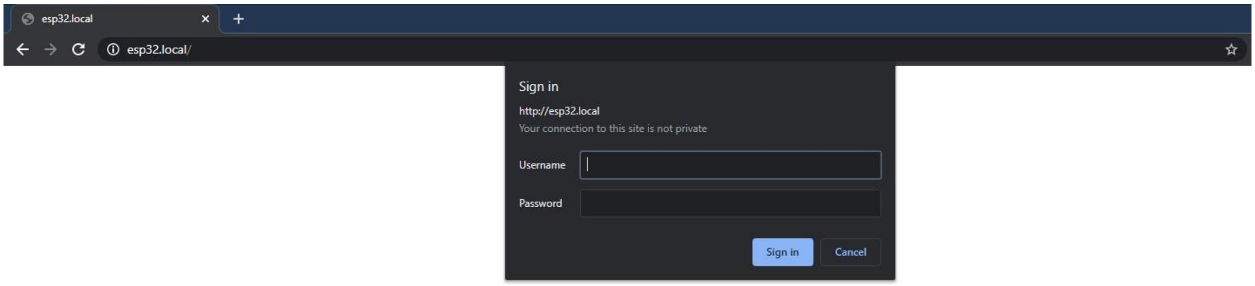

Figure 21: Log-in window

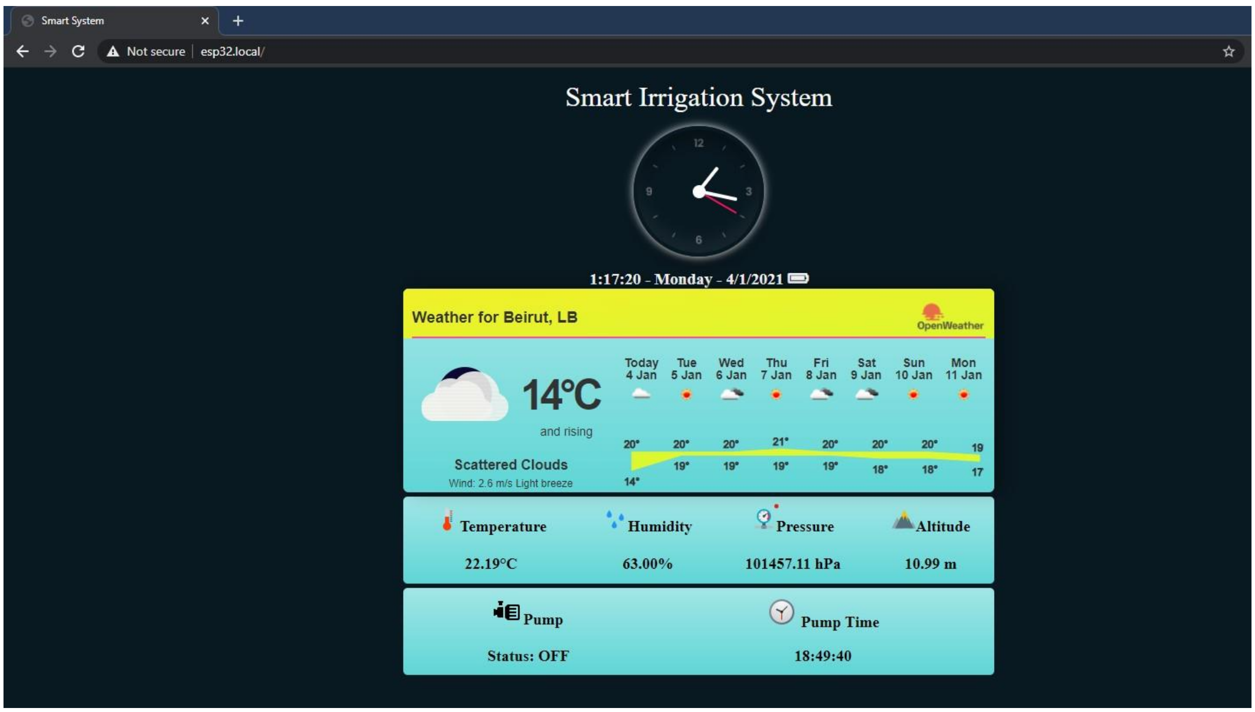

Figure 22: Webserver main page

Figure 23: Pump ON

Figure 24: Pump OFF

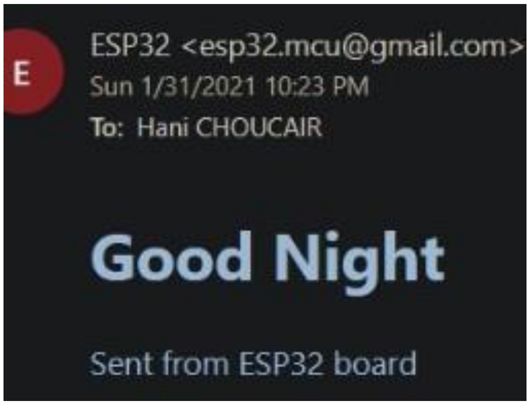

Figure 25: System before sleep

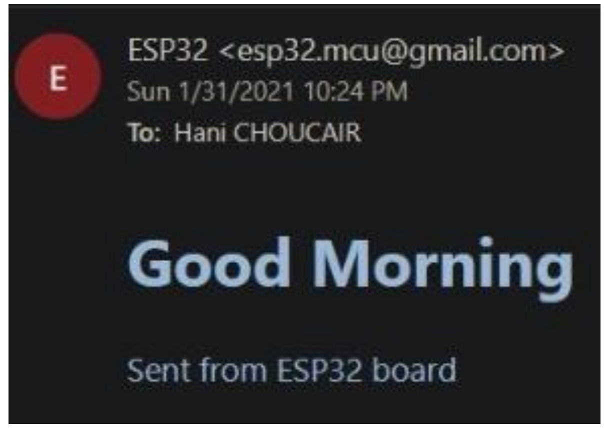

Figure 26: System after sleep

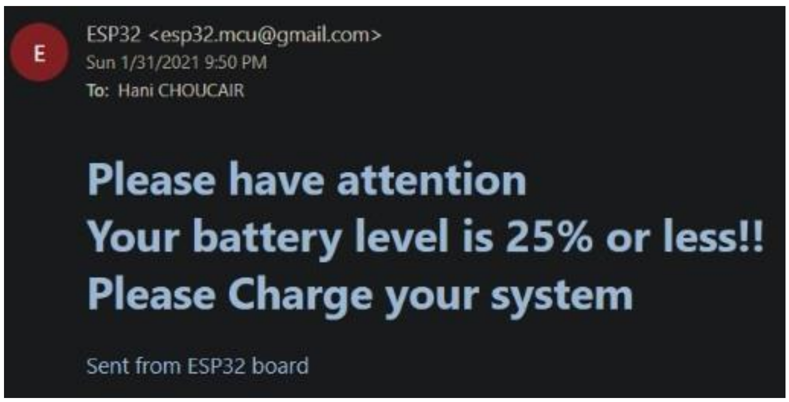

Figure 27: Low battery notification

3. Principle of operation

When the system starts, the first step made is sensor calibration for the BMP280 sensor and for the reading of the batteries, since there are several types of BMP/E sensors in the market, the calibration must be done to recognize which sensor is used, and for the voltage level of the batteries, since it's reading from a voltage divider, a lot of noise can be detected and it could affect the readings thus a Kalman filter is used to filter all the noise and stabilize the data. Then after finishing the sensor setup, the system must connect to the WI-FI router according to the username and password already given to the system and will read the time and date according to the network time protocol (NTP), then the system will initialize a webserver and upload the data files that contains the HTML and CSS files of the webpage, which are available on the flash memory of the controller, to the webserver, a hostname is added to the system then in this way the user have only to enter the hostname to enter the webpage instead to enter the IP address of the controller. Also, before entering the main loop, the system will read the weather and forecast for the first time from

Open-Weather. In the main loop of the controller, the system will send a request for the weather and forecast each 10 minutes, since there is a limit number of requests per day (less than 500 request for the free version). A timer is working in real time to calculate the remaining time to turn ON and OFF the pump, and this timer is also available on the webpage, when the pump is ON, the timer shows the remaining time to turn it OFF. Moreover, an email is sent to the user when the pump turns ON and OFF as sort of notification, these emails are shown respectively in figures 23 and 24. Since we are using batteries to supply the system, which consume 150-200mAh when it is working with WI-FI connection, a deep sleep mode is used in the night to turn the system in a low power consumption mode so it can reduce its power consumption to less than 10mAh which will increase the life of the batteries in case of low solar energy to charge them using the solar panel. When the system goes into sleep mode, an email is sent to the user notifying him that the system will turn OFF, also when the system turns ON an email also is sent to the user, as shown in figures 25 and 26 respectively. Moreover, in case of low battery voltage, the system sends a notification email to the user to notify him to charge the system, this case is when the solar panel don't have the ability to charge the batteries in rainy days, the low battery notification email is shown in figure 27. When the user wants to open the webserver, he needs to put the hostname of the controller (esp32.local) already defined in the controller, then a login window appears so the user has to enter a user name and password to have access to the main webpage, as shown in the figure 21, then it will open the main webpage that is shown in figure 22. The values shown in the webpage are updated in the background without the need to refresh the page each time, and each value has a specific interval to request a new data from the controller.

4. Future work

Regarding the future work that will be added to the system, a moisture could be added in order to get a feedback from the soil if it is wet or not, in this way we could make the water pump turn OFF when the land is wet not according a specific period of time. Also, we could apply more improvement to the webserver, increase the security system, or make it online.

5. Summary

This chapter deeply describes the evaluation and verification phase of the developed system. The results obtained show that the use of this system promotes the ability to control the usage of water, also the ability to turn OFF the pump during the rainy weather will help to reduce the wasted usage of water in agriculture and the ability to use it in other domains. Finally, a brief announcement of the future service that we want to add to the system has been considered.

Conclusion

The employment of this project could be for two applications, the first one is for farmers and gardeners who don’t have much time or they don’t live beside their land to irrigate the plants, the second application is for farmers who use water in high quantity during irrigation. Since the water has become rare and polluted in some regions, there is a crucial need to irrigate more efficiently to minimize the water use.

This smart irrigation system implemented is affordable and feasible, and it has the ability to optimizing the amount of water used for irrigation and agricultural purposes without the intervention of the user or farmer. The proposed system, will control the water sprinkler according to a specific timer and in case of unrainy days, and when the system detects a rainy day, the system won’t work and the land will be supplied by rainwater. Moreover, this system is also helpful in the countries and regions where there is a lack of water and the use of such kind of systems will improve the sustainability of water.

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