An Najah National University
Faculty of Engineering
Computer Engineering Department
Hardware Graduation Project

PERFICIENT

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Contents

1. Acknowledgment

“

In the name of Allah the Merciful, Praise be to God who gave us the strength, ability, and acknowledge completing this project. We would like to express our sincere gratitude to everyone who has supported us throughout our graduate studies. Firstly, we would like to express our sincere gratitude to our supervisors, Dr. Emad Natsheh and Dr. Suleiman Abu Kharimah, for their enthusiasm, patience, insightful comments, helpful information, practical tips, and unceasing ideas that helped us tremendously at all times in our project. Without their support and guidance, this project would not have been possible. We could not have imagined better moderators on our project. In addition, we are tremendously grateful to our family, friends, and colleagues, including the entire teaching staff of the Computer Engineering Department.

”

- *Dana, Sana’*

2. Disclaimer

Dana Ramadan and Sana' Zitawi from An-Najah National University's Faculty of Engineering's Computer Engineering Department authored this study. Other than editorial adjustments, it has not been amended or rectified as a consequence of assessment, and it may contain language and content mistakes. The opinions represented in it, as well as any results and recommendations, are exclusively those of the students Dana and Sana'. An-Najah National University assumes no responsibility or liability for the outcomes of using this study for a purpose other than what it was commissioned for.

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3. Abstract:

In the last 50 years, technology has found its place in society. Most of our lives are dominated by technology. The use of technology has become a necessity in every aspect of our lives, from the simplest to the most complex. Throughout history, the word "smart" has been used to mean intelligence in a variety of fields. One of the technologies that make people's lives easier is smart company service.

Through our project, we attempt to solve common problems in companies, including security, so that employees could enter using a Bluetooth system that receives commands from an application on their phone. Furthermore, a gas sensor will be installed in the company, which will notify employees and civil defense if the gas leakage rate exceeds a certain threshold. Additionally, the company has a cooling system that controls the temperature inside. Furthermore, the employee will be able to adjust the intensity of the lighting in his office according to his needs. Parking will be linked to the company so that every employee will have a card with a certain balance that is periodically charged.

4. Introduction

4.1 Problem Statement

People naturally strive to facilitate their lives and provide them with comfort, which saves time and effort, and may also save their lives sometimes. Modern technology is employed to increase security, provide well-being, and reduce dependence on humans.

Here is a list of applications of the smart company principle:

1. Control the security of the company and who can enter.
2. Control the lights.
3. Gas and smoke sensor and dealing with leakage and fire cases.
4. Parking system.

4.2 Objective

The main objective of this project is to use modern technologies to build a smart company system that covers the requirements of employees in companies these days, In order to do this, the following goals should be considered:

1. A protection system for the entry of employees and visitors to the company.
2. Self-lighting system and office lighting control.
3. Make gas and smoke system .
4. Provide cards for the employees to enter the parking.

4.3 Report Organization

In general, the structure of the report is divided into the following chapters:

- **Constraints and Earlier course work** representing the second section of the report which will discuss the project's constraints and limits. Finally, introducing the earlier taken courses which were beneficial in finishing the project.

- **Literature Review** representing the third section which will mention some relatedwords similar to our project idea.

- **Methodology** representing the fourth section which will explain how feature where implemented. Furthermore, showing the methods, tools, and languages where used.

- **Results and Discussion** representing the fifth section which will show the project's results and provide enough detail to substantiate the conclusion.

- **Conclusion** representing the last section which will outline the entire project, as well as the end results, and will demonstrate what we learnt along the way. It will also present some of the upcoming work in this project.

5. Constraints & Earlier course work

5.1 Constraints/ Standards

- The lack of knowledge of dealing with esp32 and Nodemcu,
- Dealing with Arduino language.
- The heavy weight of the whole design and the need to bring it to the university,
- Fixed cost,
- Dealing with esp32 camera,
- Internet instability.

5.2 Earlier coursework

It was essential for us to attend a few courses that play main role on increasingour knowledge and accomplish this project.

- PIC and Arduino Lab.
- Telecommunications lab and wireless course.
- Arduino course with Think deep academy.
- Online Arduino course from Udemy.
- Microcontrollers, Digital and electronic circuits design courses have been instrumental in implementing this project.

6 Literature Review

This field highlights distinct strategies used by analysts on the same topic and also provides a written survey of the current innovations available for IoT technology.

Door Security System application uses ESP32 CAM and Internet of Things (IoT) technology to monitor the status of the door. The AI-Thinker ESP32-CAM module is a low-cost development board with a micro-SD card port and a small (OmniVision's) OV2640 camera. It has a built-in Wi-Fi ESP32 S processor with two high-performance 32-bit LX6 CPUs and a 7-stage pipeline architecture. [1]

Bluetooth technology operate over unlicensed, its available at 2.4GHz frequency, it also can link digital devices within a range of 10m to 100m at the speed of up to 3Mbps but it depending on the Bluetooth device class [5]. With these qualifications of Bluetooth; we offer a door automation system based on Bluetooth technology, especially in door automation system.[2]

Infrared Optical Wireless Communication for Smart Door Locks Using Smart phones With the recent rapid advancements in the Internet of Things (IoT), one of the applications being developed is that of smart door lock (SDL) systems. SDL are intended to over high security, easy access and easy sharing. Unlike existing SDL solutions that mostly use biometrics or crunched RF spectrum, we uniquely propose to use Infrared (IR) optical wireless signal (OWS) using IR light emitting diode (LED) of smart phones. We designed and developed a complete system of Android smart phone app including physical layer encoding, a cloud server and programmable hardware prototypes using Arduino as well as Raspberry Pi. Optlock includes multi-level security schemes including user registration, authentication and authorization using one-time-password (OTP). This extensive experiments show 100 accuracy with 1.33 kbps of average data rate is achieved up to 20 meters of distance between a smart phone and a lock. It allows convenient remote access, easy access control and sharing as well as high security.[3]

Gas leakage detection is not only important but stopping leakage is equally essential. Not only detect gas leakage but also alert (Beep) and turn off main power and gas supplies, and send an SMS. GSM module is used which alert the user by sending an SMS. [4]

7 Methodology

7.1 Hardware parts:

Here we will talk about hardware components we used:

- Esp32
- NodeMCU
- Esp32 Cam
- IR sensor
- Servo Motor
- 12 volt lighting rope
- 2 12-volt Solenoid lock
- Fingerprint sensor
- Connecting wires
- MFRC522 RFID Reader
- 12 volt cable
- GSM
- Fan
- Dht11
- Variable resistor
- Push button
- Buzzer
- 2 2-channel Relay
- FTDI
- LED

7.2 Description

In this section we will talk about each of the hardware components that we used:

➢ ESP32

The ESP32 is a family of low-cost, low-power system-on-a-chip microcontrollers that have built-in Wi-Fi and dual-mode Bluetooth. Wi-Fi Direct is also supported by the ESP32. Without the use of an access point, Wi-Fi-Direct is a suitable choice for peer-to-peer connections.

Contains:

- 18 analog-to-digital converter channels
- 3 SPI interfaces and 3 UART
- 2 I2C and 16 PWM output channels
- 2 digital-to-analog converters

This is the project's main controller. There are gas and smoke sensors, light cords, LRs, temperature sensors, fans, “GSM”, fingerprint sensor. In the next step, a client server was created and an HTTP request was made to connect to other controllers over Wi-Fi.

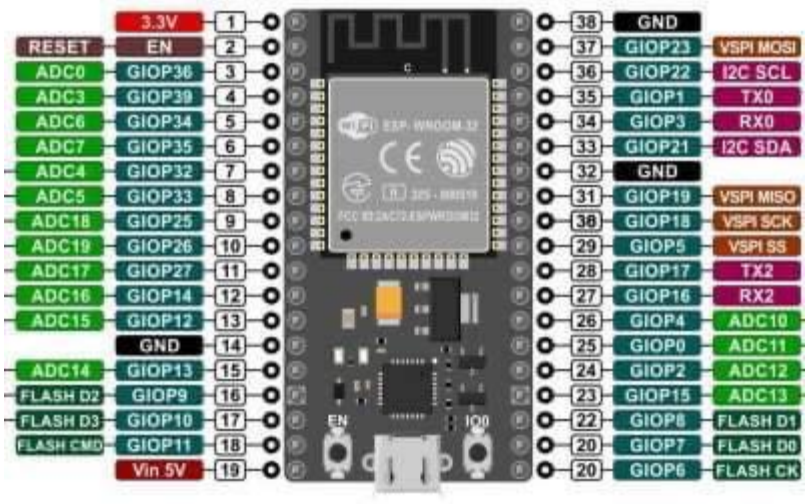

Figure 1: esp32

➢ ESP32 cam

It is a very small camera module with the ESP32-S chip. Besides the OV2640 camera, and several GPIOs to connect peripherals, it also features a microSD card slot that can be useful to store images taken with the camera or to store files to serve to clients.

Firstly, the camera has been programmed using the FTDI to download the code on it then it has been linked serially with a 12V Solenoid Lock and 2-Channel Relays that has been connected with the esp32. When the camera recognizes a face that its lens can capture, it will unlock the door. Otherwise, the lock will not open.

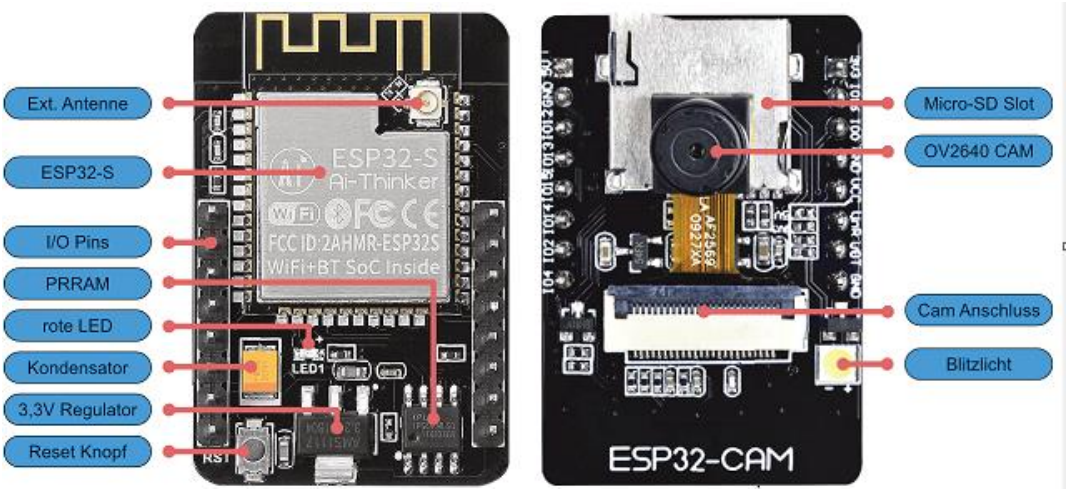

Figure 2: Esp32 cam

➢ NodeMCU:

The NodeMCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SOC) called the ESP8266.

The NodeMCU has been used for the parking system and connected with the RFID card reader and with the esp32 using client server connection.

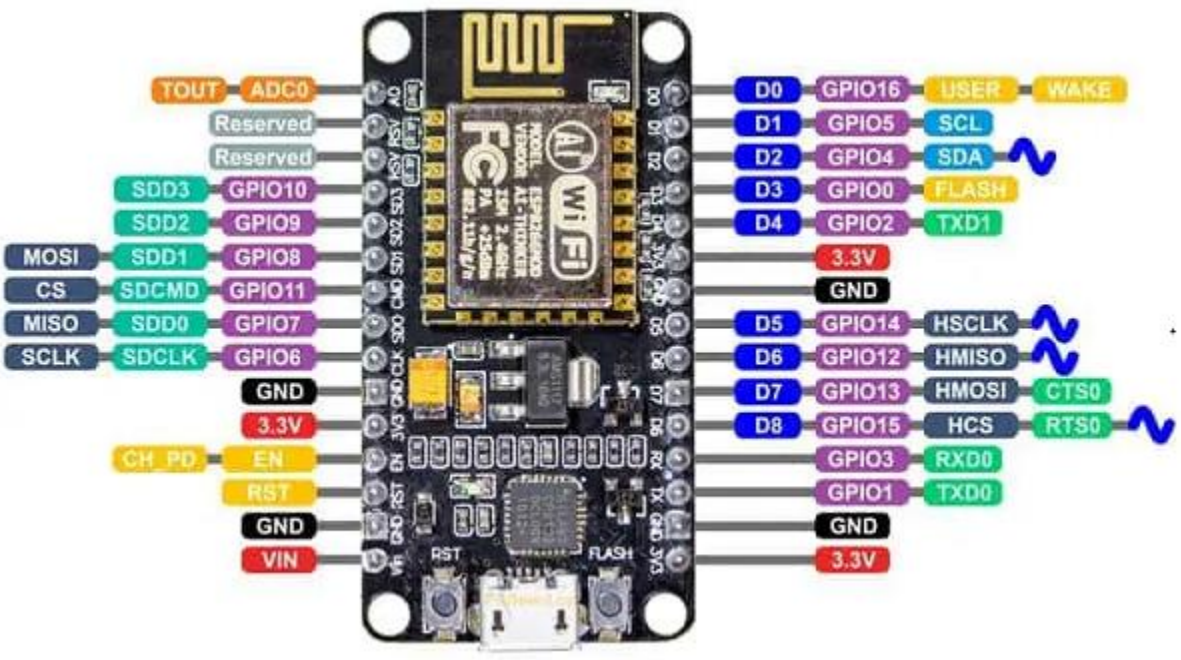

Figure 3: NodeMCU

➢ IR sensor:

The infrared (IR) sensors are made up of infrared (IR) LEDs and photodiodes. The IR LED is referred to as a photo emitter, while the IR photodiode is referred to as a receiver. The LED's infrared light hits the surface and is reflected back to the photodiode. The photodiode then produces an output voltage proportionate to the reflectance of the surface, which is high for a bright surface and low for a dark surface.

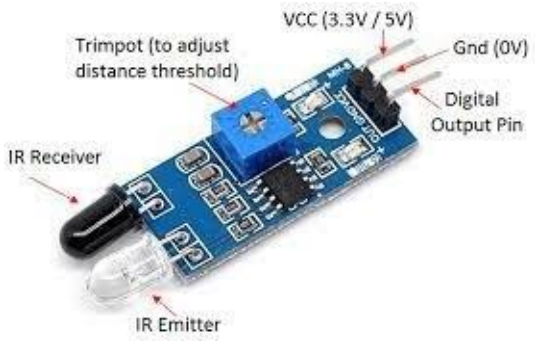

Figure 4: IR sensor

➢ Fingerprint sensor:

This sensor works by first recording fingerprint scans of all authorized individuals for a particular system or facility. These scans are saved within a database. The user requiring access puts their finger on a hardware scanner, which scans and copies the input from the individual and looks for any similarity within the already-stored scans. If there is a positive match, the individual is granted access. The fingerprint sensor used can store 127 fingerprints

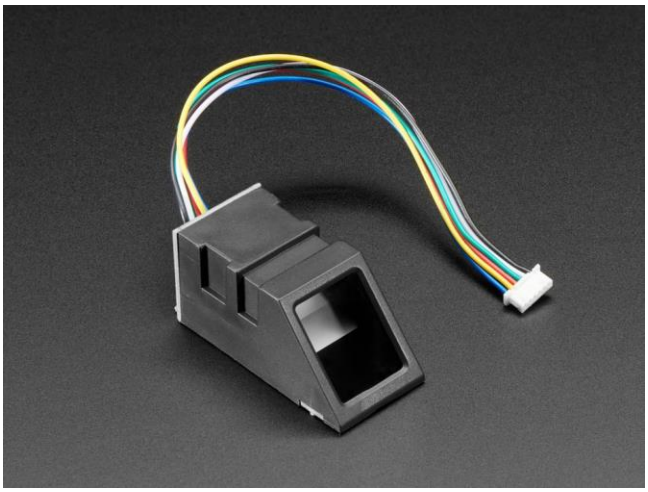

Figure 5: Fingerprint sensor

➢ Dht11

The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. Good for 0-50°C temperature readings ±2°C accuracy

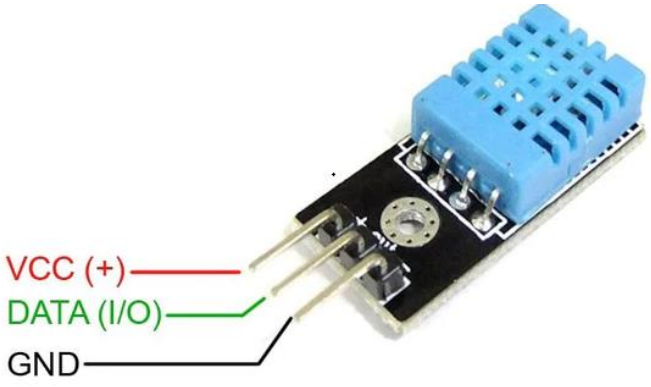

Figure 6: Dht11

➢ GSM:

A GSM module is a specialized type of device, which accepts a SIM card, and operates over a subscription to a mobile operator, just like a cell phone or pager. From the mobile operator perspective, a GSM modem looks just like a phone.

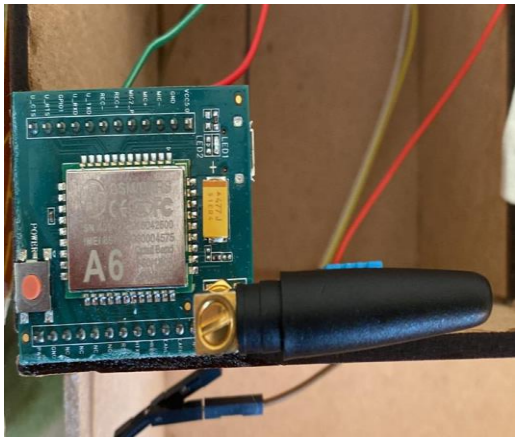

Figure 7: GSM

➢ Gas Sensor:

Gas sensor is an electronic device that detect and identify different types of gasses. It is commonly used to detect toxic or explosive gasses and measure gas concentration.

Figure 8: MQ-5

➢ RFID

RFID (radio-frequency identification) is a technology that employs electromagnetic fields to identify and track tags attached to items. A radio transponder, a radio receiver, and a transmitter make up an RFID system. The tag transmits digital data, generally an identifying inventory number, back to the reader when activated by an electromagnetic interrogation pulse from a nearby RFID reader device.

Figure 9: RFID

- **Servo Motor**

  A servomotor is a rotary actuator or linear actuator that allows for Precise control of angular or linear position, velocity and acceleration.

Figure 10: Servo motor

7.3 Methods and techniques:

- **Main Door Security System:**

1. **Staff entry using Bluetooth technology from ESP32**
   The esp32 was used in this step because it has built-in Bluetooth, so it was connected to a relay because the LISB32 needs 5 volts, then the relay was connected to a solenoid lock that needs 12 volts. Then the lock is controlled using the Bluetooth application.

2. Staff entry using ESP32 cam:

This feature relies on recognizing the person's face and comparing it with the data base and determining whether it is in the data base, so he is allowed to enter or not.

The circuit below combined with an FTDI board, Relay Module, and Solenoid Lock. The FTDI board is used to flash the code into ESP32 cam as it doesn't have a USB connector while the relay module is used to switch the Solenoid lock on or off. VCC and GND pins of the FTDI board and Relay module is connected to the VCC and GND pin of ESP32-CAM. TX and RX of the FTDI board are connected to RX and TX of ESP32 and the IN pin of the relay module is connected to IO4 of ESP32-CAM.

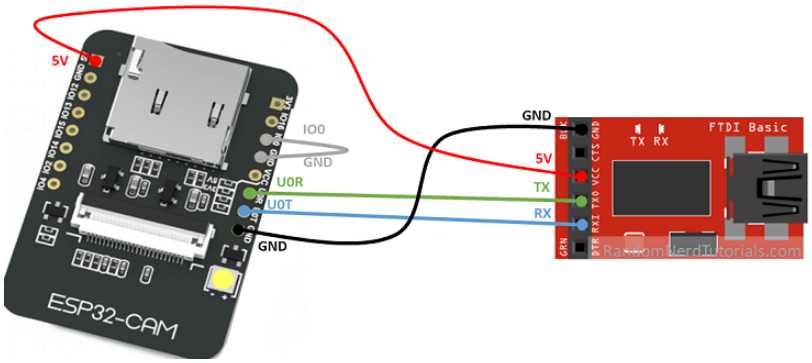

Figure 11: ESP32 cam with FTDI

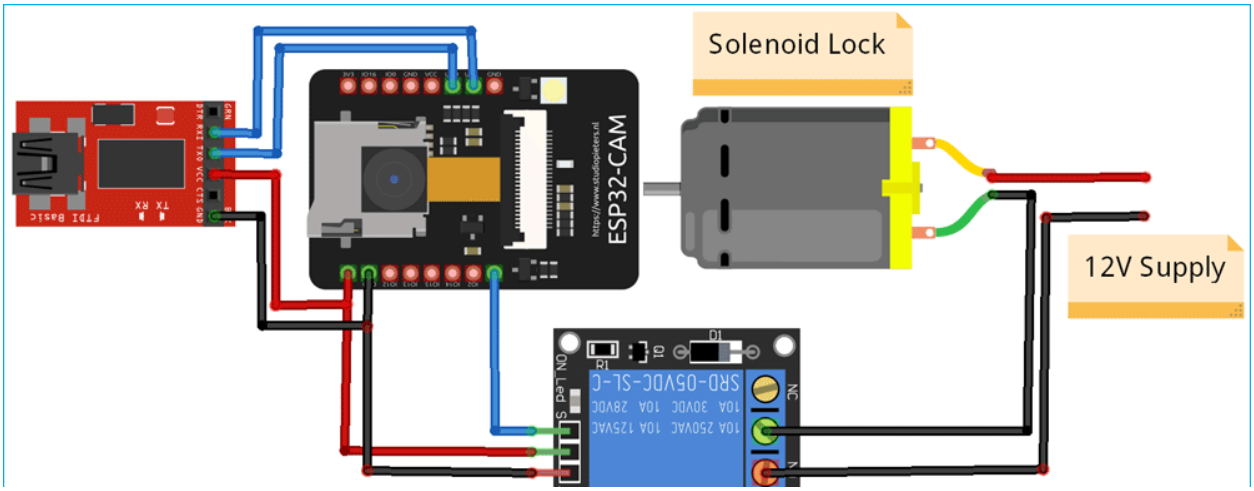

Figure 12: ESP32 cam circuit

3. Visitors enter the company by ringing the bell

This feature depends on increasing security so that no one will be allowed to enter the company, except after ringing the bell, then one of the employees will enter the visitor by placing his palm against the IR sensor from inside the company

This is by connecting the IR sensor with esp32 and solenoid lock

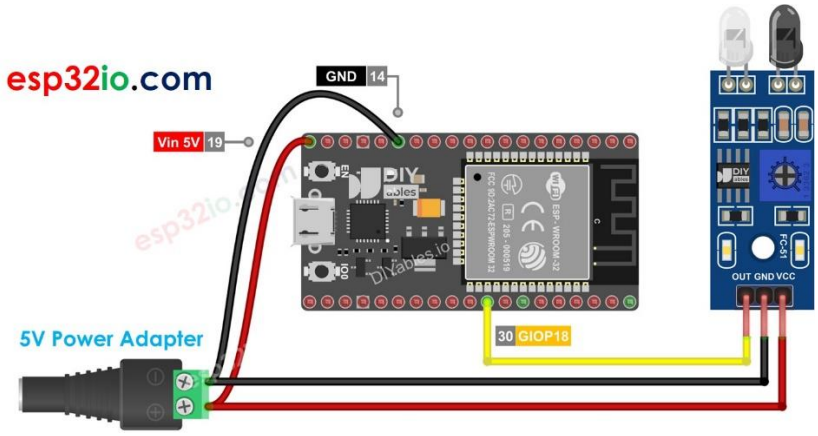

Figure 13: IR sensor with esp32

- **Gas leakage detection**

This technology depends on examining the percentage of gas in the air of the company using a gas detector (MQ-5) that is attached to the esp32. If the percentage is higher than 400, the GSM that has been connected with the esp32 will send a text message to the manager of the company, and if the percentage increases to exceed The 600 GSM calls the Civil Defense, then the alarm is triggered and the company door's locks will be unlocked

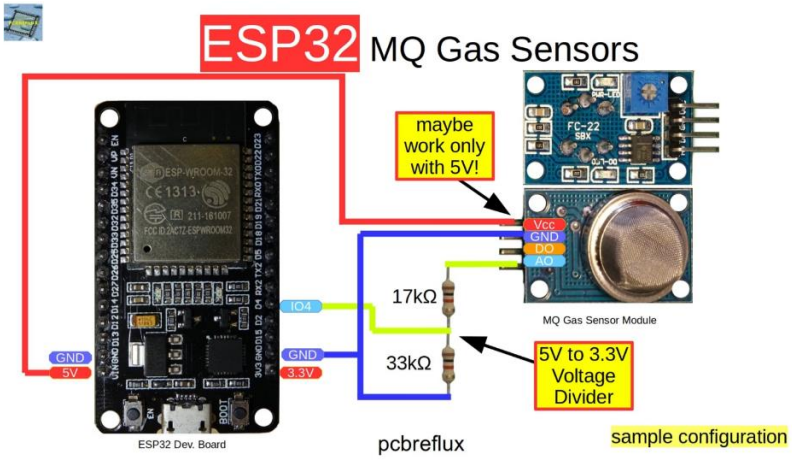

Figure 14: MQ Gas sensor with esp32

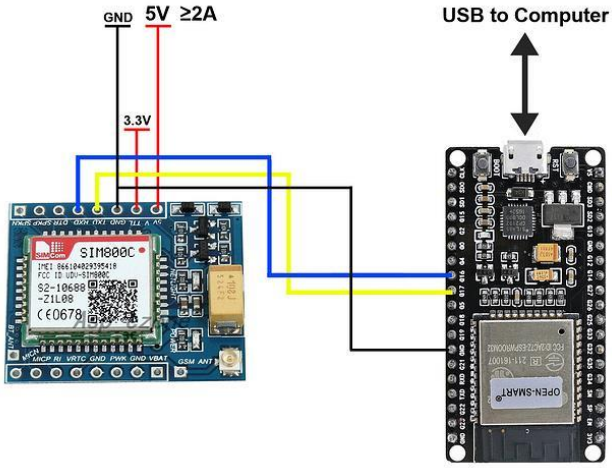

Figure 15: GSM with esp32

- **The company's self-lighting system**

This feature operates the company's lights automatically at eight in the morning and closes them at eight in the evening, and it will not allow the lighting to work on holidays and weekends. This feature is based on **NTP server** provided by ESP32
To get date and time with the ESP32, simply need to include the time.h library in the code. The pool.ntp.org is a NTP server that can be used to request time as a client, which is the esp32

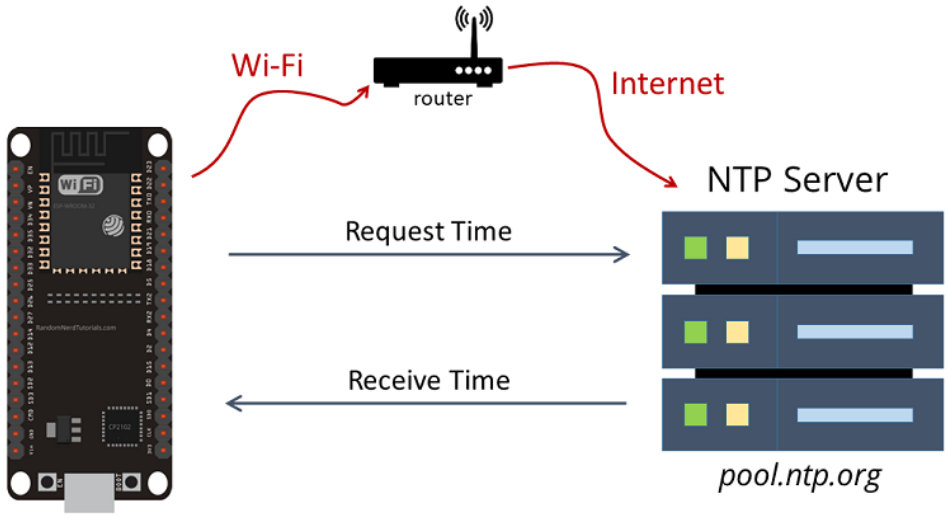

Figure 16: NTP server and esp32 as client

Therefore, a lighting cord that needs 12 volts was connected to a relay, and then connected to an ESP 32

- **Office lighting control**

The office lighting is controlled by connecting an LED with a variable resistor, all of which are connected to the ESP32. When changing the value of the resistance, the glow of the light changes.

- **Temperature control system**

The ESP32 has been connected with a Dht11 sensor, so when the air temperature rises above 28 degrees, the fan will start automatically
The Dht11 sensor contain a chip that does analog to digital conversion and spit out a digital signal with the temperature.

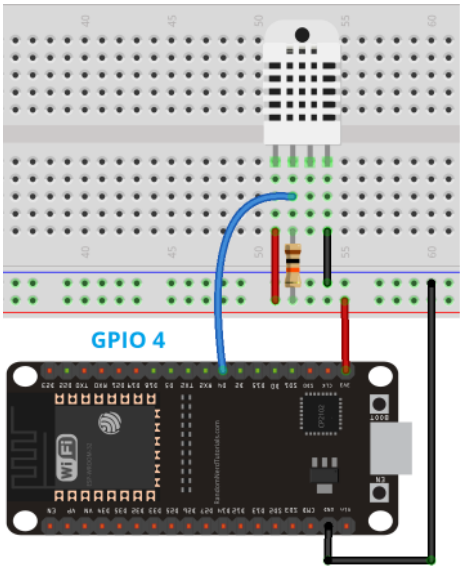

Figure 17: Dht11 with esp32

- **Back door security system**

The fingerprint sensor was placed on the back door of the company, in case the employee wanted to reach the parking lot faster and easier. So when the sensor recognize the fingerprint of the employee the ESP32 will open the second solenoid lock

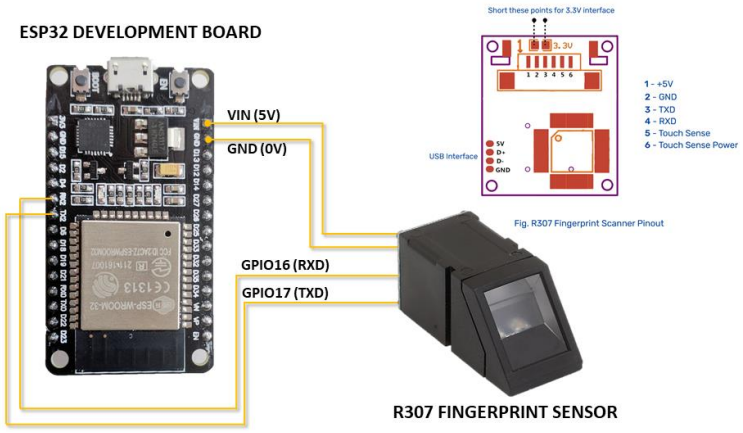

Figure 18: Fingerprint sensor with ESP32

- **Car Parking system**

This system relies on the use of the Node MCU as a controller, as it has been connected to an RFID reader to read the cards. If the card is present in the data base and the car is entering the garage, the servo motor will move and open the garage door, part of the car owner balance will be deducted, and it will make an Http request to connect with esp32 and get an http response so the esp32 will open the back door lock of the company automatically so that the employee does not have to turn around and go through the main door. Moreover, if the car is leaving the garage, the servomotor will move and open the garage door, and part of the balance will withdraw.

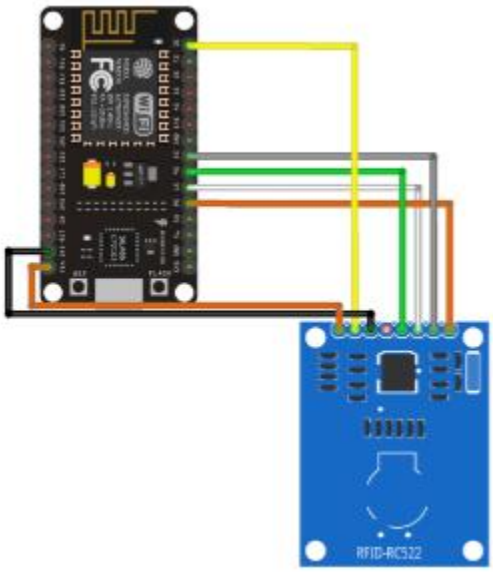

Figure 19: RFID with NodeMCU

7.4 Libraries

We include the following libraries:

1. The SPI library used by microcontrollers to communicate with one or more peripherals.
2. RFID Library for communicating with RFID readers.

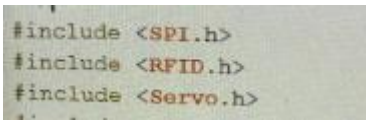

Figure 20: RFID libraries

3. Time library to get the time and date to use the NTP server
4. Wi-Fi and BluetoothSerial libraries
5. DHT library to use the temperature sensor
6. HTTPClient library to perform HTTP requests on NodeMCU and ESP32.
7. ESPAsyncWebServer library to make web server in ESP32.
8. HardwareSerial library to setup a serial connection between ESP32 and ESP32 cam.
9. Adafruit_Fingerprint library to use the fingerprint sensor with esp32 to save photos and detect the fingerprint.
10. Servo library to control the servomotor.

8 Result and Discussion:

PERFICIENT company that combines the ease of use of its features and the efficiency of performance, will facilitate the lives of the company's heads and employees and gives them the best experience in many aspects, the most important of which is protection. We met the project's objectives and gained a lot from the experience. It was really beneficial to us on both a human and technical level.

9 Conclusion and recommendations:

After building the smart company, we have acquired a lot of skills:

- Handle all configurations and settings with ESP32 and NodeMCU
- How to handle the esp32 cam, store photos and recognize faces.
- Dealing with many hardware components: IR sensor, fingerprint sensor, gas sensor, RFID, servo.
- Dealing with GSM, making self-calls and sending SMS
- How to create a server and client connection between the controllers

More attention should be paid to hardware courses and projects in computer science and computer engineering departments because they focus on realism and creating things that benefit the students themselves and societies in general.

10 Future work

Most of the useful features were identified during the development of the smart company, and many of them were implemented. However, due to lack of the practical knowledge constraints and other factors. So, in summary, the development features are as follows:

- Establishing a heating system
- Control the company features using a phone application
- Adding more features to parking, such as sensors to determine vacant spaces
- Include voice assistant to help newbies and visitors

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