HO CHI MINH UNIVERSITY OF TECHNOLOGY

ELECTRICAL ELECTRONIC ENGINEERING

Electronic Department

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EE3427: Embedded System

Mini project: HOME ALARM SYSTEM

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SUBJECT:	**Embedded System**
GROUP:	**9**
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HO CHI MINH CITY, 2025

1. Introduction

1.1 Abtract

The rapid advancement of technology has revolutionized the way we approach home security, leading to the development of smart home security systems that provide enhanced safety and convenience. This essay explores the design and implementation of a Home Alarm System utilizing the STM32 microcontroller, which serves as a robust platform for integrating various security features. By leveraging the capabilities of STM32, the system incorporates sensors, cameras, and alarm mechanisms to create a comprehensive security network.

The architecture of the smart security system encompasses multiple components including motion detectors, IR sensors, and OLED for displaying, all of which communicate seamlessly through a central STM32 unit. Additionally, the system is designed to be user-friendly, allowing homeowners to monitor and control their security settings via pc using an usb port. This integration not only enhances real-time response to potential threats but also provides users with the ability to receive alerts and notifications, ensuring peace of mind.

1.2 Requirement statement

Functional-requirement:

FR1/ shall detect abnormally using sensors.

- the system shall read the digital signals from the PIR sensors every time is triggers.
- the system shall read the digital signals from the IR sensors every time is triggers.
- the system shall read the digital signals from the Flame sensors every time is triggers.

FR2/ shall trigger alarm when detect something.

- the buzzer shall stay on until there is a command to turn off.
- the red led shall turn on when in ON state and remain till there are a command to turn off.
- the led shall only trigger when detect somehing in ARM state.

FR3/ shall send the information to the pc via usb uart.

- the serial port should recieve the alert when something is detected.
- the serial port shall display the real time when sensors is trigger.

FR4/ shall display the current status of the house on OLED screen.

- the oled should display the current status of the system every 1000ms.
- the oled shall display the sensors that get triggers.

FR5/ shall be able to control through PC by usb to uart serial comunication.

- the system shall turn ON/OFF when recieve ON/OFF command from the serial port.
- the system shall reset the state of the sensors when recieve RESET command.
- the system shall change to ARM state when receive ARM command.

Non-function requirement:

NFR1/ Performance:

- Sensor to alarm reponse time < 1000 ms.
- Serial command to action respone < 1000ms.

NFR2/ Reliability:

- Should operation 24/7.
- Should prevent critical values when RESET.

NFR3/ Usability:

- Serial message shoul display slow for readability and command.
- Have a small OLED to display message.
- OLED message should be clear.

NFR4/ Software:

- Should be well commented.
- Shall be reusable for other sensors.

NFR5/ Communication protocol:

- Use USB to UART for communication operating at 115200 baud rate.
- Use I2C to display on OLED.

NFR6/ Safety:

- Buzzer sound loud and repeatedly.
- Buzzer when silient in ARM and OFF mode.
- LED have to be ON when alarm.

2. Components :

2.1 STM32F103RCT6 ARM CORTEX-M3 MINI:

The STM32F103RCT6 ARM Cortex-M3 Mini development kit is designed to support basic experiments with the STM32F103RCT6 microcontroller. This kit includes essential components such as:

-USB Port: For easy connection and communication with a computer.
-LED and Button: For conducting simple control experiments.
-External Flash Memory: To expand data storage capabilities.
-Standard JTAG Programming Port: For programming and debugging support.
-UART Port: For connecting with other devices.
-NRF24L01: Integrated for wireless communication.
-LCD Port: To display information, serving various applications.
-Power supply: 5VDC from mini-USB port or GPIO.
This kit is ideal for beginners looking to learn about programming and applications of STM32, providing a solid foundation for developing creative and practical projects.

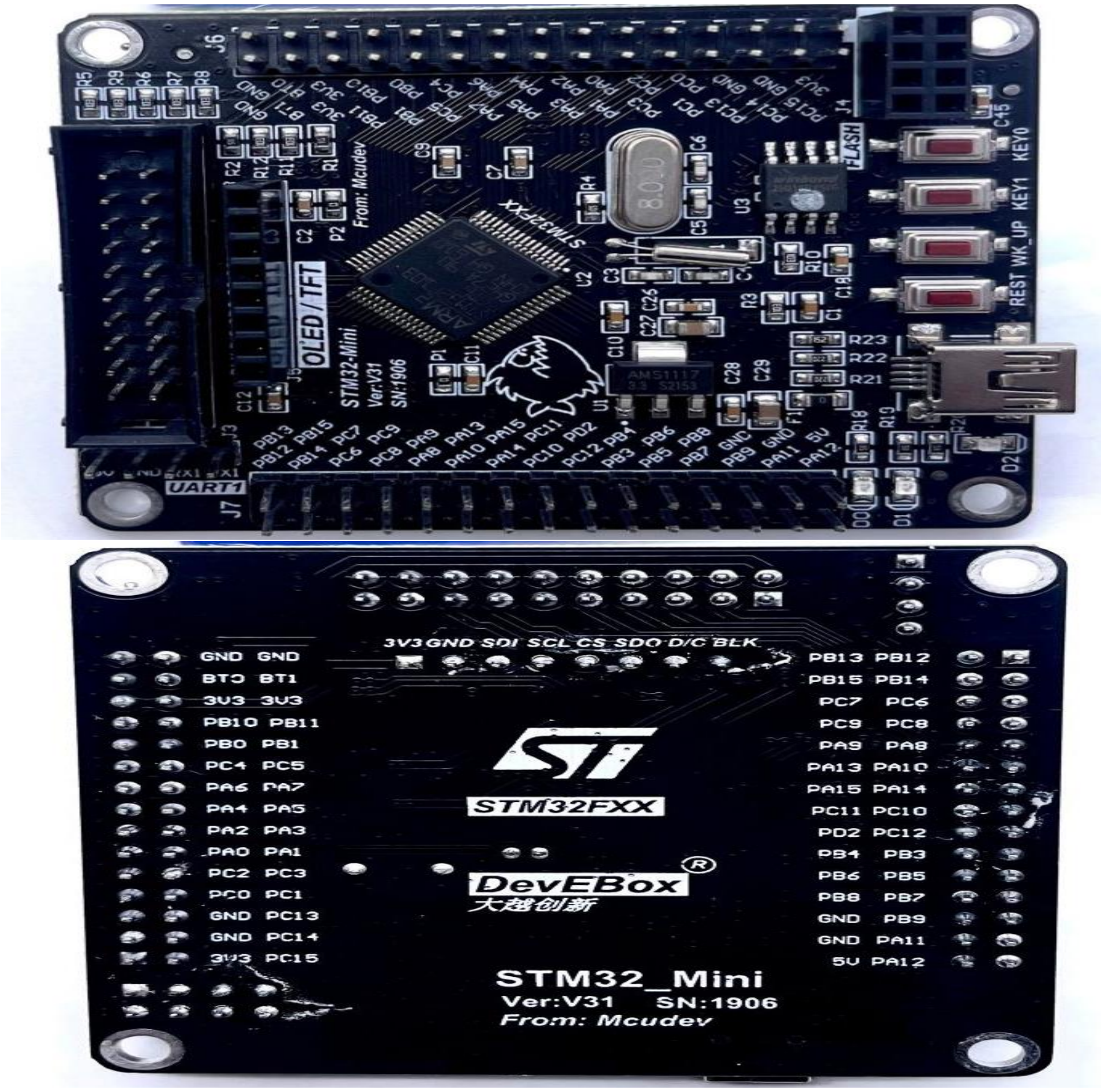


Figure STM32F103ECT6 module

Schematic:

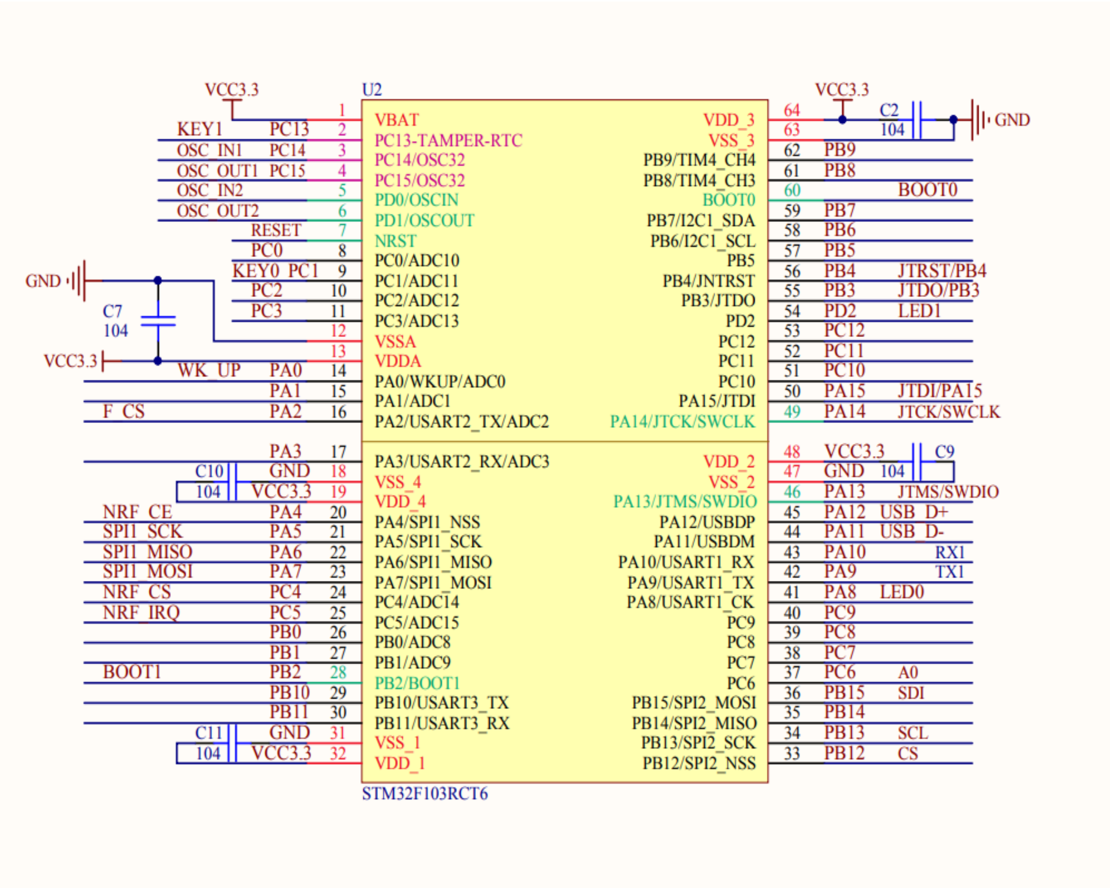


Figure Pin of STM32F103RCT6

In this project, we chose to use this module because of its price and because it is very easy to use and debug. With many GPIO pins, we can easily use them to connect with many sensors, combined with the UART port, and OLED port it makes connecting wires to other components more easily.

2.2 PIR AM312 mini:

The PIR AM312 mini is a Passive Infrared (PIR) motion sensor used to detect the movement of objects emitting infrared radiation (such as humans, animals, and heat-emitting objects). The sensor's sensitivity can be adjusted to limit the detection range and the intensity of radiation from the desired object.

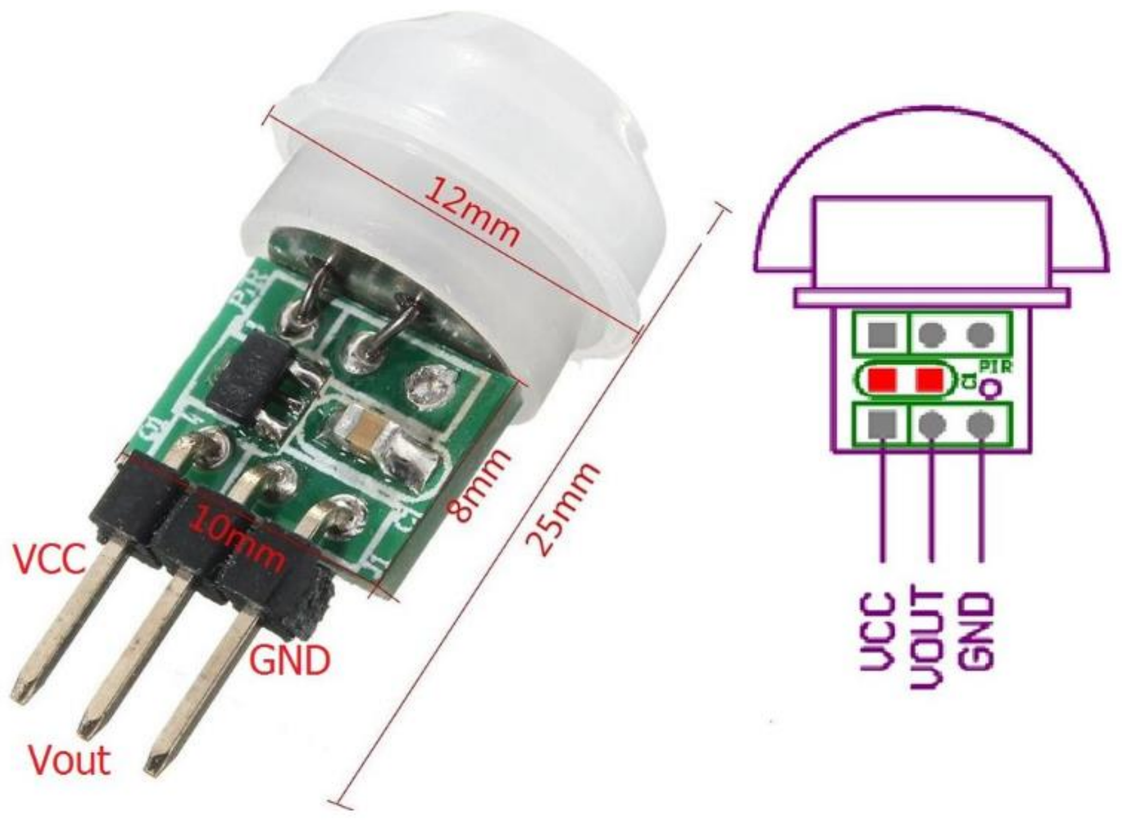


Figure PIR AM312 Mini

Specifications:

- Detection Range: 100-degree angle, 3 meters.
- Operating Temperature: -20 - +60 °C.
- Operating Voltage: DC 2.7V - 12V.
- Current Consumption: ≤ 0.1 mA.
- Delay Time: 2 seconds.
- Trigger: Can be repeated.

2.3: Flame sensor: The flame sensor is commonly used for fire detection applications such as fire-fighting robots and fire alarms. The detection range of the sensor is approximately 80 cm, with a scanning angle of 60 degrees. It is most effective at detecting flames with wavelengths between 760 nm and 1100 nm.

The flame sensor features two output signals: Digital and Analog, making it very easy to use.

Specifications:

- Power Supply: 3.3V - 5V DC
- Current Consumption: 15 mA
- Output Signal: Digital 3.3 - 5V DC (depending on power supply) or Analog
- Distance: 80 cm
- Scanning Angle: 60 degrees
- Dimensions: 3.2 x 1.4 cm

Figure Flame sensor module

2.4 IR Infrared Obstacle Avoidance

The infrared obstacle avoidance sensor is used to detect obstacles using infrared light. The sensor has a simple usage method with a potentiometer to adjust the detection distance, and it provides a digital output that easily interfaces and programs with microcontrollers. It is suitable for applications such as obstacle-avoiding robots, alarm systems, and automatic door models.

Specifications:

- Operating Voltage: 3.3 - 5 V DC
- Detection Method: Using infrared light
- Output: Digital TTL
- Feature: Integrated potentiometer to adjust the detection distance
- Size: 3.2 x 1.4 cm

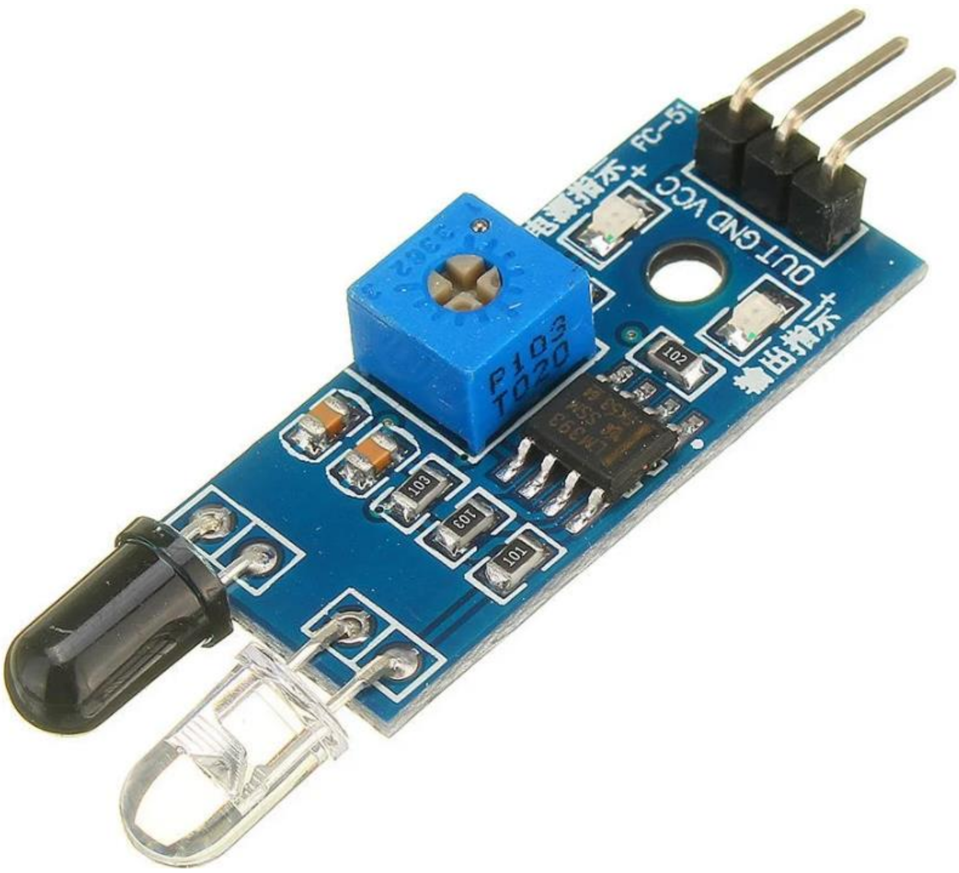


Figure IR sensor module

2.5 Buzzer

The buzzer circuit is used to produce sound when a signal is triggered (PWM), and it is applicable in signaling systems, alarm systems, and more.

Specifications:

- Operating Voltage: 3.3 - 5 V DC
- Trigger Signal: PWM
- Size: 32 x 13 mm

Figure Buzzer module

2.6 OLED 0.96 inch:

Specifications of the OLED Display:

- Operating Voltage: 2.2 ~ 5.5 V DC
- Power Consumption: 0.04 W
- Viewing Angle: Greater than 160 degrees
- Display Points: 128 × 64 points
- Screen Width: 0.96 inch
- Display Color: White
- Interface: I2C
- Driver: SSD1306
- VCC: 2.2 ~ 5.5 V DC
- GND: 0 V DC
- SCL: Clock Pulse
- SDA: Data In

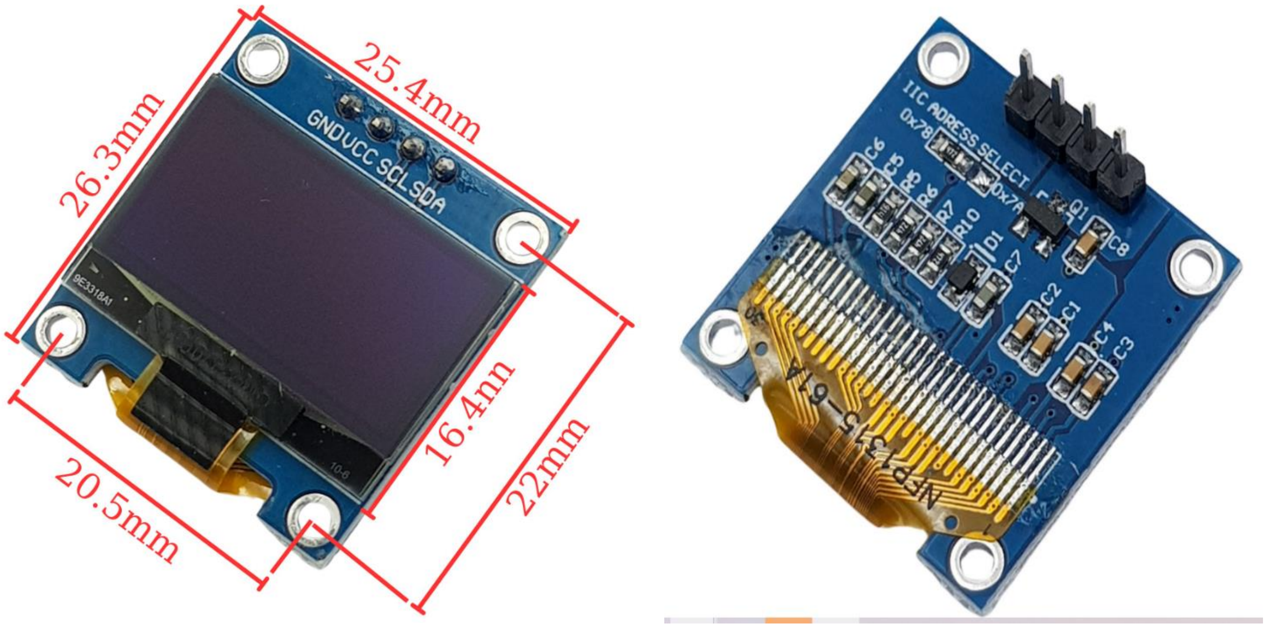


Figure OLED 0’96 inch module with I2C

2.7 Led

The 3 Kind 5mm Color LED Set includes three common types of 5mm LEDs, with 10 pieces of each type (totaling 30 pieces). This set is perfect for conducting experiments on a breadboard with modules, microcontrollers, sensors, and more.

This component acts as light or alarm elert

Figure LED

2.8 bread boards and wire

Acts as the base of the project also connects above components.

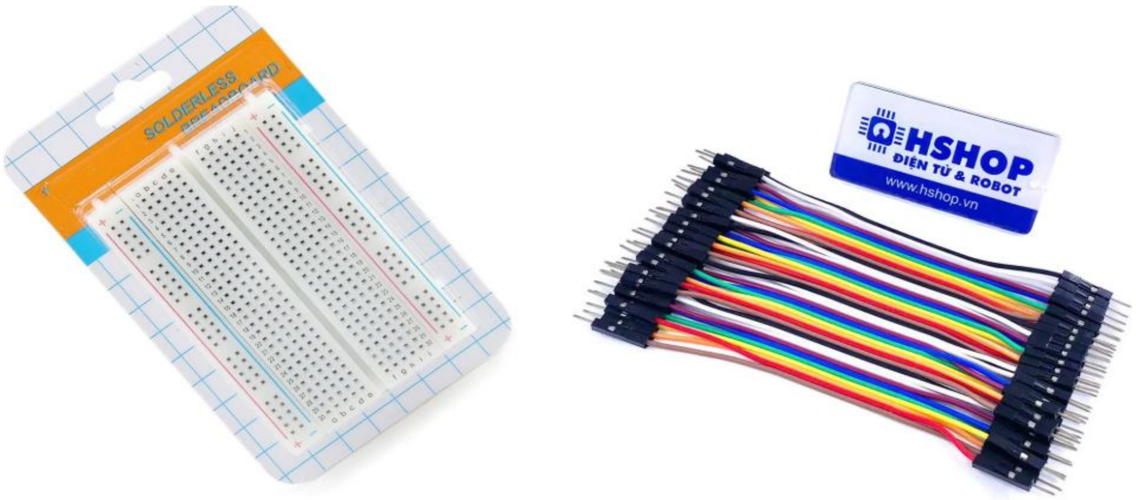


Figure Breadboard and wire

2.9 The CH340G USB to UART converter circuit

The USB UART CH340G converter is low-cost and is used to convert UART TTL signals to USB communication and vice versa. The module is compatible with most current operating systems: Windows, Mac, and Linux. The USB UART CH340G converter includes a jumper to select the TX and RX signal levels as TTL 3.3VDC or 5VDC.

Technical specifications:

- Operates at 5VDC supplied directly from the USB port.
- Output signal pins:
  - 5V: Supplies 5VDC from the USB port, up to 500mA.
  - VCC: Signal level selection pin for TX/RX; connecting to 5V gives 5VDC, connecting to 3V3 gives 3.3VDC.
  - 3V3: 3.3VDC power pin (very low current supply, max 100mA); not for powering devices, typically used for setting logic signal levels.
  - TXD: UART TTL data transmission pin, used to connect to the RX pin of modules using TTL signal levels.
  - RXD: UART TTL data reception pin, used to connect to the TX pin of modules using TTL signal levels.
  - GND: 0VDC ground pin.
- Integrated TX and RX signal LEDs.
- Compatible with most current operating systems: Windows, Mac, and Linux.

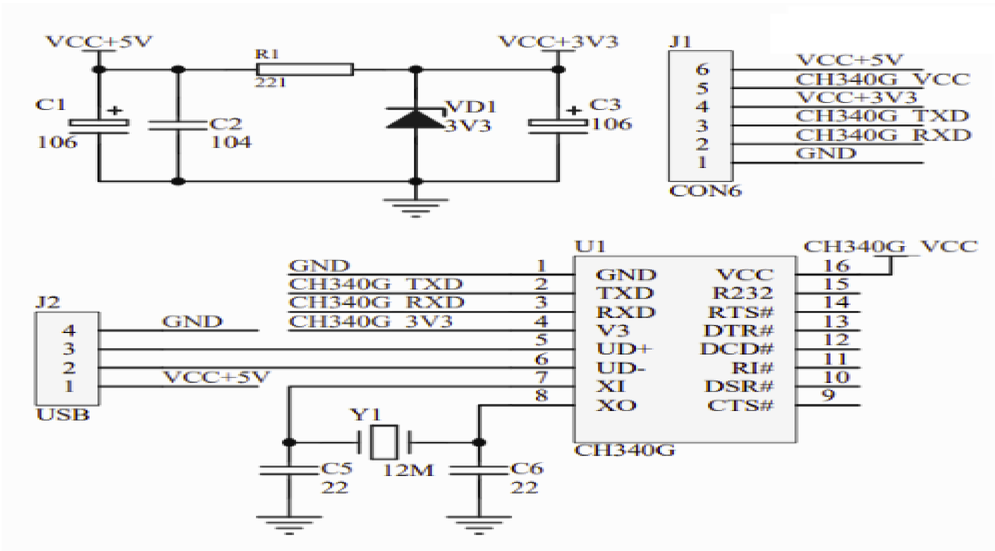


Figure CH340G USB to UART model

3. Implementation and process

3.1. Block diagram:

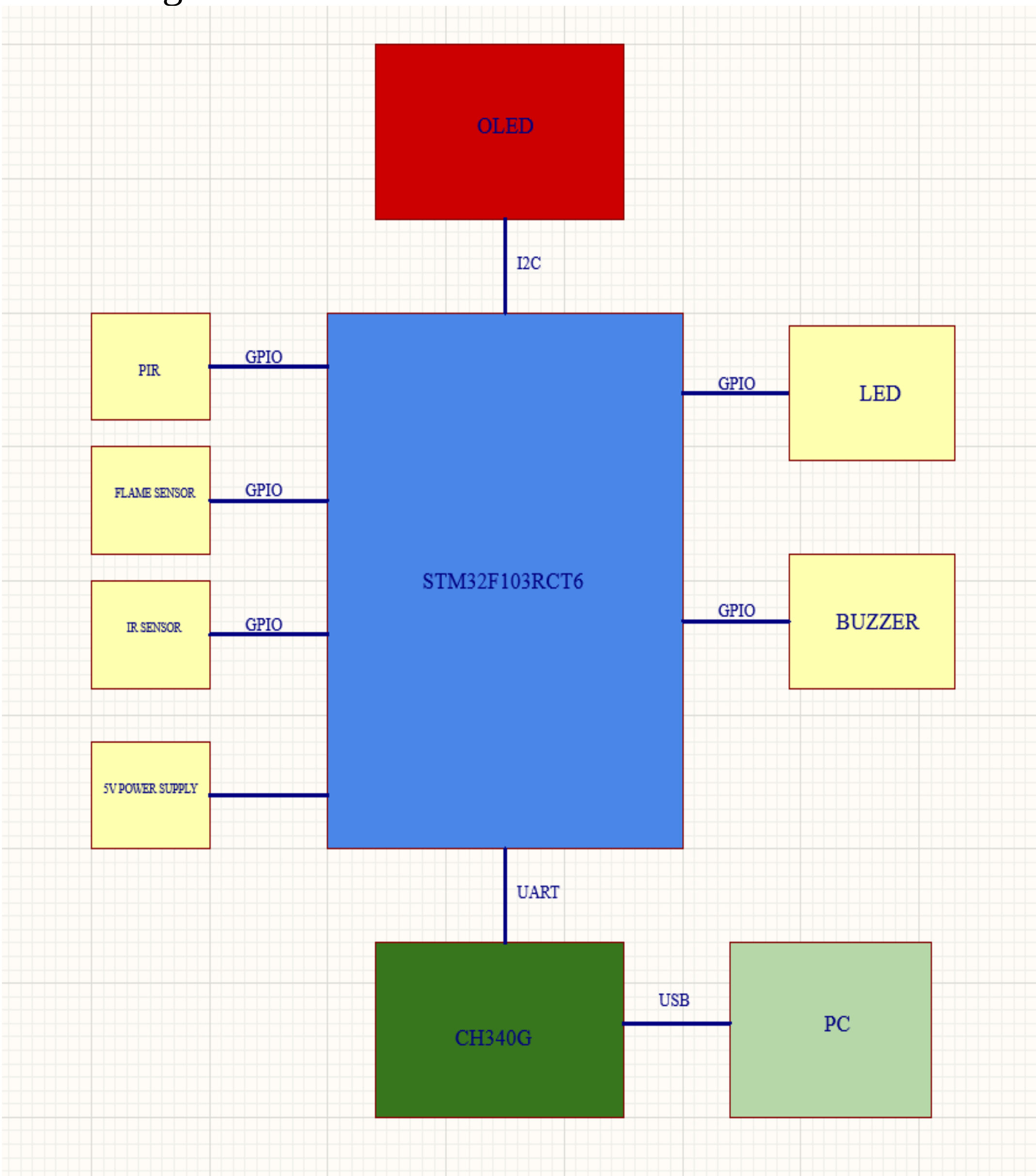


Figure Block diagram of Home Alarm System

3.2. Schematic:

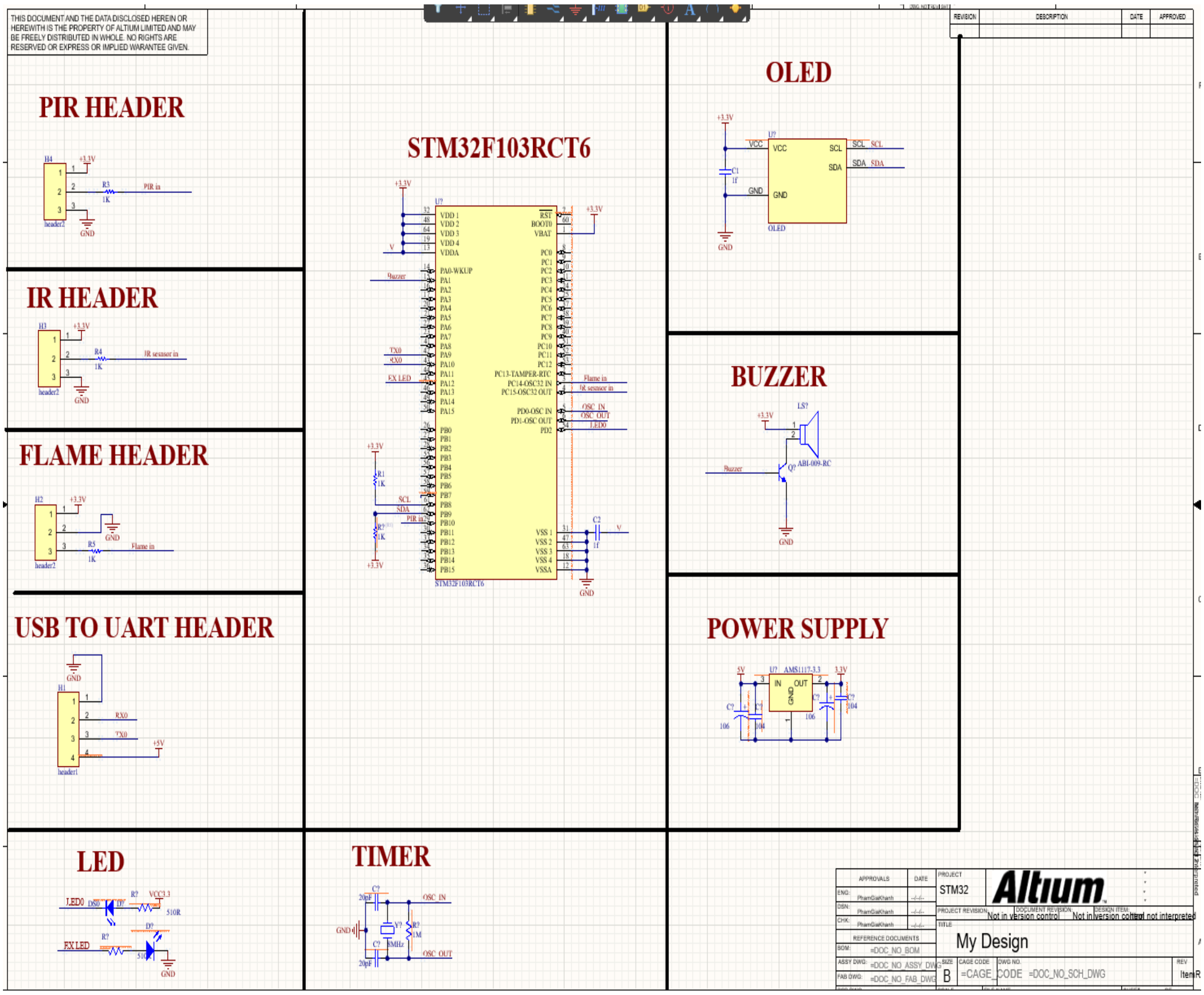


Figure Schematic of Home Alarm System

In this project we will use:

- 2 USART Pin PA9, and PA10.
- 2 I2C Pin PB8 for SCL, and PB9 for SDA.
- 3 Pin for Sensor input PC15, PC14 and PB10.
- 1 Pin PDO for LED of the module.
- 1 Pin PA12 for outside LED.
- 1 Pin PA1 using TIM1 for Buzzer.
- The Power supply of 5V.
- The inside TIMER of the module.

3.3. Flowchart:

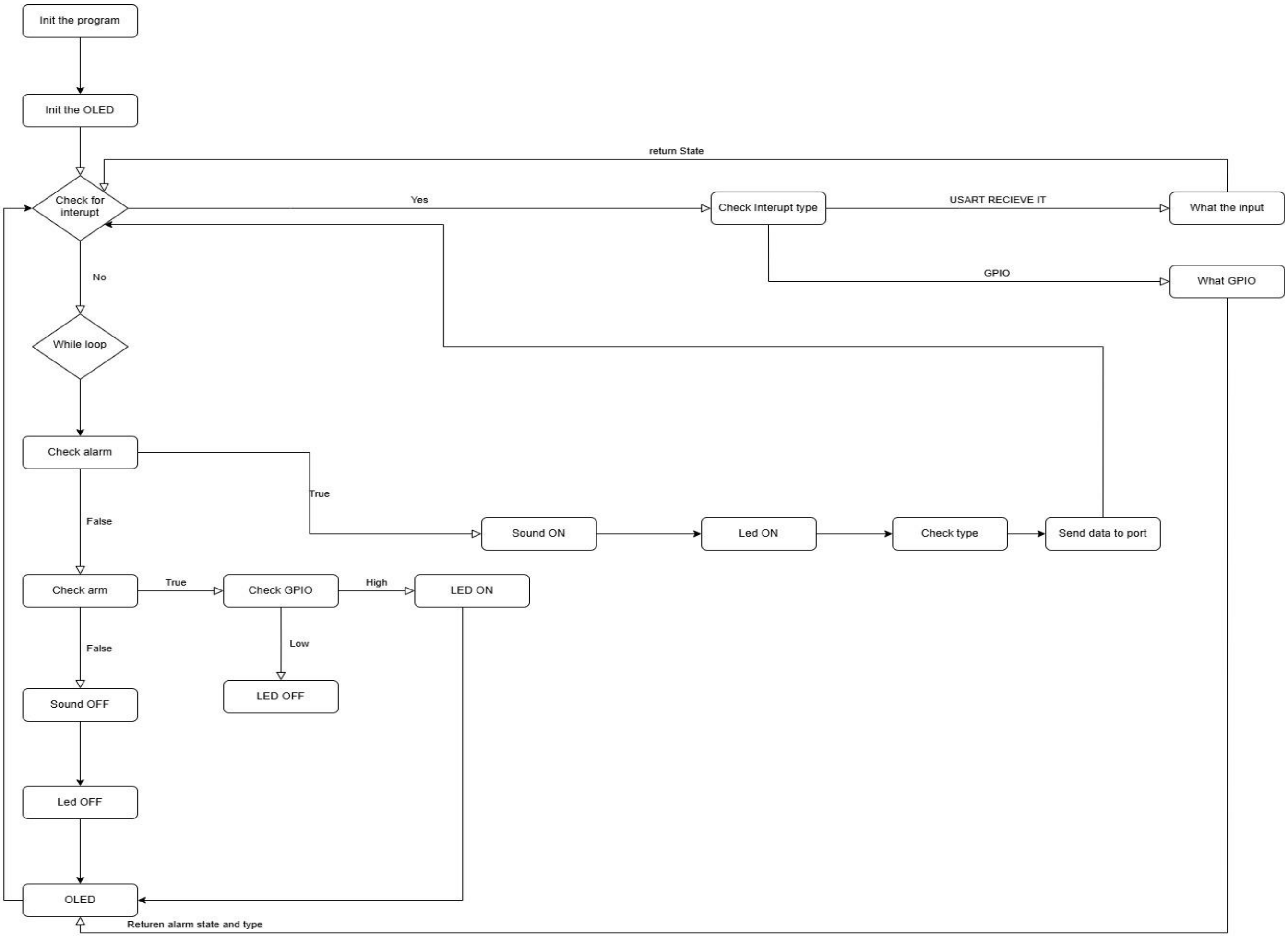


Figure Flowchart of the code

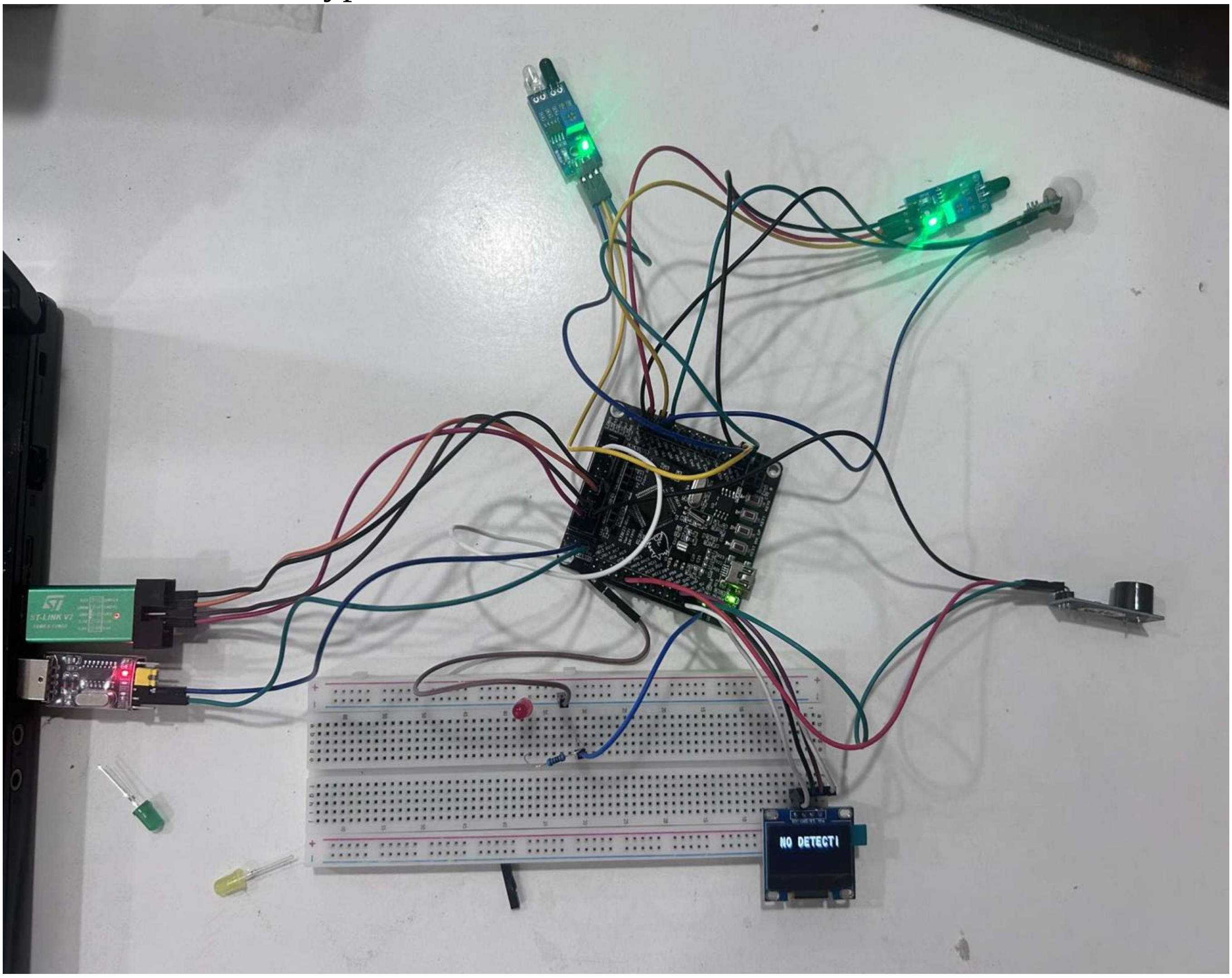
As can be seen in the figure above, the flow of the system go through some main parts:

- First is to check for the inerupt typte.
- If the interupt is cause by the GPIO, display it on the OLED then return the alarm state and what type of the sensors.
- If the input is from port serial, it will detect what have been type in and return the sate of the system.
- The while loop will check what sate the system in and what type of sensors have been trigger, echo back to the serial port, turn on/off LED, and trigger the buzzer depend on the return state.

The system will be operate in four main sate:

- ON: In this state the alarm will trigger when the sensors detect something, and stay on until receive different state from the PORT.
- OFF: In this state the the system will turn OFF and the sensors can't trigger anything.
- RESET: Reset the state of the alarm to false, turn off LED, and buzzers. The system still operate like normal.
- ARM: In this state the alarm won't trigger but the sensor still working and turn on the LED when it detect something from the sensors and turn OFF when else.
- Other input: The system stay the same.

3.4. Prototype:



3.5. Result:

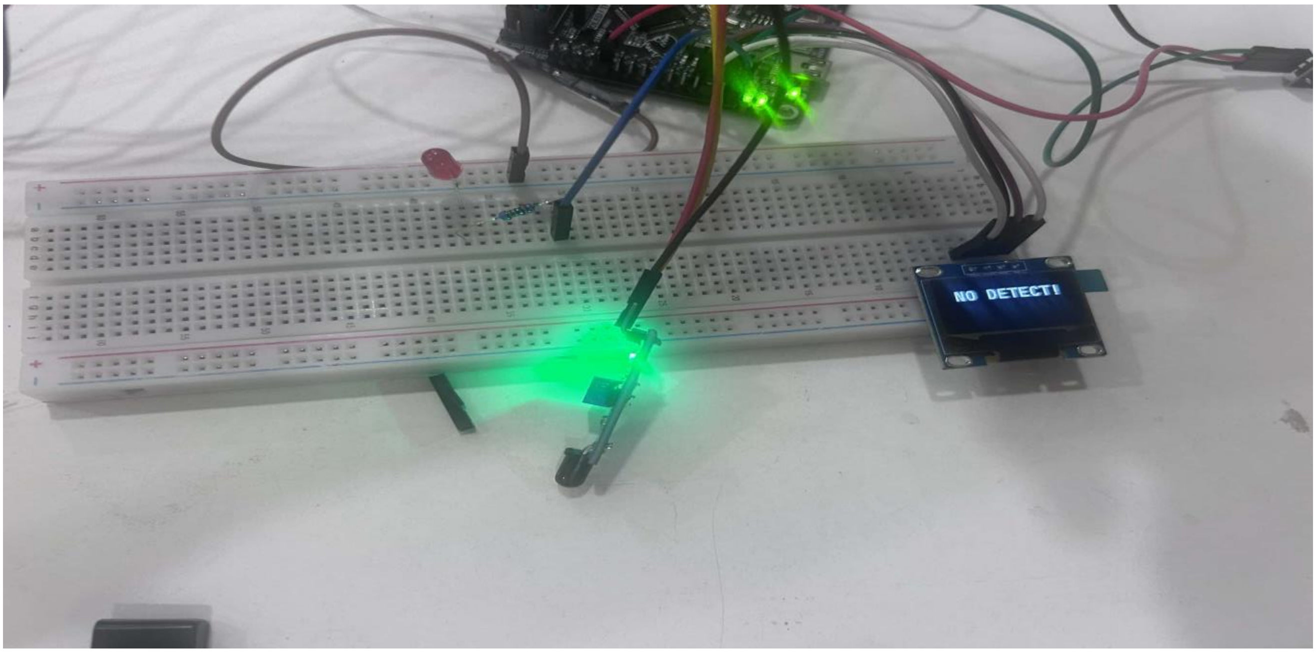


Figure NO DETECT

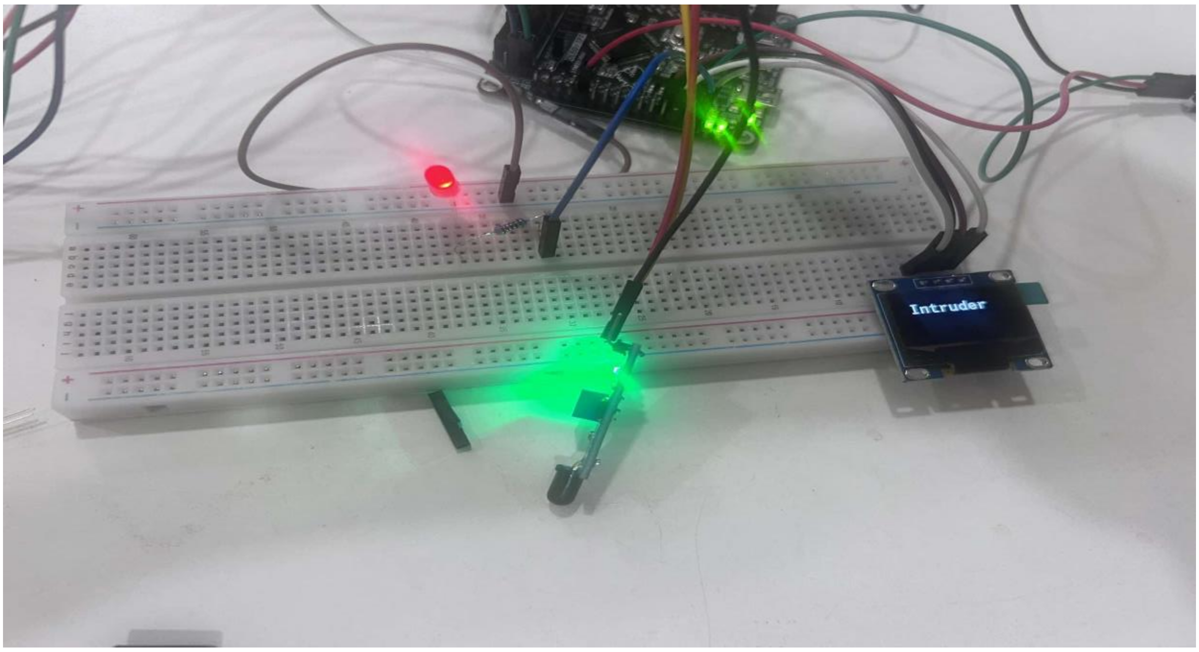


Figure INTRURDER (IR sensors).

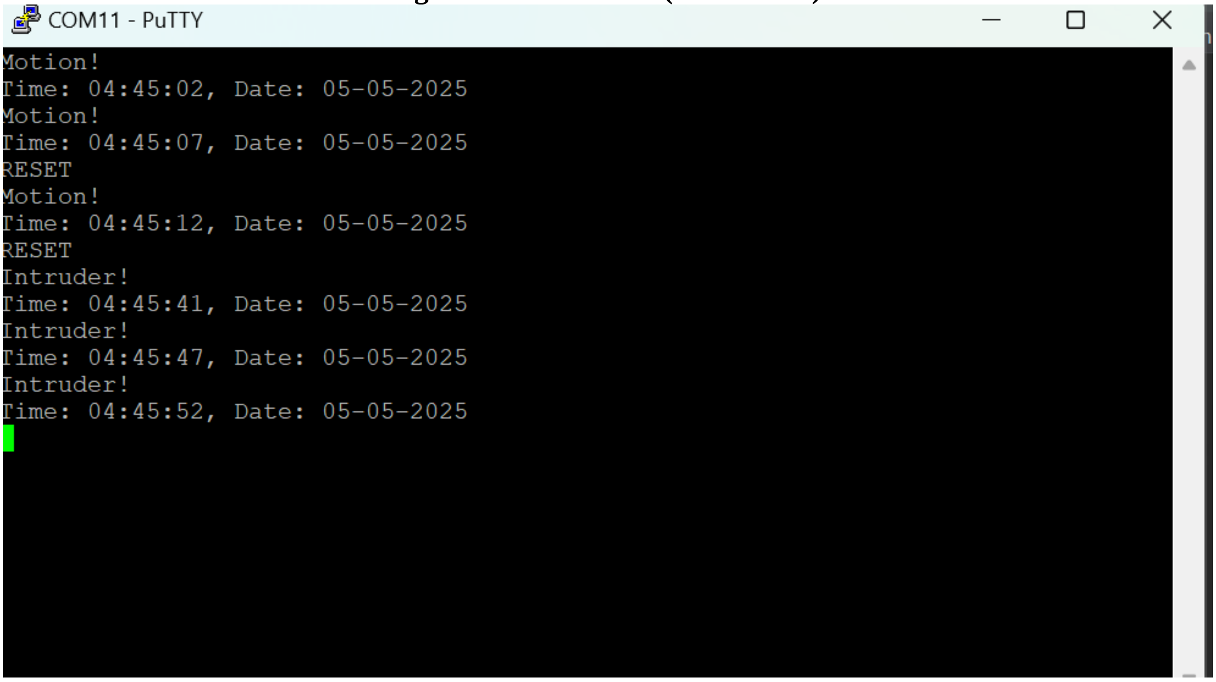


Figure Serial Port of USB when IR sensor detect

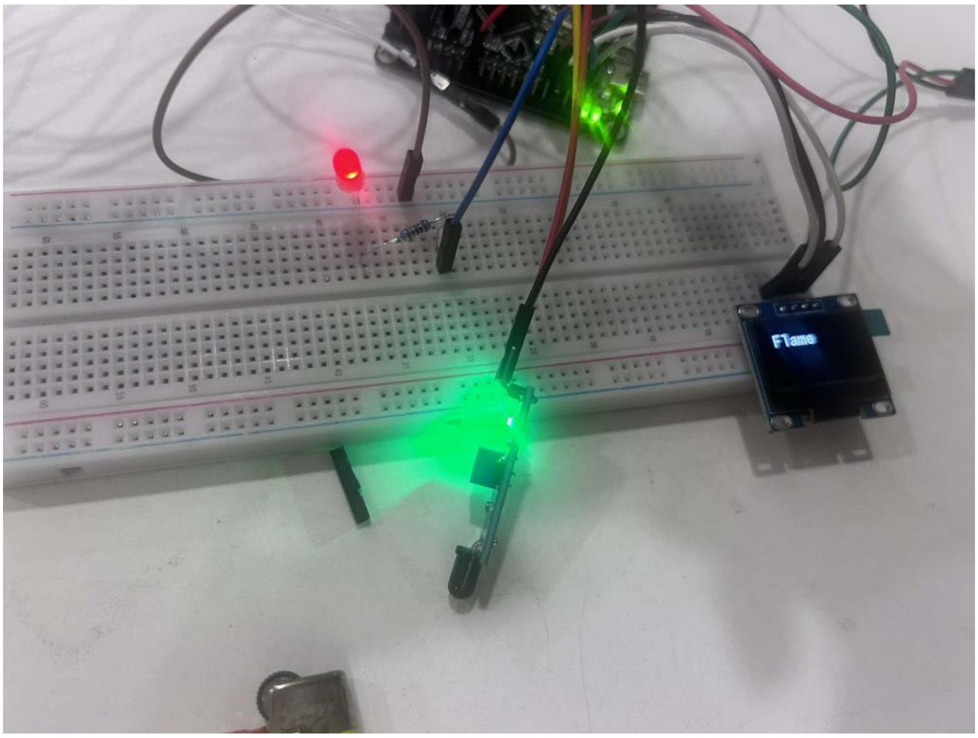


Figure FLAME (flame sensor)

```
on
ON
Flame!
Time: 04:46:59, Date: 05-05-2025
Flame!
Time: 04:47:04, Date: 05-05-2025
Flame!
Time: 04:47:09, Date: 05-05-2025
RESET
Flame!
Time: 04:47:14, Date: 05-05-2025
OFlame!
Time: 04:47:19, Date: 05-05-2025
RESET
Flame!
Time: 04:47:24, Date: 05-05-2025
RESET
Flame!
Time: 04:47:36, Date: 05-05-2025
Flame!
Time: 04:47:41, Date: 05-05-2025
Flame!
Time: 04:47:46, Date: 05-05-2025
```

Figure Serial Port of USB when Flame sensor detect

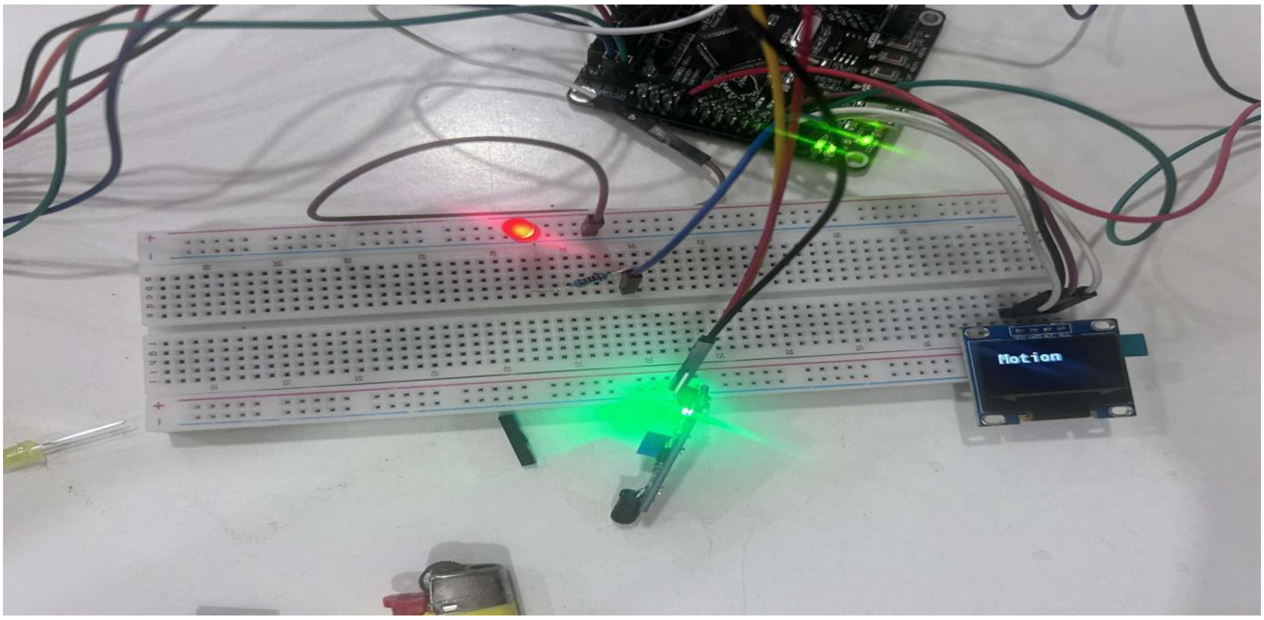


Figure MOTION (PIR sensor)

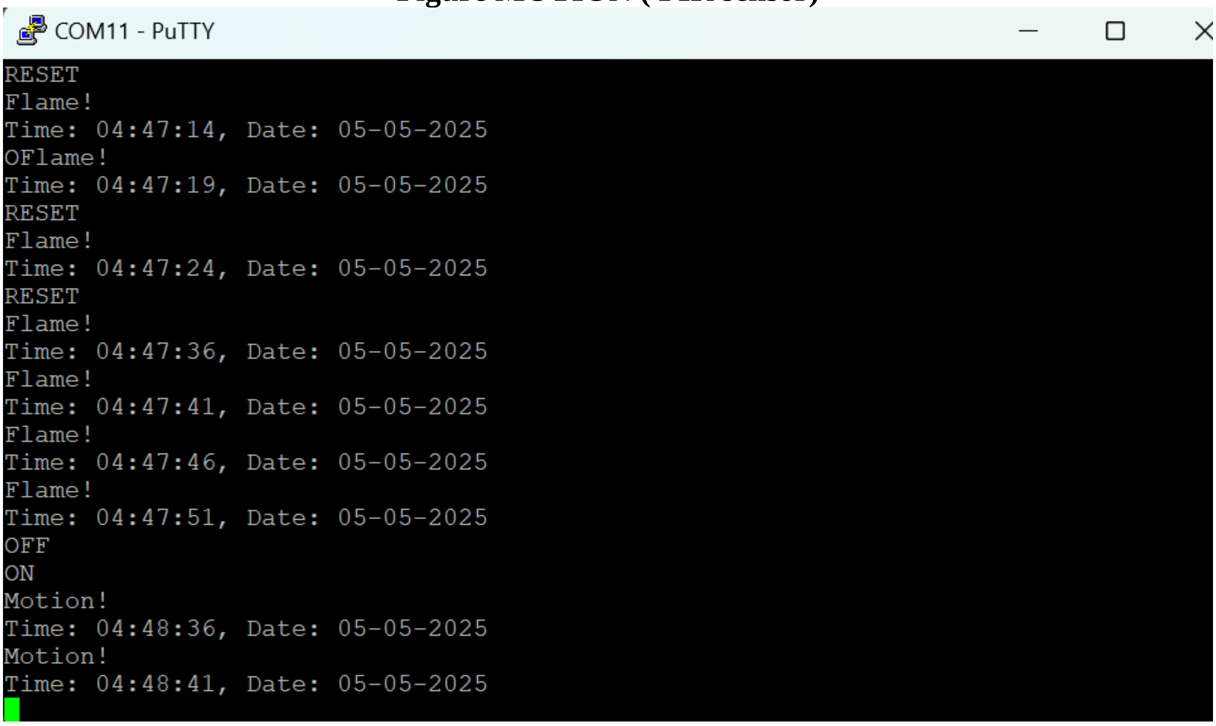


Figure Serial Port of USB when PIR sensor detect

4. Further development:

In this project, we only using the USART port to communicate with the USB serial port. The device still lacking in some IOT aspect, and In Power aspect the system will reset everytime the the POWER its OFF. To improve the system, we think the system can be add some IOT module like GSM or ESP module for receiving data wireless. The system also can be design with a back up battery so that its can remain ON when needed. Moreover, the system can also be expand with more sensors as there still have many unused GPIOs.

5. Conclusion:

In conclusion, the Home Alarm System using STM32 offers a robust and efficient solution for enhancing residential safety. By leveraging the capabilities of the STM32 microcontroller, this system integrates various sensors and communication technologies to provide real-time monitoring and control.

Although there still many things criteria are miss when designing the system.Overall the system has work as expected. The design are make so that in can be evaluate for further enhancement. Throughout the project, we have leran many news things about embedded system. The flow of designing an embedded system from listing the requirement, choosing the componets to drawing the schematic and coding the project. We learn how to interface with the STM32CubeIDE for coding, using OLED screen through I2C port, using USART for debugging, mointor, and control the system.