A project report on

SMART DEVICE TO ENSURE WOMEN SAFETY

Submitted partial fulfilment of the requirements for award of the degree of

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

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SRI VASAVI ENGINEERING COLLEGE

(Affiliated to JNTUK, Accredited by NBA & NAAC with A 'grade)

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SRI VASAVI ENGINEERING COLLEGE

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CERTIFICATE

This is to certify that the project report entitled **"SMART DEVICE TO ENSURE WOMEN SAFETY"** being submitted by the students **V. DHARANI KUMAR (21A81A0466), M. L. D. AISWARYA (21A81A0438), M. KOWSHIKA PRIYA (21A81A0432), E . R A J U (21A81A0416), G. BHUPENDRA PRAKASH (21A81A0417)** in partial fulfilment for award of the degree of Bachelor of Technology in Electronics and Communication Engineering for the academic year 2024 - 2025 from Sri Vasavi Engineering College, Tadepalligudem, affiliated to the Jawaharlal Nehru Technological University Kakinada (JNTUK), Approved by A.I.C.T.E., New Delhi &Accredited by NAAC with 'A' Grade is a record of Bonafide work carried out by them under my guidance and supervision.

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We would like to thank our project guide **Dr. CH. V. NAGA BHASKAR, M. Tech., PhD** for the guidance and help throughout the development of the project by providing us with required information.

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DECLARATION

We hereby declare that the project entitled "**SMART DEVICE TO ENSURE WOMEN SAFETY**" is submitted in partial fulfilment of the requirements for the award of **Bachelor of Technology in Electronics and Communication Engineering** under the esteemed supervision of **Dr. CH. V. NAGA BHASKAR, M. Tech., PhD, Department of ECE.**

This is a record of work carried out by us and results embodied in this project report have not been submitted to any other **University** or **Institution** for the award of any **Degree** or **Diploma.**

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ABSTRACT

India still faced deep-seated patriarchal problems, including violence tied to rape and, most tragically, molestation, despite its ambitions to become a global superpower and economic leader. Due to the constant fear of physical and sexual abuse, women's safety has become a major concern. Although several initiatives have been undertaken to address this issue, there remains a critical need for effective solutions that empower women to feel safe in their daily lives. The creation of a women’s safety device emerged as a potential remedy to these ongoing tragedies. Most of the existing women’s safety devices were wearables that could be easily detected by abusers, which posed a significant threat to the safety of women using them. To overcome this vulnerability, we developed a smart, discreet device designed to provide a safer and more reliable option. This device was equipped with a GPS module that automatically broadcasts the user's current location to their parents/guardians when the panic button was pressed for three seconds. Additionally, the device could make an automatic call to the user’s guardians, allowing them to hear the sounds in the vicinity via a GSM module.

The device was specifically designed to operate discreetly, ensuring that it would not be easily detected by potential threats, thereby providing an added layer of protection. It aims to offer a quick and reliable means of alerting loved ones and ensuring immediate action can be taken in case of danger. We successfully developed and tested this project, creating a tangible solution that enhances the safety and security of women, helping them feel more empowered and protected in their everyday lives.

KEY WORDS: Smart device, GSM module, Location tracking, Crisis response, Safety device.

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CHAPTER 1

INTRODUCTION

1.1 Introduction:

In today's world, women's safety is a growing concern across the globe. With increasing instances of harassment, violence, and other safety threats, there is a critical need for innovative solutions to protect women, especially in urban environments. Traditional methods of ensuring safety, such as carrying personal alarms or relying on phone applications, may not always be practical or effective in urgent situations. This project, titled **"Smart device to Ensure Women's Safety,"** aims to provide an innovative and discreet solution to address these concerns. The concept involves integrating advanced technologies such as GPS tracking, real-time alerts, and emergency response systems into a wearable form, specifically, a pair of devices. These smart devices are designed to offer an intuitive and reliable safety mechanism, enabling women to send distress signals and share their real-time location with trusted contacts or emergency services when needed.

By leveraging wearable technology, the smart device not only ensures the safety of the wearer but also provides the convenience of not requiring any manual intervention during critical moments. The device is engineered to function seamlessly in the background, allowing women to go about their daily activities with peace of mind. This project focuses on creating a product that merges comfort, style, and security, empowering women to feel safer in any situation. This report will cover the design, functionality, and potential impact of the Smart device, as well as the challenges and solutions in the development process. Through this project, we aim to contribute to enhancing personal safety and fostering a sense of security for women worldwide.

The **Smart device to Ensure Women's Safety** integrates cutting-edge technology with everyday footwear to create a seamless and user-friendly solution. The device is equipped with a discreet panic button, a GPS tracking system, and sensors that detect specific movements or sudden impacts, such as falls or physical distress. When activated, either through the panic button or automatically triggered by the sensors, the device immediately sends an alert with the wearer's precise location to pre-programmed contacts, local emergency responders, or a dedicated safety network. This allows for a swift response in emergency situations.

1.2 Why Women safety?

Women's safety has become an urgent and critical issue in societies around the world. Despite advances in gender equality and women's rights, women continue to face significant risks of harassment, violence, and discrimination in both public and private spaces. According to numerous studies, incidents of physical and sexual violence, as well as verbal harassment, remain alarmingly high, particularly in urban areas, on public transportation, and in workplaces. The fear of such incidents often limits women's freedom, mobility, and quality of life, as they feel forced to take extra precautions just to go about their daily routines. Beyond the immediate physical threat, these safety concerns have broader societal implications. The constant fear of danger or harm can have a long-lasting emotional and psychological impact, leading to anxiety, stress, and a sense of powerlessness. In addition, the stigma associated with being a victim of violence or harassment can prevent women from seeking help or speaking out. Therefore, addressing women's safety is not only about preventing physical harm but also about empowering women to live without fear, contributing to their overall well-being, independence, and equality. By prioritizing women's safety, we move towards a society where women can participate fully and equally in all aspects of life without the constant concern for their personal security.

Women's safety is also crucial for the broader social and economic development of society. When women feel unsafe, it can limit their participation in public life, restrict their access to education, employment, and social opportunities, and create a cycle of inequality that affects entire communities. Fear of violence and harassment can prevent women from traveling freely, accessing basic services, or fully engaging in activities that promote personal growth and economic empowerment. By addressing the safety of women, we foster an environment where women can thrive, contribute to society, and break free from the constraints imposed by fear. This, in turn, strengthens the fabric of the community and drives positive change on a much larger scale.

1.3 Types of Women safety devices:

1. Smart glove for women security:

Smart gloves as shown in fig 1.1 is designed for safety purposes and their design is based on electric shock technology. Smart gloves are an electroshock weapon. It delivers an electric shock aimed at temporarily disrupting muscle functions and inflicting pain without causing significant injury. Electric shock gloves a temporary high-voltage, low-current electrical discharge to override the muscle-triggering mechanisms. The recipient is immobilized via two metal probes connected to the electric shock device. The recipient feels pain and can be momentarily paralyzed while an electric current is being applied to him/her. Smart gloves are an excellent, safe device that can be used in situations where an immediate safety situation requires quick action to neutralize an attacker. This device is perfect for such a situation. In electric shock device circuits, the concept of mosquito bat is used. Electric shock device is fixed into the glove. Whenever the push button is triggered, the shock is generated on to the tip of the glove. In electric shock device, circuit the concept of mosquito bat is used. Electric shock device which is placed in the glove Is shown in fig.1.2. The remaining circuit is placed in a box. If someone tries to harass the user, the user will trigger the push button switch. As soon as the button is pressed, it forms a path, and a shock is generated at the tip of the glove. The input supply given to the device is between 1.5 Volt to 4 Volt with 3 to 5 Amp. The output of the electric shock device is in the range of 100 V up to 4 kV, current intensity output is in the range of 100 to 500 mA.

Fig 1.1: Smart glove

The individual impulse duration is in the range of 10 to 100 μs (microseconds), frequency of impulse is in the range of 2 to 40 Hz, electrical charge delivered is in the range of 15 to 500 μC (micro coulombs), energy delivered is in the range of 0.9 to 10 J.

Fig 1.2: The circuit placed in a box

2. IOT Based Women Safety Gadge:

WSG model, shown in Fig. 2, is an integrated approach of the existing strategies and the newly added security features to safeguard a working woman. It mainly comprises an Arduino-based controller, MCU 8266 for the Wi-Fi connection, a balloon working as a paper spray, a database stored in the Firebase cloud environment, and GSM and General-Packet-Radio-Service (GPRS) modules for messaging and communication. The components are fitted in a glove for experimental purposes and activated by pressing an artificial nail button on the finger. WSG is created by combining hand harness hardware and a mobile application. Firebase is used to connect both hardware and software. When a woman is in danger, she will activate the device's artificial nail button. Instantly a text message with the location is sent to the closest and most specific volunteers of the user near the victim. The victims can receive administrative and volunteer assistance through the system quickly. The device also triggers a pepper spray system that distributes the pepper spray to a nearby area. The WSG model is divided into two components, i.e., Hardware and Software.

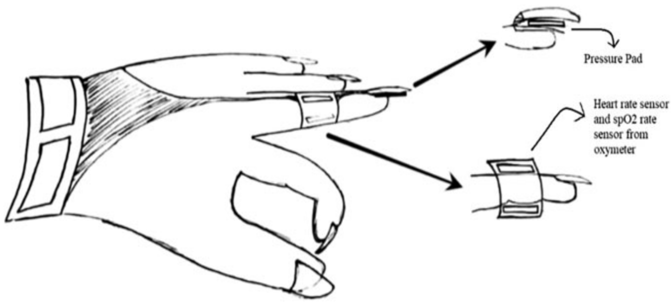

Fig 2: IOT based WSG

Pressure is applied at the nail tip to activate the device. When it gets started, the device will check the pulse rate sensor reading; if it is more than the threshold, an alert message is generated along with the victim's current location, with the help of a mobile site. This message is forwarded to the victims' contacts which the user has saved in close contacts. An immediate defense is activated by the Pepper Spray System, which will release pepper spray by bursting a pepper spray balloon. The project ensures the women safety in the critical situation, but the women should be strong to be safe.

CHAPTER 2

LITERATURE SURVEY

- Ponnusamy et al. [1] in his work identified the security concern related to IoT and traffic analysis. The wireless network has eliminated the physical connectivity of the devices such as smart phones, cameras, and drones and facilitated touch-less communication. With these features, IoT-enabled security devices can be remotely connected and used for sharing information. The information captured by women's safety gadgets can be affected by security vulnerabilities. Network attacks and security breaches can hamper the emergency information sent by the safety gadgets. The author focused on wireless Intrusion-Detection-System (IDS) implications and suggested adopting some preventive measures.
- Patel et al. [2] identify the influence of safety and health on the productivity of women workers. For this purpose, intelligent hardware and software can monitor and identify. Wearable devices and connected commercial workplaces allow constant monitoring of associated risks, injuries, and women assault detection. For this purpose, the authors suggested using intelligent industrial applications, IoT gadgets, and surveillance systems. Message processing in most devices is location-based so that the IoT sensor can be attached to a Mobile Edge Computing (MEC) system. The data arrival on these devices is multiple access services based on a time-sharing system. The actual offloading situations are more complex than synchronized ones.
- This issue has been addressed by Chen et al. [3] in their work which studied a polling callback energy-saving offloading. Data trans- mission and task processing time are asynchronous. They proposed a game-learning algorithm that combines Dueling-Deep-Q-Networks (DDQN) and distributed Long-Short-Term-Memory (LSTM) neural network with the intermediate state transition.
- Wang et al. [4] describe the threshold quantum state-sharing scheme's advantage over security and efficiency. However, these schemes need to be more secure and subjected to attack. Hence the authors have suggested a novel verifiable multi-dimensional (t, n) threshold quantum state-sharing scheme. Here the identity is verified through the rotational- unitary operator and Hash function. This protocol can prevent attack strategies performed by the illegal participant and dishonest participants during the verification phase.
- Pasupuleti et al. [5] state that several preventive laws exist to combat molesters, yet we need instant measures to deal with critical situations. For this purpose, they have suggested wearing intelligent devices for girls and women. The device is enriched with a solid electric shock system and a stun gun to protect the women. The electronic system comprises IoT devices such as GPS, GSM, Light-Emitting-Diodes (LED), a shock system, and a charging

system.

- Arshad et al. [6] raised the issue of women's protection in their work. According to their investigation, one in every three women has experienced physical and mental violence. They have proposed a wearable mechanism that can help monitor women in public toilets, parking, and offices. The device is low-powered and based on a single-chip ATmega328 microcontroller with an 8-bit Reduced-Instruction Set-Computer (RISC). The software is written in Java and runs on Windows, MacOS X, and Linux. Using a motion detector sensor, the device can automate an emergency alert system and send alerts to close friends and families. Download and installation of the Integrated Development Environment Arduino IDE can be learnt from this website.
- Samal et al. [7] is a self-contained gadget activated via speech, switch, or shock/force. The victim's voice is acknowledged by the device and immediately sends distress signals. If the attacker throws the device, it will activate a force sensor to communicate the victim's position information to her family and friends. It also captures the longitude and latitude of the victim's location. The site is tracked using those coordinates using Google Maps. An SMS to inform the pre-stored contacts is also sent about the situation. The approach also attempts to capture guts, beat, and blood heat when the victim cannot press the button. A fingerprint scanning device proposed by Akram et al.

CHAPTER 3

METHODOLOGY & IMPLEMENTATION

3.1 Existing Model:

The WSG system is implemented as a glove to visualize it more clearly, as shown in Fig. 5. The main Arduino board controlling the device is attached to the right side of the glove. A force sensor is attached to the middle finger, which, when pressed, will activate the heart rate sensor and pepper spray mechanism attached to the left side of the glove. In consists of a shaft and a balloon filled with pepper spray. Beneath is the MCU 8266 for the Wi-Fi connection to connect with the backend server. All these connections are set with the help of breadboard and jumper wires.

Layer 1: It consists of the Android app and the Gadget, which will be at the user's end. Android app will show, send/receive all the messages from the GSM server and send the location to close contacts. The Gadget is the primary system the user will wear in their hand.

Layer 2: It consists of all the logic behind our design. The conditions to be checked and the Messages are programmed here. This layer also acts as an interface between the application and the backend server. The WSG system is implemented as a glove to visualize it more clearly, as shown in Fig. 3.

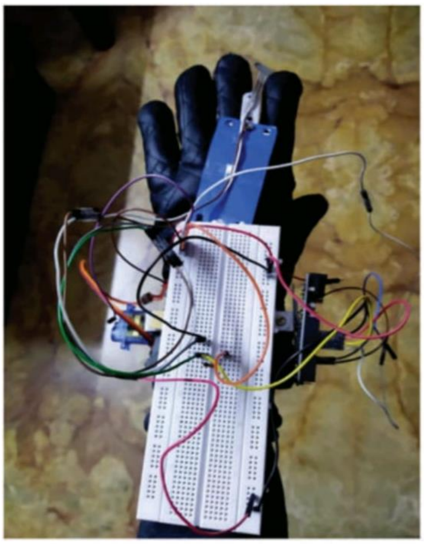

Fig 3: Smart Glove for Women Safety

Algorithm 1 shows the working of the WSG system. The mobile application is connected to the firebase at the back end (a real-time database). A variable gets updated with force readings from Arduino using the ESP8266 module. As there is a need to access location and messaging, one needs to set permissions to the user and be done initially when the application is installed. There is an activity where the user can save three phone numbers on local memory.

3.2 Basic Working:

1. Panic Button Activation: The smart device is equipped with a hidden panic button embedded within the device's design. When the wearer finds herself in a distressing situation, she can press the panic button for three seconds. The button's placement ensures it is not easily detectable by potential abusers, thus maintaining the element of surprise and security.
2. Location Tracking via GPS: Once the panic button is pressed, the device activates the GPS module. This module captures the wearer's real-time geographical location and transmits it to a predefined set of contacts, including her parents, guardians, or other trusted individuals, as well as law enforcement authorities (such as the police).
3. Communication through GSM Module: After the panic button is pressed, the device also uses a GSM (Global System for Mobile Communications) module to initiate a call to the specified guardians or authorities. The GSM module allows the device to make a voice call to emergency contacts, enabling them to hear the surroundings and assess any potential danger. This feature allows for real-time audio feed of the environment, helping both guardians and the police to determine if immediate action is necessary.
4. Real-Time Alerts: In addition to broadcasting the location, the system will send text or voice alerts to the predefined contacts. These alerts will notify them of the emergency, providing enough time for swift intervention by law enforcement or guardians.
5. Battery and Power Efficiency: The device is designed to work efficiently and remain active for extended periods of time. The power supply system ensures that the GPS and GSM modules function optimally while maintaining minimal energy consumption to extend battery life.
6. Emergency Response Mechanism: The combination of real-time location tracking, voice communication, and emergency alerts ensures that the smart device can provide immediate assistance to the wearer in case of an emergency. The connected guardians or authorities will have the necessary information to intervene, thus helping prevent or mitigate any potential harm.
7. In essence, the smart device works by discreetly activating the safety features upon pressing the panic button. Through GPS and GSM technologies, the device sends location data and enables audio communication to enhance the safety of the wearer and ensure swift intervention in emergencies. This device could be a vital tool in addressing the ongoing safety concerns women face, especially in situations where traditional safety wearables may be detected or rendered ineffective. The aim of this project is to develop a discreet and

effective women’s safety device in the form of a smart device, which enhances personal safety by leveraging GPS and GSM technology. The device will be equipped with a panic button that, when pressed for three seconds, will trigger an automatic broadcast of the user’s location to their guardians and law enforcement. Additionally, the device will have the ability to make calls to the guardians.

3.3 Block Diagram:

The overall flow of the system is simple yet effective. When the user presses the panic button, the microcontroller processes the signal, triggers the GPS to capture the location, and communicates with the GSM module. This results in the guardians receiving an SMS with the location and a phone call allowing them to hear the surroundings. This immediate, discreet communication allows for swift action from the guardians, enhancing the user's safety in critical situations.

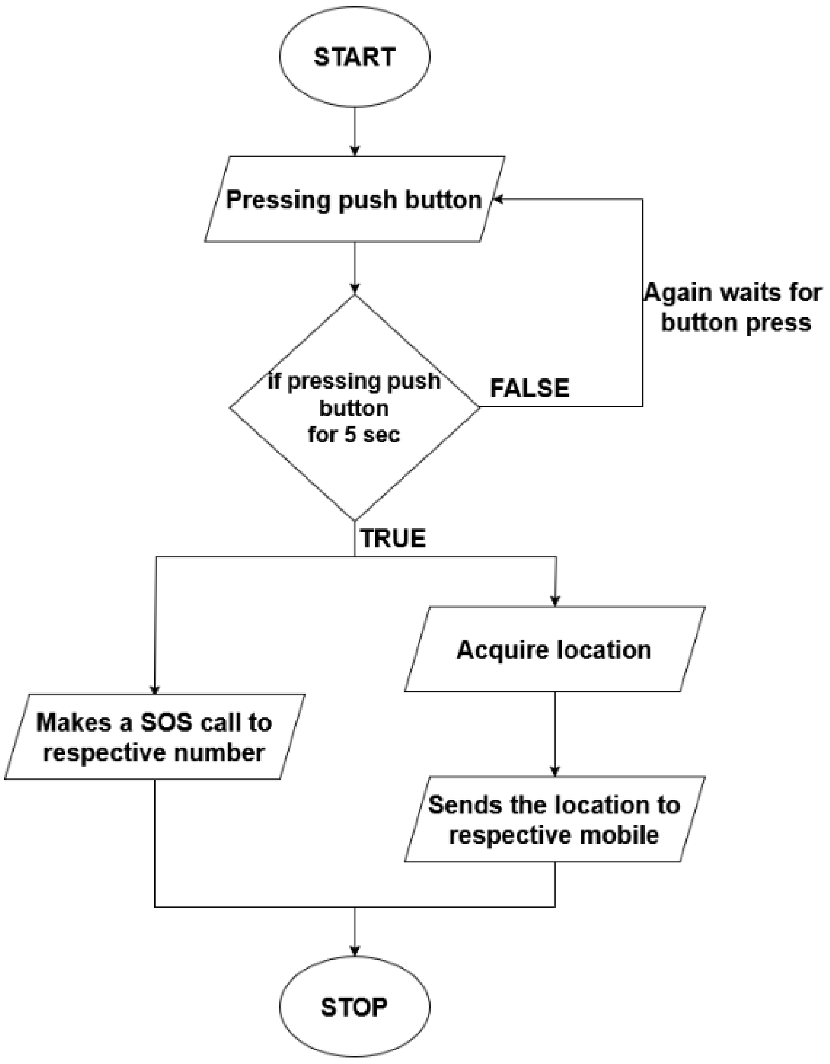

Fig 4: Block Diagram of Smart device to Ensure Women Safety

3.4 HARDWARE IMPLEMENTATION:

The Hardware Implementation section encompasses the circuit diagram, circuit connections, and the detailed design of the hardware system developed for this project. These steps are crucial for the successful realization and functioning of the system in the hardware domain. The circuit diagram provides a visual representation of how various components are interconnected, allowing for a clear understanding of the system's architecture. Proper circuit connections ensure that the components communicate effectively, and that the system operates as intended. The design phase also involves careful selection of components based on the project requirements, such as power ratings, voltage levels, and compatibility with other hardware parts. By following these steps meticulously, we ensure that the hardware section of the project is both robust and efficient, laying the foundation for the overall success of the project.

In addition to the basic circuit design, this section also details the assembly process, including the layout of the components on the breadboard or PCB (Printed Circuit Board), ensuring optimal space utilization and minimizing signal interference. The connections between the components are carefully checked for consistency and reliability, with special attention given to factors like grounding, power distribution, and signal integrity. During this stage, testing and troubleshooting play a pivotal role in verifying the functionality of each part of the hardware. We employed a series of tests to validate the circuit's performance under different conditions, ensuring stability and robustness in real-world scenarios. Furthermore, any issues identified during testing, such as voltage discrepancies or short circuits, were addressed by adjusting the circuit layout or replacing faulty components. This iterative approach to design and testing ensures that the hardware implementation aligns with the intended functionality, contributing to the overall success of the project.

3.4.1 Circuit Diagram:

We developed this safety device with the primary goal of reducing the circuit complexity found in existing models, such as the Smart Glove, to create a device that is simple, effective, and easy for any woman to wear, helping them protect themselves in emergencies. In this project, I utilized the **XIAO ESP32 C3** as the central microcontroller, integrating it with the **A9G module** to enable GSM communication and GPS tracking capabilities. The main objective was to design a functional system in which the XIAO ESP32 C3 microcontroller communicates seamlessly with the A9G module, and a push button allows the user to activate the device in times of need.

The circuit design for this safety device is intentionally kept simple to ensure that it can be easily assembled and replicated by individuals with basic electronics knowledge. By reducing unnecessary complexity, we have made the system more accessible, so that even non-experts can create the device themselves with minimal guidance. The simplified circuit structure ensures that the device remains cost-effective, user-friendly, and easy to manufacture, without compromising on the critical safety features, such as real-time location tracking and emergency alerts through GSM communication. This approach allows for a broader adoption of the device, ultimately empowering women with an affordable and effective safety tool.

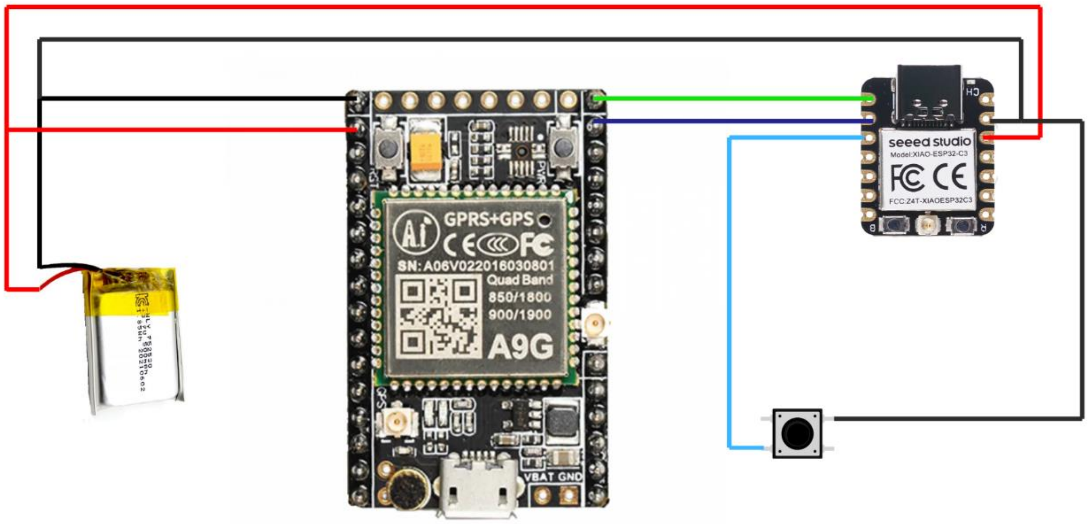

Fig 5: Hardware Connections

3.4.2 Circuit Connections:

- XIAO C3 GPIO1 to A9G TX: This connection enables serial communication where the GPIO1 pin of the XIAO C3 is connected to the TX pin of the A9G module, allowing the microcontroller to send data to the A9G module.
- XIAO C3 GPIO2 to A9G RX: Similarly, the GPIO2 pin of the XIAO C3 is connected to the RX pin of the A9G module, enabling the microcontroller to receive data from the A9G module.
- XIAO C3 GPIO3 to Push Button: The GPIO3 pin of the XIAO C3 is connected to one terminal of the push button. When the button is pressed, it sends a signal to the microcontroller, enabling it to trigger specific actions, such as starting communication with the A9G module.
- XIAO C3 GND to Push Button: The other terminal of the push button is connected to the ground (GND) of the XIAO C3. This connection ensures the circuit is completed when the button is pressed.
- LIPO Battery Positive to A9G and XIAO C3 Positive: The positive terminal of the LIPO battery is connected to the VCC pins of both the A9G module and the XIAO C3. This powers both components of the system, ensuring they can function properly.

- LIPO Battery GND to A9G and XIAO C3 Negative: The negative terminal of the LIPO battery is connected to the ground (GND) pins of both the A9G module and the XIAO C3, providing a common ground for the entire circuit.

3.4.3 Designed Circuit:

Since our project is based on Embedded Systems, it required a soldering process to establish secure and reliable connections between the necessary GPIO pins, the power supply, and the ground (GND) pins of the **A9G** module and the **XIAO ESP32 C3** board. The process of soldering ensures that all connections are firm, reducing the risk of loose contact or signal issues that could interfere with the device's performance. After carefully following the circuit design and ensuring all pins were correctly soldered, we proceeded with testing the connections to verify their integrity and functionality.

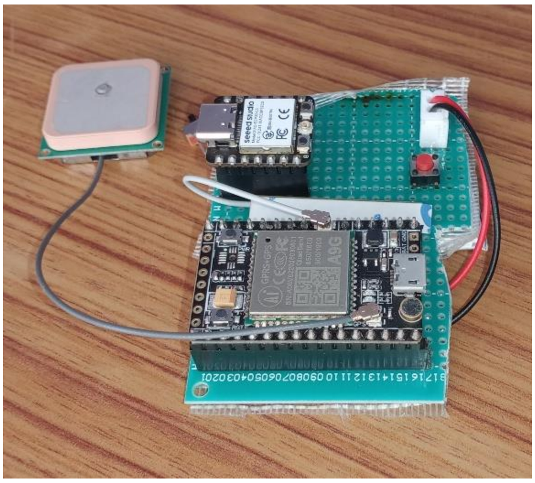

Fig 6: Designed Circuit (Top View)

Once the connections were successfully made as per the proposed circuit diagram, we were able to assemble the device, which included not only the microcontroller and communication module but also the power components. The device was then tested for power-up, communication between the modules, and the triggering of the push-button functionality. The result was a fully operational prototype.

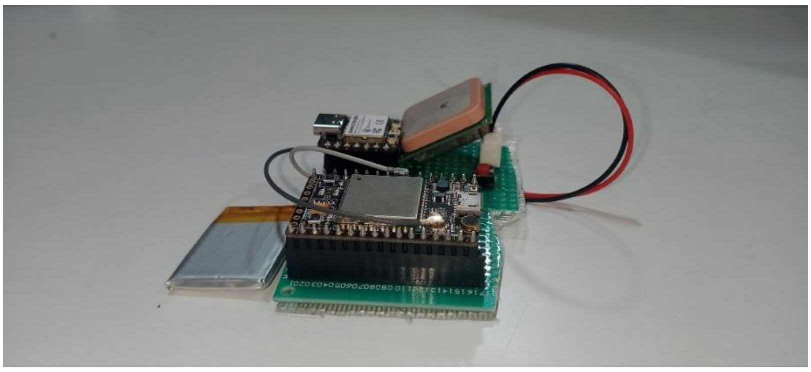

Fig 7: Designed Circuit (side View)

3.5 SOFTWARE IMPLEMENTATION:

In the software implementation phase, we used the **Arduino IDE** to program the **XIAO ESP32 C3** board, as it serves as the central control unit of our project. The XIAO ESP32 C3 is the "heart" of the system, responsible for processing inputs, controlling the communication modules, and executing the core functionality of the safety device. As shown in the project block diagram, the software flow was carefully designed to align with the intended operation of the device. The programming of the device consists of two main phases. First, the program constantly monitors the state of the **push button**. Once the button is pressed for a continuous period of **5 seconds**, it triggers the next phase of the system. This input is captured by the XIAO ESP32 C3, which then processes the data and proceeds to fetch the **user's location** using the **GPS module** integrated with the **A9G GSM/GPS module**.

Once the location is obtained, the next task is to send this GPS data as an **SMS message** to a designated contact number (such as a parent or guardian). This is achieved by utilizing the GSM capabilities of the A9G module, which communicates over the cellular network. After successfully sending the SMS, the system proceeds to make a **phone call** to the same contact number using the GSM functionality, ensuring that the user’s location is conveyed through multiple communication methods for maximum safety.

This dual approach—sending an SMS followed by a phone call—ensures that the guardian is informed promptly and can take necessary action in case of an emergency. The programming logic was structured to handle the timing and communication protocols efficiently, ensuring that the system responds quickly and reliably.

3.5.1 ESP32 Arduino on the Arduino IDE:

To program my Arduino Mega offline, I needed to install the Arduino Desktop IDE, which is the Integrated Development Environment (IDE) used for all Arduino boards. Before proceeding, I made sure to install the Arduino Software (IDE) on my PC, as outlined in the "Getting Started" section on the Arduino website. Once the IDE was set up, I connected my Arduino Mega to my computer using an A-B USB cable, commonly referred to as a USB printer cable. This USB connection was essential not only for programming the board but also for powering it up. The Mega board automatically drew power either from the USB connection or from an external power supply, depending on what was available. After setting up the Arduino Mega, when I decided to switch to programming the ESP32 XIAO C3, I adjusted the board settings in the Arduino IDE.

First, I installed the ESP32 board package by adding the appropriate URL in the preferences section of the IDE. Then, I used the **Boards Manager** to install the ESP32 package and selected the **ESP32 XIAO C3** from the available boards under **Tools > Board**. Finally, I selected the correct port for the connected board under **Tools > Port**, and I was ready to upload my code to the XIAO C3.

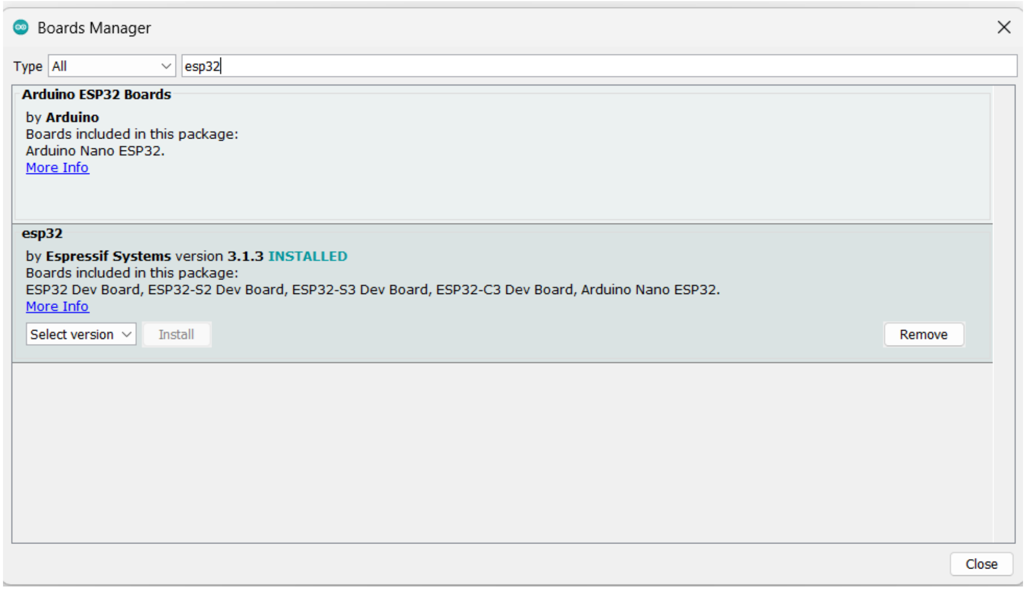

Fig 8: Install the ESP Library

3.5.2 Install the Board Drivers:

The objective of this project was to program the XIAO ESP32 C3 board using the Arduino IDE. The ESP32 is a versatile microcontroller offering both Wi-Fi and Bluetooth capabilities, making it an ideal choice for IoT applications. To begin, the Arduino IDE was installed on the computer by downloading it from the official website. Following the installation, the ESP32 board package was added to the IDE by entering the provided URL in the Preferences section of the IDE, allowing the board to be recognized. If the board was not automatically recognized, the drivers were manually installed by accessing the Device Manager in the Control Panel and updating the driver for the board under Ports (COM & LPT).

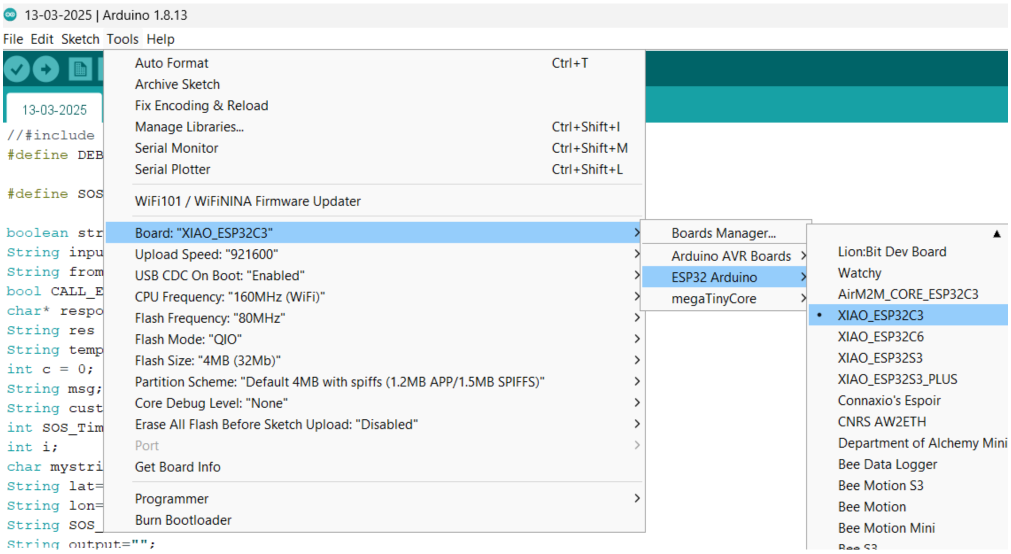

Fig 9: Select the XIAO ESP32 Board

3.5.3 Select the COM Port:

To program the XIAO ESP32 C3 using the Arduino IDE, it's essential to select the correct serial port to ensure proper communication between the board and the IDE. To do this, first open the Arduino IDE on your computer. Then, navigate to the Tools menu at the top of the screen and select Port from the dropdown menu. This will display a list of available COM ports on your system. If you have multiple devices connected, you may need to identify which port corresponds to the XIAO ESP32 C3. Once identified, reconnect the board and select the port that corresponds to Adafruit ESP32 XIAO C3 or something similar, such as COMxx. After selecting the correct port, the Arduino IDE will be able to communicate with the board.

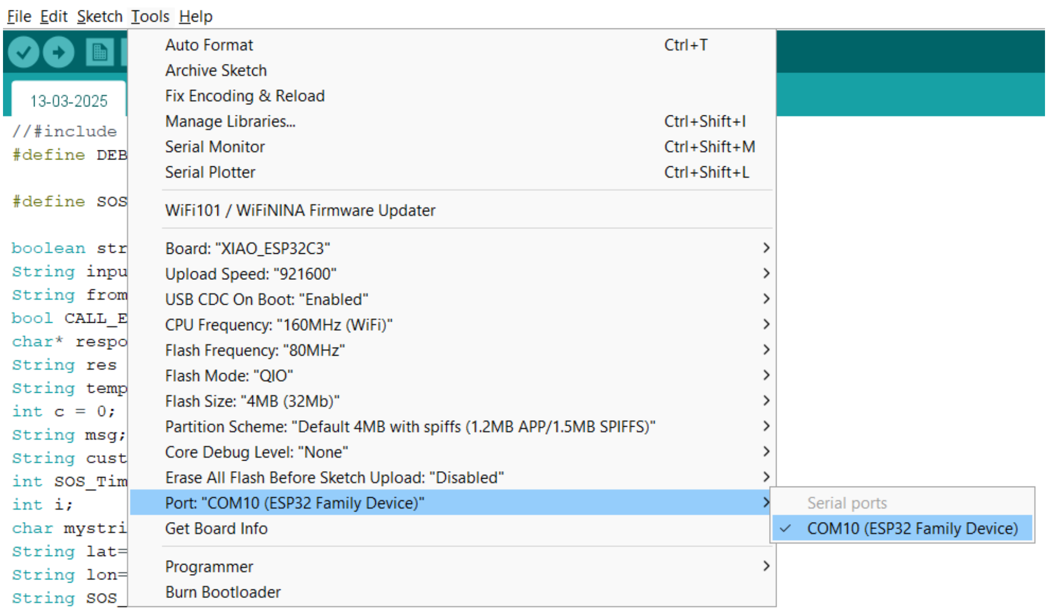

Fig 10: Select the COM Port

3.5.4 Upload the Program:

To program the XIAO ESP32C3 Board, the pre-written program. First, ensure that the board is correctly set to Adafruit ESP32 XIAO C3 under Tools > Board, and the appropriate serial port is selected under Tools > Port.

Fig 11: Upload the Program

3.5.5 Arduino Program for the Project:

The program outlined below has been specifically developed for our project to facilitate the smooth and efficient execution of all processes involved. By integrating various components and functionalities, this program ensures that each task within the system is performed accurately and in a timely manner.

```
//#include "WiFi.h"
#define DEBUG true
#define SOS_Button D3
boolean stringComplete = false;
String inputString = "";
String fromGSM = "";
bool CALL_END = 1;
char* response = " ";
String res = "";
String temp = "";
int c = 0;
String msg;
String custom_message;
int SOS_Time = 5;
int i;
char mystring[]="";
String lat="";
String lon="";
String SOS_NUM = "+919989073195";
String output="";
void A9G_Ready_msg();
void Send_SMS(String s);
String sendData(String command, const int timeout, boolean debug);
void handleButtonPress();
String comma;

void setup()
{
  Serial.begin(115200);
  Serial1.begin(115200, SERIAL_8N1, D0, D1);  // D0= TX pin, D1= RX pin
  pinMode(SOS_Button, INPUT_PULLUP);
  //WiFi.mode(WIFI_OFF);  // WiFi OFF
  btStop();
  delay(5000);

  msg = "";
  msg = sendData("AT", 1000, DEBUG);
  while ( msg.indexOf("OK") == -1 ) {
   msg = sendData("AT", 1000, DEBUG);
   Serial.println("Trying");
  }

  msg = "";
  msg = sendData("AT+GPS=1", 1000, DEBUG);
  while ( msg.indexOf("OK") == -1 ) {
```

```
    msg = sendData("AT", 1000, DEBUG);
    Serial.println("Trying");
  }
  msg = "";
  msg = sendData("AT+CMGF=1", 1000, DEBUG);
  while ( msg.indexOf("OK") == -1 ) {
   msg = sendData("AT", 1000, DEBUG);
   Serial.println("Trying");
  }
  delay(1000);
  Serial.println("A9G Module Initialized. Ready to send location and messages.");
}

void loop()
{
  // Handle button pre SOSss for
  handleButtonPress();
}

void handleButtonPress()
{
  if (digitalRead(SOS_Button) == LOW && CALL_END)
  {
    Serial.print("Waiting for button press...");

    // Wait for 5 seconds with button held down
    for (int c = 0; c < SOS_Time; c++)
    {
      Serial.println(SOS_Time - c);
      delay(1000);
      if (digitalRead(SOS_Button) == HIGH) return;  // Button released early
    }
    // Button pressed for required duration
    sendLocation();
    //Send_SMS(temp);
    delay(2000);
    callSOS(true);
  }
}
void sendLocation()
{
  Serial.println("Fetching Location:");
  delay(1000);
  Serial1.println("AT+LOCATION = 2");
  Serial1.println((char)26);
  delay(1000);
  while (Serial1.available())
  {
    char add = Serial1.read();
    if(add=='1' | add=='2' | add=='3' | add=='4' | add=='5' | add=='6' | add=='7' | add=='8' | add=='9' |
      add=='.')
    {
      res = res + add;
    }
    delay(1);
```

```
  }
  lat= res.substring(1,9);
  lon=res.substring(10,20);
  output = "I'm Here " + ( "http://maps.google.com/maps?q=" + lat + "+" + lon);
  Serial.println("Recevied Data - ");
  delay(1000);
  Serial.println(output);
  //Serial.print(lat);
  //Serial.print(',');
  //Serial.println(lon);
  delay(1000);
  //Send_SMS(output);
  Serial1.println(res);
}
boolean callSOS(boolean CALL_END)
{
  Serial.println("Calling SOS number...");
  Serial1.println("ATD" + SOS_NUM + ";");
  return false;
}

String sendData(String command, const int timeout, boolean debug)
{
  String temp = "";
  Serial1.println(command);
  long int time = millis();
  while ( (time + timeout) > millis())
  {
    while (Serial1.available())
    {
      char c = Serial1.read();
      temp += c;
    }
  }
  if (debug)
  {
    Serial.print(temp);
  }
  return temp;
}
void Send_SMS(String message)
{
  //for (int i = 0; i < Total_Numbers; i++)
  {
    Serial1.println("AT+CMGS=\"" + SOS_NUM + "\"\r");
    delay(1000);
    Serial1.println (message);
    delay(1000);
    Serial1.println((char)26);
    delay(1000);
    Serial.println("SOS Alert Sent");
   // Serial1.println("AT+CMGD=1,4"); // delete stored SMS to save memory
    delay(3000);
  }
}
```

3.5.6 Writing Sketches:

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. Ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor. The software, too, is open-source, and it is growing through the contributions of users worldwide. Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low-cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics.

Designers and architects build interactive prototypes, musicians and artists use it for installations and experimenting with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone – children, hobbyists, artists, programmers – can start tinkering just following the step-by-step instructions of a kit or sharing ideas online with other members of the Arduino community. There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handy board, and many others offer similar functionality. All these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantages for teachers, students, and interested amateurs over other systems:

Inexpensive – Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50.

Cross-platform – The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment – The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

Open source and extensible software – The Arduino software is published as open- source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

Open source and extensible hardware – The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module to understand how it works and saves money.

3.5.7 Sketch Book:

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog. Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty. Usbmodem241 (for an Uno or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or/dev/tty. USA19QW1b1P1.1 (for a serial board connected with a Key span USB-to- Serial adapter). On Windows, it is probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) – to find out, you look for USB serial device in the sports section of the Windows Device Manager. On Linux, it should be /dev/ttyACMx, /dev/ttyUSBx or similar. Once you have selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you will need to press the reset button on the board just before starting the upload. On most boards, you will see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete or shows an error. When you upload a sketch, you are using the Arduino boot loader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The boot loader is active for a few seconds when the board resets; then it starts with whichever sketch was most recently uploaded to the microcontroller. The boot loader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

3.5.8 Libraries:

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code. There is a list of libraries in the reference. Then the Library Manager will open, and you will find a list of libraries that are already installed or ready for installation. In this example we will install the Bridge library.

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code. There is a list of libraries in the reference. Then the Library Manager will open, and you will find a list of libraries that are already installed or ready for installation. In this example we will install the Bridge library.

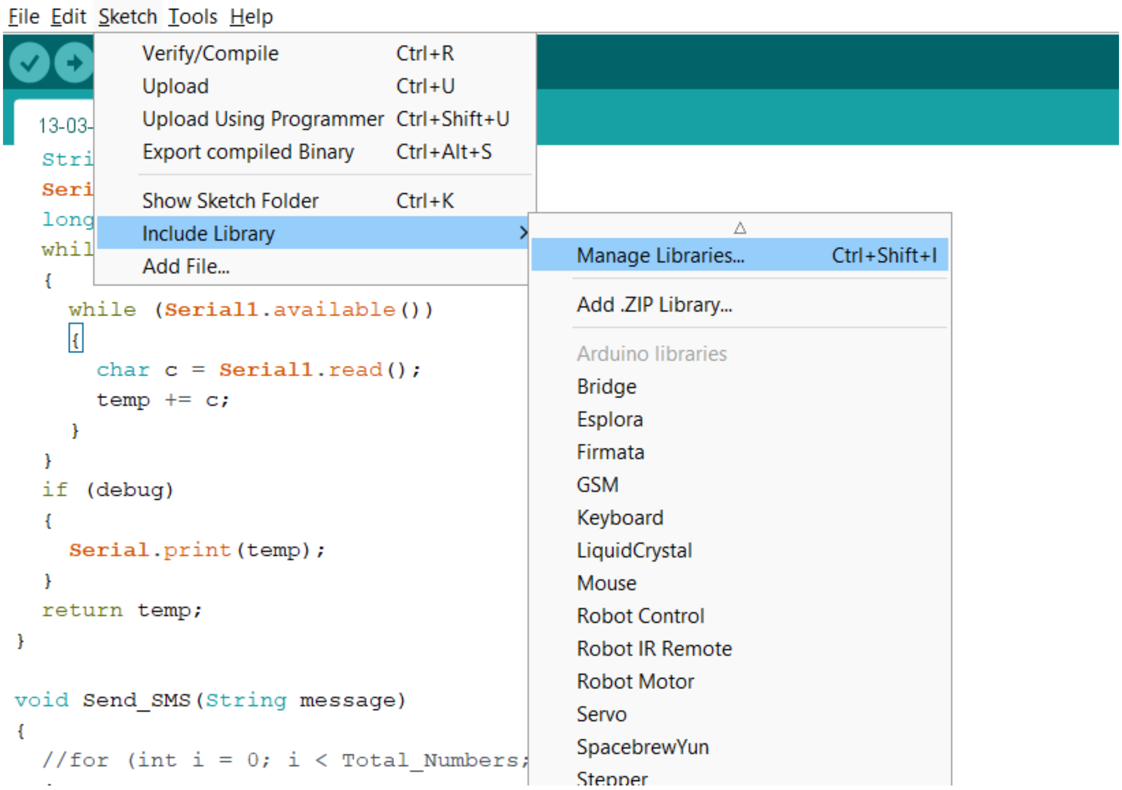

Fig 12: Manage Library

Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you can import a library from a zip file and use it in an open sketch. See these instructions for installing a thirdparty library. To install a new library into your Arduino IDE you can use the Library Manager (available from IDE version 1.6.2). Open the IDE and click to the “Sketch” menu and then include library manage.

The same happens for the libraries present in additional cores installations. It is also important to note that the version of the library you put in your sketchbook may be lower than the one in the distribution or core folders, nevertheless it will be the one used during compilation. When you select a specific core for your board, the libraries present the I core’s folder are used instead of the same libraries present in the IDE distribution folder.

Last, but not least important is the way the Arduino Software (IDE) upgrades itself: all the files in Programs/Arduino (or the folder where you installed the IDE) are deleted and a new folder is created.

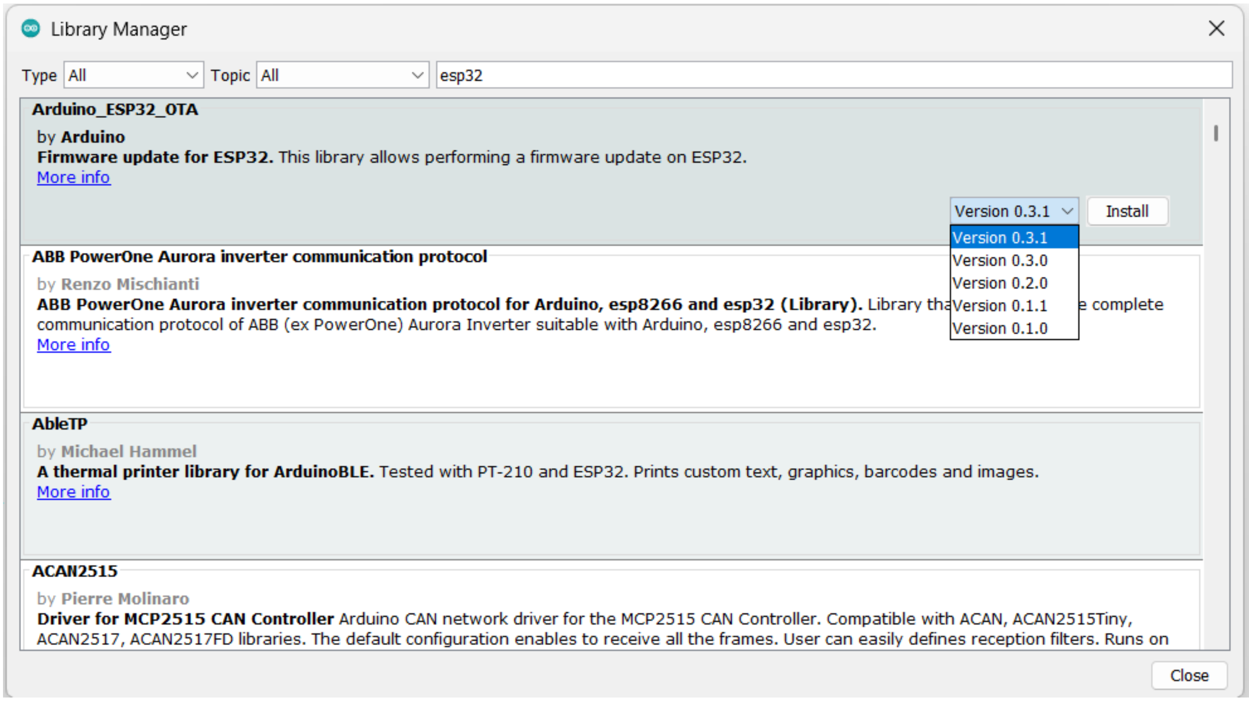

Fig 13: Library Manager

The way libraries are chosen during compilation is designed to allow the update of libraries present in the distribution. This means that placing a library in the “libraries” folder in your sketchbook overrides the other libraries versions. This is why we recommend that you only install libraries on the sketchbook folder, so they are not deleted.

3.5.9 Serail Monitor:

This displays serial sent from the Arduino or Genuino board over USB or serial connector. To send data to the board, enter text and click on the “send” button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will run your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters.

3.5.10 Boards:

The board selection has two effects: it sets the parameters (e.g. CPU speed and baud rate) used when compiling and uploading sketches; and sets and the file and fuse settings used by the burn boot loader command. Some of the board definitions differ only in the latter, so even if you have been uploading successfully with a particular selection, you will want to check it before burning the boot loader. You can find a comparison table between the various boards here. Arduino Software (IDE) includes the built-in support for the boards in the following list, all based on the AVR Core.

HARDWARE COMPONENTS DESCRIPTION

XIAO ESP32C3:

The XIAO ESP32-C3 is a compact and low-power development board based on the ESP32-C3 chip, making it an ideal choice for IoT projects like the women's safety smart device. It features a 160 MHz RISC-V 32-bit microcontroller with 4MB of flash memory and 400KB of RAM, providing sufficient processing power for managing GPS, GSM, and panic button functionalities. The board supports wireless connectivity through 2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth Low Energy (BLE) 5.0, allowing for seamless communication with mobile apps or nearby devices. Additionally, the XIAO ESP32-C3 offers 11 GPIO pins that can be configured for digital input, output, or special functions like PWM, ADC, and UART, making it highly flexible for interfacing with various sensors and modules.

The board's small size (27mm x 20mm) and light weight (approximately 5 grams) are particularly advantageous for embedding the device discreetly into the device without compromising comfort. It is designed for low power consumption, featuring sleep modes to extend battery life, which is critical for portable, battery-powered safety devices. Furthermore, the built-in security features, such as secure boot and flash encryption, ensure that communication and data transmitted by the device remain secure.

The XIAO ESP32-C3 can be programmed using **MicroPython** or **Arduino IDE**, offering flexibility for developers based on their preferred programming environment. It also supports multiple communication protocols like I2C, SPI, UART, and more, allowing easy integration with other components like GPS and GSM modules. Overall, the XIAO ESP32-C3's combination of compact size, low power consumption, wireless connectivity, and programming flexibility makes it an ideal component for the women's safety smart device project, ensuring reliable and secure operation for daily use.

Power systems of XIAO:

Operating Voltage: The XIAO ESP32-C3 operates on a **3.3V** voltage, which is typical for most ESP32-based boards. This allows it to be powered by low-voltage sources, ensuring safety and compatibility with a wide range of power supplies.

Power Supply:

The board is typically powered via the **USB Type-C port**, which provides 5V from an external power source. The on-board voltage regulator then steps this down to the required **3.3V** to power the ESP32-C3 chip and other components. Alternatively, the board can be powered via an external **3.7V Li-Po** battery, which is common for battery-powered projects. This provides a more portable power option, particularly for wearable devices like the women’s safety smart device.

Low Power Consumption:

The XIAO ESP32-C3 is designed for **low-power consumption**, making it ideal for battery-operated devices. It has several power modes to optimize energy usage:

Active Mode: When the board is fully active and performing tasks like processing data, Wi-Fi or Bluetooth communication, or interacting with sensors.

Deep Sleep Mode: The board can enter a **deep sleep mode** to conserve power when not in use, with current consumption dropping as low as **10 µA**. This is ideal for devices that need to conserve power over extended periods, such as wearables or IoT devices that require intermittent activity.

Light Sleep Mode: In this mode, the board consumes more power than deep sleep but less than active mode. It can maintain Wi-Fi or Bluetooth connections while keeping energy consumption low.

Battery Charging and Management:

If using a **Li-Po battery**, the XIAO ESP32-C3 includes built-in support for **charging circuits**. It can handle charging and power regulation for the battery, ensuring safe and efficient charging while connected to the USB Type-C port. The battery voltage is typically managed between **3.7V** to **4.2V** for optimal performance.

Fig 14: XIAO ESP32C3

Input & Output Pins:

The **XIAO ESP32-C3** offers a versatile range of input and output (I/O) pins that are ideal for interfacing with various sensors, modules, and other peripherals in your project. It includes **11 GPIO (General Purpose Input/Output) pins** (GPIO0 to GPIO10) that can be configured for digital input or output, allowing for flexible control of external devices. These GPIO pins can be used for a variety of functions, including reading signals from sensors like a panic button or controlling outputs like LEDs or motors. Additionally, several of the GPIO pins support **analog-**

to-digital conversion (ADC), allowing you to read analog signals from sensors such as temperature sensors or potentiometers.

For communication, the XIAO ESP32-C3 supports several standard protocols, including **I2C**, **SPI**, and **UART**. Specifically, **GPIO6 and GPIO7** are designated for I2C communication (SCL and SDA), while **GPIO8, GPIO9, and GPIO10** are used for **SPI communication** (SCK, MISO, and MOSI). The board also includes **UART TX** and **RX** pins (GPIO1 and GPIO3), which are essential for serial communication, such as connecting to a GSM or GPS module.

Pin	Function	Description
GPIO0	Digital I/O, ADC, PWM	It can be used as a digital I/O pin, ADC input, or PWM output.
GPIO1	Digital I/O, UART TX	Used for digital I/O, or UART TX for serial communication.
GPIO2	Digital I/O, ADC, PWM	Digital I/O, ADC input, PWM output.
GPIO3	Digital I/O, UART RX	Used for digital I/O, or UART RX for serial communication.
GPIO4	Digital I/O, ADC, PWM	Digital I/O, ADC input, PWM output.
GPIO5	Digital I/O, ADC, PWM	Digital I/O, ADC input, PWM output.
GPIO6	Digital I/O, I2C SCL	Used for I2C clock signal (SCL).
GPIO7	Digital I/O, I2C SDA	Used for I2C data signal (SDA).
GPIO8	Digital I/O, SPI SCK	Used for SPI clock (SCK).
GPIO9	Digital I/O, SPI MISO	Used for SPI MISO (Master in Slave Out) data.
GPIO10	Digital I/O, SPI MOSI	Used for SPI MOSI (Master Out Slave In) data.
3V3 Pin	Power pin	Supplies 3.3V to external devices.
5V Pin	Power pin	Supplies 5V power (from USB).
GND Pin	Ground pin	Common ground reference.

Table 1: PIN Configuration of the XIAO ESP32C3

Specifications:

The XIAO ESP32-C3 is a powerful, compact microcontroller developed by Seeed Studio and based on the ESP32-C3 chip from Espressif Systems. It is designed to be a versatile, low-power solution for embedded systems, particularly suited for Internet of Things (IoT) applications. At its core, the ESP32-C3 features a 32-bit RISC-V processor running at a clock speed of 160 MHz, providing a balance of performance and efficiency. This processor is supported by 4MB of flash memory for storing program code and 400KB of SRAM for runtime data, ensuring that the device can handle relatively complex tasks and real-time operations. The XIAO ESP32-C3 board integrates both **Wi-Fi (802.11 b/g/n)** and **Bluetooth 5.0 (BLE)** connectivity, making it an ideal choice for projects that require wireless communication. The built-in Wi-Fi capability allows the device to connect to local networks and communicate with cloud services or other devices, while Bluetooth provides low-power wireless communication for short-range applications. Additionally, the board offers multiple **General Purpose Input/Output (GPIO)** pins, which allow it to interface with a variety of external sensors, actuators, and peripherals, making it highly adaptable to different project needs.

Processor	ESP32-C3 SoC
	RISC-V single-core 32-bit chip processor with a four-stage pipeline that operates at up to 160 MHz
Wireless	Complete 2.4 GHz Wi-Fi subsystem
	Bluetooth 5.0 / Bluetooth mesh
On-chip Memory	400 KB SRAM & 4 MB Flash
Interface	1x UART, 1x I²C, 1x I²S, 1x SPI, 11x GPIO (PWM), 4x ADC
	1x Reset button, 1x Boot button
Dimensions	21 x 17.5 mm
Power	Circuit operating voltage: 3.3 V @ 200 mA
	Charging current: 50 mA/100 mA
	Input voltage (VIN): 5 V
Deep Sleep Power Consumption	Deep Sleep Model: >44 µA
Wi-Fi Enabled Power Consumption	Active Model: <75 mA
	Modem-sleep Model: <25 mA
	Light-sleep Model: <4 mA
BLE Enabled Power Consumption	Modem-sleep Model: <27 mA
	Light-sleep Model: <10 mA

Table 2: Specifications XIAO ESP32C3

Pin Description of the XIAO ESP32C3:

Vin Pin: The Vin pin allows you to supply an input voltage range between 7V and 20V to power the board. The Vin pin provides access to the supplied voltage from the power jack, which is then regulated to 5V for the board's internal operations. This pin is useful when you need to power the board using an external power source.

Serial Communication (TXD/RXD):

The XIAO ESP32-C3 features multiple serial communication interfaces. The TXD (Transmit Data) and RXD (Receive Data) pins are used for serial data transmission and reception. The board supports four serial interfaces:

Serial 0: TX (1) & RX (0)

Serial 1: TX (18) & RX (19)

Serial 2: TX (16) & RX (17)

Serial 3: TX (14) & RX (15) allows the board to communicate with others.

External Interrupts:

The XIAO ESP32-C3 supports external interrupts on six pins, enabling the board to trigger actions based on external events. The interrupt pins are:

Interrupt 0: GPIO0

Interrupt 1: GPIO3

Interrupt 2: GPIO21

Interrupt 3: GPIO20

Interrupt 4: GPIO19

Interrupt 5: GPIO18 These pins can be configured to trigger interrupts on LOW, rising edge, falling edge, or change in input value.

LED:

The XIAO ESP32-C3 board includes a built-in LED connected to pin 13, which is designated as digital pin 13. This LED can be controlled by setting pin 13 to HIGH or LOW, allowing you to create visual indicators, perform debugging, or trigger actions in your program.

Analog Pins (A0 - A15):

The XIAO ESP32-C3 provides 16 analog pins (A0 to A15) that can be used as digital I/O pins as well. These analog pins provide 10-bit resolution (range of 0-1023) and can measure voltages between 0V and 3.3V. These pins are essential for reading analog sensors such as temperature, light, and motion sensors. The AREF pin can be used to modify the voltage reference for these analog inputs.

I2C Communication:

The I2C communication protocol is supported by the XIAO ESP32-C3 using the following pins:

SDA (Serial Data Line): GPIO21

SCL (Serial Clock Line): GPIO22

These pins are used for I2C communication.

Pin Diagram of XIAO ESP32C3:

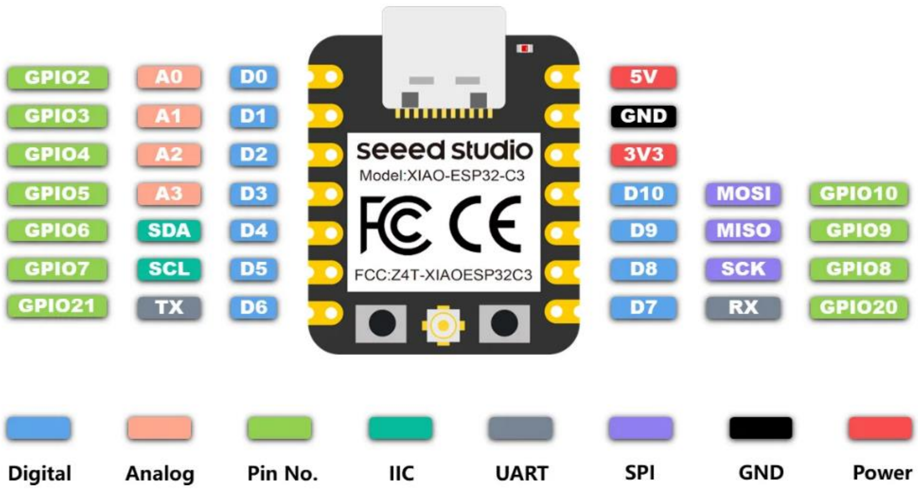

Fig 15: XIAO ESP32C3 PIN DIAGRAM

A9G Board:

The A9G Board is a versatile development board that integrates both GPS and GSM/GPRS modules, making it ideal for a wide range of applications, particularly those that require real-time location tracking and communication. This board combines the functionality of a GPS receiver and a GSM/GPRS communication module, allowing it to provide accurate geographic location data and facilitate communication via mobile networks. GPS functionality enables the board to track and report data such as latitude, longitude, altitude, and speed, making it perfect for projects such as vehicle tracking systems, wearable safety devices, or remote monitoring applications.

The GSM/GPRS module on the A9G Board allows for SMS messaging and voice calls, making it highly suitable for applications that need real-time communication or emergency alerts. For example, in a safety device project, the board can send location data to a guardian or make a call to emergency services in case of an emergency.

In addition to its GPS and communication capabilities, the A9G Board is designed with low power consumption in mind. This feature is particularly useful for portable, battery-powered applications, as the board supports various power-saving modes to help extend battery life. The board also uses UART (Universal Asynchronous Receiver-Transmitter) for communication, allowing it to easily interface with other microcontrollers or devices, further enhancing its versatility in embedded systems.

Overall, the A9G Board is a robust solution for projects that require both GPS tracking and GSM-based communication. Its combination of location tracking, SMS, and call functionality, along with its low power usage.

Power System of A9G:

Power System Overview

The A9G Board operates primarily on 3.7V lithium-ion or lithium-polymer batteries, making it suitable for mobile and outdoor applications where access to a constant power source may not be feasible. In addition to battery power, the board can also be powered through an external power supply, typically within the range of 5V to 12V. When using an external power supply, the board's built-in voltage regulator ensures that the internal circuitry receives a stable 3.3V to operate efficiently.

Power Management and Charging

For charging purposes, the **A9G Board** often integrates a **charging circuit** that allows for easy recharging of the lithium battery via a USB or external power supply. The integrated power management system ensures that the battery is charged safely and efficiently, providing long operational periods between charges.

Voltage Regulation

The **A9G Board** contains an internal **voltage regulator** that converts higher input voltages (e.g., 5V to 12V) to a stable **3.3V** output, which is required for the board's microcontroller and other components. This regulated voltage is crucial for ensuring the stable performance of both the **GPS** and **GSM/GPRS** modules.

Power Supply Pins

The board is equipped with several pins for power input and output:

- **VCC (Power Supply Pin)**: Supplies the required voltage to power the board, typically 3.3V when using the onboard voltage regulator.
- **GND (Ground Pin)**: Provides the common ground reference for the circuit.
- **Battery Pin**: If using a lithium-ion battery, this pin connects to the battery for power supply.

Specifications for A9G:

The A9G development board is a versatile and powerful module commonly used in Internet of Things (IoT) projects, featuring both GSM/GPRS and GPS functionalities. At the heart of the board is the A9G chip, which operates with an ARM Cortex-M3 processor, running at a clock speed of 72 MHz. The board supports Quad-band GSM frequencies (850 MHz, 900 MHz, 1800 MHz, and 1900 MHz), allowing it to be used globally for SMS, voice calls, and data transfer over GPRS. The GPS module on the board enables accurate location tracking by receiving signals from GPS satellites, with support for the NMEA standard for GPS data communication.

The A9G operates on a voltage range of 3.4V to 4.4V, which is compatible with standard 3.7V Li-ion or Li-Po batteries. Its current consumption varies depending on the mode of operation, with idle consumption around 20mA, GSM transmission drawing approximately 200mA to 400mA (depending on signal strength), and GPS activity consuming around 50mA.

For interfacing with other devices, the A9G board includes multiple digital I/O pins, allowing it to connect with sensors, relays, and other peripherals. It also features analog I/O capabilities via an ADC, as well as PWM (Pulse-width modulation) for controlling devices like motors or adjusting the brightness of LEDs. In addition to these features, the GPS module supports L1 band signals at 1575 MHz, providing reliable real-time positioning data, including latitude, longitude, and altitude information. However, the GPS function requires an external antenna for optimal performance. The A9G board is a compact yet powerful solution for IoT applications, offering an all-in-one platform for wireless communication and location tracking.

Model Name	A9G
Package	SMD54
Size	19.2*18.8*2.7(±0.2)mm
Frenquency	850/900/1800/1900MHz
GPRS Multi-slot	Class 12
GPRS Mobile Station	ClassB
Compatible with GSM Phase 2/2+	Class 4 (2W@850/ 900MHz) Class 1 (1W@1800/1900MHz)
Power supply	3.5~4.2V typical value 4.0V
Current	1.14mA@DRX=5
	1.03mA@DRX=9
AT command	3GPP TS 27.007, 27.005
GPRS Class 12	Max 85.6kbps (up & down 3
Coding scheme	CS 1,2, 3, 4
Text	Point to point sms send and receive
	Cellular broadcast message, Text / PDU mode
Voice coding mode	Half Rate (HR)!Full Rate (FR)!
	Enhanced Full Rate (EFR)! Adaptive Multi-Rate (AMR)
Audio processing mechanism	Echo Cancellation, Echo suppression, Noise suppression
SIM Card	1.8V/3V
UART	3 pcs (including firmware upgrade serial port), baud rate support
	2400~1843200bps , default 115200bps
Antenna	Pad（include GSM!GPS 3
Communication Interface	I2C!USB!UART!SDMMC!GPIO!ADC
	Cold start: -148 dBm Hot start: -162 dBm Recapture: -164dBm
GPS Sensitivity	Tracking: -166 dBm
GPS boot time	Cold start < 27.5s Hot start < 1s
	Recapture < 1s
GPS accuracy	Horizontal positioning accuracy：2.5m
	High positioning accuracy：3.5m
Working temperature	-20°C ~ +75°C
Weight	3.0g

Table 3.2: Specifications of A9G Board

A9G Board Hardware:

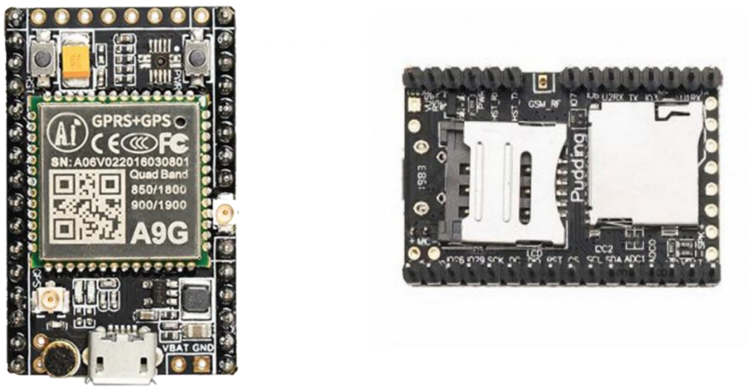

Fig 16: A9G BOARD

Pin Description of A9G Board:

The A9G Board features a range of pins that provide essential functionality for GPS and GSM/GPRS operations, as well as general-purpose input/output for a variety of applications. Here's a detailed description of the specific pins on the board:

1. **VCC:** The power supply input pin for the board. It typically connects to a 3.7V Li-ion battery or an external 5V-12V power supply, which the board regulates to ensure stable operation.
2. **GND:** The ground pin, providing the reference ground for the entire circuit. All other components on board share this common ground.
3. **TXD (Pin 1):** The Transmit Data pin used for UART communication. This pin transmits data from the A9G Board to external devices.
4. **RXD (Pin 2**): The Receive Data pin used for UART communication. This pin receives data from external devices, such as microcontrollers or sensors.
5. **RST (Pin 3):** The Reset pin, used to restart or reset the board. By pulling this pin low, the system is reset, allowing for a fresh start or recovery from errors.

SIM: The pin connected to the SIM card slot. This slot allows the board to connect to a cellular network, enabling the sending of SMS messages,

1. making voice calls and accessing GPRS for data transmission.
2. **PWR:** The Power Pin for connecting the board to external power supplies. This is where 5V-12V is input to power the system.
3. **GPS**: This set of pins connects to the GPS module, allowing the board to receive GPS signals and determine the device's geographic position (latitude, longitude, altitude).
4. **ADC (Pin 5 and 6):** These are Analog-to-Digital Converter pins, which are used to read analog signals, such as sensor data. These pins can also function as digital I/O pins if needed.

5. **I2C SDA (Pin 7):** The Serial Data Line for I2C communication, used to transfer data between the A9G Board and external I2C-compatible devices, such as sensors or actuators.
6. **I2C SCL (Pin 8):** The Serial Clock Line for I2C communication, which provides the clock signal for synchronizing the data transfer between devices.
7. **BATT**: This pin is connected to the battery (typically 3.7V Li-ion), providing power to the system for portable use when not connected to an external supply.
8. **GPIO (Pin 14-19):** These are General Purpose Input/Output pins that can be used for a variety of purposes, such as controlling relays, reading switches, or triggering alarms. These pins are highly flexible and can be configured for either input or output depending on the application.
9. **External Antenna Pins**: The A9G Board supports external antennas for both the GPS and GSM modules. These antenna pins help improve signal reception, especially in areas with weak GPS or cellular coverage.

A9G Board External Antennas:

The GPS module on the A9G Board allows the device to receive signals from GPS satellites and determine its geographic location. The external GPS pins facilitate the connection of an external GPS antenna, improving signal reception and accuracy. These pins are essential for applications like location tracking, vehicle monitoring, and personal safety devices, where precise location data (latitude, longitude, altitude, and speed) are required. The GPS antenna pin enhances the module's ability to maintain a strong connection to satellites, especially in environments with weak GPS signals, such as urban areas or indoors.

Fig 17: GPS Antenna

The GSM/GPRS module on the A9G Board enables cellular communication for tasks like sending SMS messages, making voice calls, and transferring data over the GPRS network. The external GSM pins allow for the connection of a GSM antenna, which is vital for ensuring reliable cellular network connectivity. These external GSM antenna pins ensure optimal signal reception, which is especially critical in areas with poor mobile network coverage. By using these pins, the A9G Board can communicate with external systems or alert authorities or guardians in case of emergencies, making it ideal for personal safety and remote monitoring applications.

Fig 18: GSM Antenna

LIPO Battery:

The 3.7V LiPo (Lithium Polymer) battery is a widely used power source in portable electronics, including embedded systems and IoT projects, due to its high energy density, lightweight design, and ability to provide a stable voltage output. Unlike traditional lithium-ion batteries, LiPo batteries use a polymer electrolyte, which allows for more flexible shapes and sizes, making them ideal for space-constrained applications.

Fig 19: 3.7v LIPO Battery

Features:

- **Lightweight and Compact**: Ideal for portable applications where size and weight are crucial, such as wearable devices and safety systems.
- **High Energy Density**: Can store more energy in a smaller volume, allowing for longer usage

times without increasing the size of the device.

- **Rechargeable:** LiPo batteries are cost-effective and can be easily recharged for long-term use.
- **Voltage Range:** Provides a nominal voltage of 3.7V, with a safe range between 4.2V (fully charged) and 3.0V (discharged), compatible with the A9G Board.
- **Safety Considerations**: Requires careful handling to avoid overcharging, over discharging, and physical damage; often includes a protection circuit for enhanced safety.
- **Portable Power:** Ensures the A9G Board remains operational in field-based or remote scenarios, providing reliable GPS and GSM functionality.
- **Specialized Charging**: Requires a LiPo charger with features like overcharge protection, current regulation, and temperature monitoring for safe operation.

Universal PCB Board:

To successfully integrate all the components of the project into a single, functional platform, we have utilized a universal PCB (Printed Circuit Board). A universal PCB serves as a versatile and flexible solution for assembling various electronic components in one compact unit. In the context of our project, it allows for the seamless integration of essential modules, such as the A9G Board, GPS module, GSM module, and LiPo battery, along with any additional sensors or actuators that may be required for smart device.

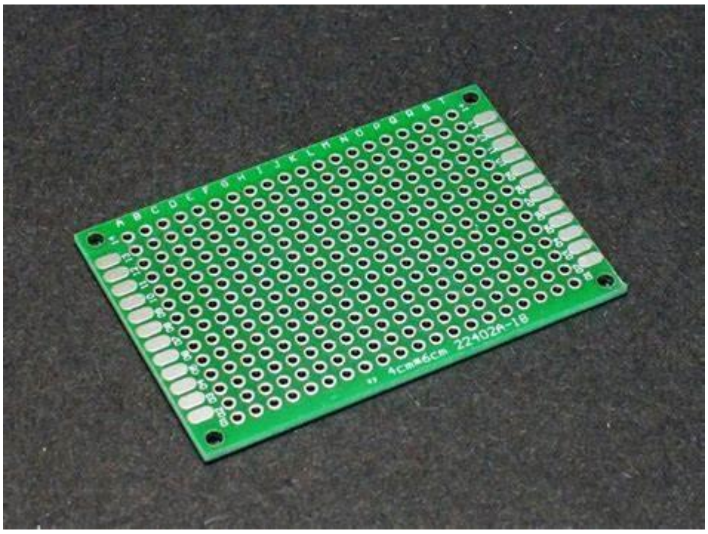

Fig 20: Universal PCB Board

Features:

- **Compact and Space-Efficient Design:** The universal PCB is designed to be compact, making it ideal for projects where space is a critical factor. It allows for the efficient placement of all components in a small footprint, which is essential for wearable devices like smart devices.

- **Easy Assembly**: The board comes with pre-printed tracks and holes, making it easier to solder and assemble the components. It reduces the complexity of wiring and ensures that connections are made securely, ensuring that the system works properly without any loose connections.
- **Cost-Effective Solution**: Using a universal PCB is a cost-effective option compared to designing and fabricating a custom PCB from scratch. It saves both time and resources, making it ideal for rapid prototyping and small-scale production.
- **Stable Power Distribution**: The universal PCB ensures stable power distribution to all connected components, including the A9G Board and GPS/GSM modules. Proper power management is crucial for reliable operation.

Connecting Wires:

In my project, I used jumper wires to establish temporary connections between various components, such as the microcontroller, sensors, and other peripherals. These wires were crucial during the prototyping phase, allowing me to quickly and easily modify the circuit without the need for soldering. The jumper wires I used came with pre-crimped connectors on both ends, which made them ideal for plugging into the breadboard and header pins. This flexibility was particularly useful as I could easily reconfigure the connections when testing different configurations or troubleshooting issues. I chose jumper wires in multiple colors to help organize and distinguish power, ground, and signal lines, which made the circuit easier to manage and debug.

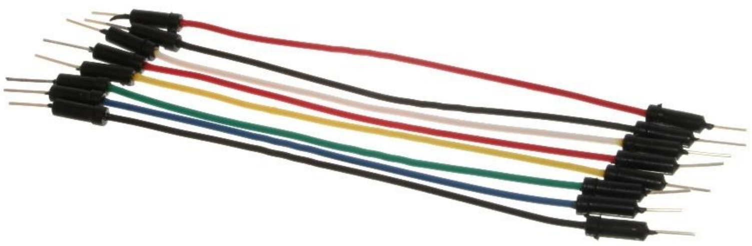

Fig 21: Jumper Wires

Slide Switch:

In my project, I used a slide switch to control the battery connections to both the XIAO C3 microcontroller and the A9G GSM/GPRS module. The slide switch served as an on/off mechanism, allowing me to easily toggle the power supply to these components. This setup was essential for conserving battery life and ensuring that the system could be powered on or off as needed.

Fig 22: Slide switch

Push Button:

In my project, I used a 4-pin push button as a critical component in the design of smart devices for women's safety. The push button serves as the panic button, which plays a key role in triggering an emergency response when the wearer feels threatened. When the button is pressed for three seconds, it activates the system, broadcasting the user’s location via a GPS module and simultaneously initiating a call to the user's guardians and the police via a GSM module.

Fig 23: 4-Pin Push Button

The 4-pin configuration of the push button ensures stable and reliable operation for the emergency function. The button is momentary, meaning it only activates the circuit while being pressed, providing an immediate and clear signal for an emergency. This functionality is essential for the system’s success, as it allows the user to discreetly signal for help, without drawing attention, which is crucial in dangerous situations. The use of the 4-pin push button in the design makes it easy to integrate into the smart device, providing a simple yet effective interface for users to activate the safety features in times of distress. By incorporating the 4-pin push button in this safety device, the system ensures that the user can easily and reliably call for help, making it a vital part of the overall design for providing increased safety and peace of mind for women in potentially dangerous situations.

USB-C Type Cable:

In my project, I used a USB Type-C cable to program the XIAO C3 board. The USB Type-C connection offers several advantages, including a reversible connector design, which makes it easier to plug in without worrying about orientation. This feature is particularly useful during development, as it simplifies the process of connecting and disconnecting the board to the computer. The USB Type-C cable allows for both power and data transfer, providing a reliable connection between the XIAO C3 and the development environment. It facilitates easy programming and debugging of the board by enabling direct communication between the microcontroller and the computer. The cable is compatible with the modern standards for data transfer speeds, ensuring that the uploading process of code onto the XIAO C3 is fast and efficient. Using a USB Type-C cable also ensures future-proof compatibility, as this type of connection is becoming the industry standard for many devices.

Fig 24: USB-C type cable

Overall, the USB Type-C cable played a crucial role in the development of my project, offering a convenient, reliable, and efficient method to program the XIAO C3 board and transfer data during testing and development.

2-Pin JST Connector:

In my project, I used a 2-pin JST connector for connecting the battery to the universal PCB board. The 2-pin JST connector is a compact, reliable, and secure solution for establishing power connections in embedded systems. Its small form factor makes it ideal for space-constrained designs while ensuring a stable and solid electrical connection between the battery and the PCB.

Fig 25: 2-Pin JST Connector

The 2-pin JST connector consists of two pins—one for the positive terminal and one for the negative terminal—ensuring clear and consistent connections for the power supply. The locking mechanism of the JST connector provides added security, preventing accidental disconnections, which is crucial for maintaining a stable power supply throughout the operation of the system. This feature is especially important in battery-powered projects, where reliability is a key factor. Using a 2-pin JST connector in my project allows easy and efficient power management, providing a convenient way to connect and disconnect the battery from the universal PCB board during testing or maintenance. The connector's reliability and ease of use made it an excellent choice for the power connections in my embedded system.

CHAPTER 4

RESULTS & DISCUSSION

4.1 Serial Monitor Output:

The serial monitor output as shown in fig 26 provides key insights into the functioning of the smart device, which is designed to enhance women's safety. It shows that the GPS module continuously tracks the user's real-time location. When the panic button is pressed for three seconds, the device automatically broadcasts the user’s location to the designated guardians or police. Additionally, the system is programmed to make an emergency call using the GSM module, connecting the user to their guardians or the authorities. The serial monitor confirms the success of these actions, indicating that the emergency call has been made, and that the location has been sent successfully.

```
COM10                                                        Send
AT

OK
AT+GPS=1

OK
AT+CMGF=1

OK
A9G Module Initialized. Ready to send location and messages.
Waiting for button press...5
4
3
2
Waiting for button press...5
4
3
2
1
Fetching Location:
Recevied Data -
I'm Here http://maps.google.com/maps?q=17.44857+78.375298
Calling SOS number...
```

Fig 26: Serial Monitor output

In the serial monitor as shown in fig 26, we can observe all the processes being carried out within the safety device. This allows us to monitor and troubleshoot the device during development. The serial monitor serves as a valuable tool for understanding the internal operations of the system. However, it is important to note that once the device is fully assembled and deployed in real-time use, the serial monitor data will no longer be visible. This is because the device will be operating independently, and the serial communication that sends data to the monitor will not be available in the final implementation. The information displayed in the serial monitor during development is meant for reference and debugging purposes. In the serial monitor we will get the output.

4.2 Getting SOS Call from Device:

In my project, I got the SOS call output as shown in fig 27, which is a key feature for ensuring the user's safety. When the panic button on the smart device is pressed for three seconds, the device automatically triggers an SOS call to the pre-programmed guardians or the police. Upon activation, I received the call output in the serial monitor, confirming that the GSM module successfully made the connection. The serial monitor displayed details such as the call duration and connection status, verifying that the SOS call function was working properly.

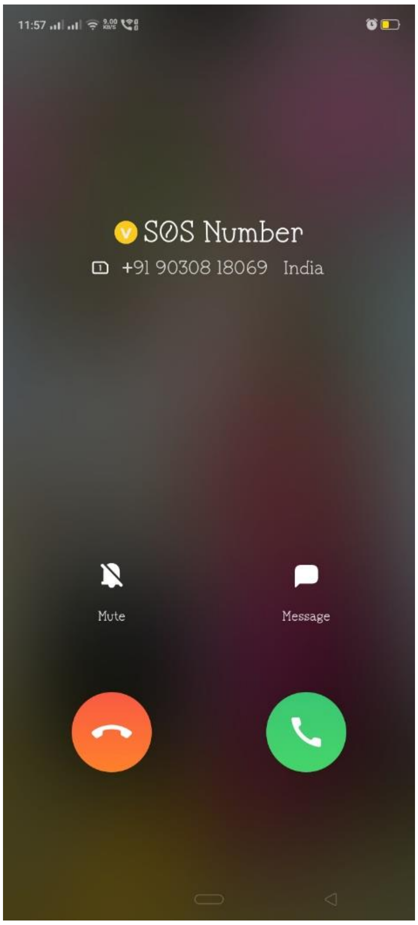

Fig 27: SOS call from the Device

Here, we are receiving an SOS call from the device, which allows us to understand the conversation happening at the location. Since the A9G module has a built-in microphone, we can listen to the conversation directly from our mobile device. Sometimes, the panic button may be accidentally pressed, but in such situations, we can quickly determine whether our child any other women is in danger, ensuring timely assistance if needed. This ensures that, whether the activation is accidental or genuine, we can promptly assess if there is an actual emergency. In situations where the user might be in distress. this quick response capability enables us to take immediate action and offer help, ensuring the safety of our children, women.

4.3 Getting GPS Location Via SMS:

In my project, I also received the output of the user’s location sent via SMS to the designated guardian or parent number as shown in fig 28. When the panic button on the smart device is long pressed for three seconds, the device not only triggers an SOS call but also sends the user’s real-time location to the pre-programmed phone numbers through the GSM module. This location output is displayed in the serial monitor, confirming that the GPS module successfully captures the user’s coordinates and sends them via SMS. The message contains accurate latitude and longitude details, allowing the guardians or authorities to pinpoint the user's position quickly. This feature is crucial for ensuring timely intervention and assistance, as it enables the recipients to track the user's whereabouts in real-time.

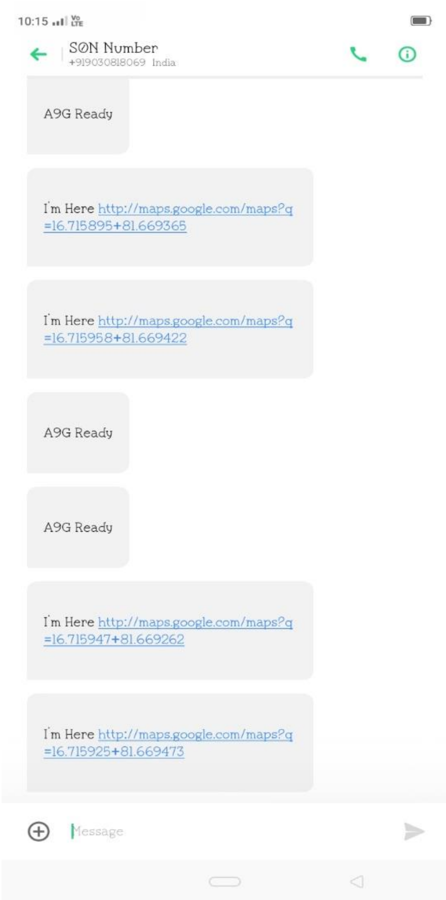

Fig 28: Getting GPS Location Via SMS

In the A9G module, we are receiving real-time GPS coordinates of the user as shown in fig 27. In this project, we have implemented Google Map link generation using these real-time GPS coordinates to make it easier for parents or guardians. If we only send the coordinates, the parent will have to manually copy and paste them into Google Maps to view the user's location, which is time-consuming. To eliminate this hassle, we decided to automatically generate a Google Maps link within the project. By doing this, the parent or guardian can simply click the link and be redirected to Google Maps, saving time and reducing complexity.

4.4 Opening the G-map link:

In my project, upon receiving the location output via SMS, I opened the provided Google Maps link as shown in fig 29 and was able to view the exact location of the device. The location coordinates (latitude and longitude) sent through the SMS were accurately mapped on Google Maps, allowing the guardians or authorities to pinpoint the user's position in real-time. This feature is especially crucial in emergencies, as it provides a visual representation of the user's whereabouts, making it easier for responders to reach the location quickly and efficiently.

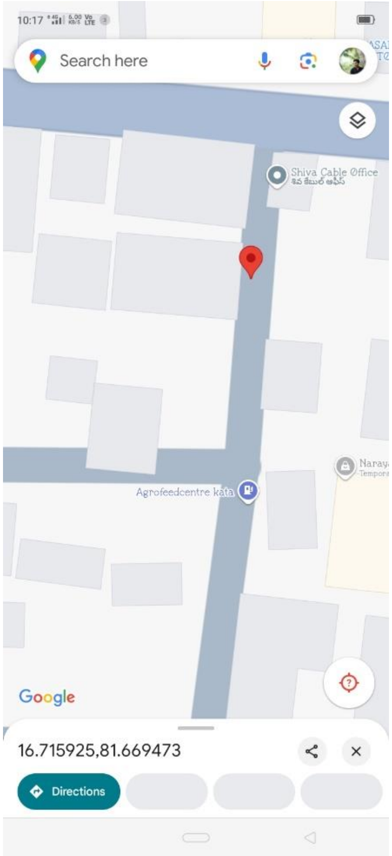

Fig 29: Opening the G-map link

The system provides real-time GPS coordinates with an impressive accuracy of 5 meters, ensuring that the location displayed is precise. With this level of accuracy, the GPS coordinates indicate the user's position with minimal deviation as shown in fig 29. Once the link is opened, it redirects the user to Google Maps, where they can see the exact location of the person in distress. Additionally, by starting the navigation from the Google Maps link, the guardian can be guided directly to the user's precise location, ensuring that they reach the right place as quickly as possible. This process eliminates the need for manually entering coordinates or searching for locations, which can be time-consuming, especially in emergency situations. The systems provide accurate, real-time GPS data and seamless navigation makes it easier for parents or guardians to respond swiftly, offering a more efficient and reliable way to ensure the safety of women.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

Here, the conclusion about the performance of Smart device to ensure women safety and the Future scope of this system has been mentioned below,

CONCLUSION:

The development of a smart device as a women's safety device presents a promising solution to address the growing concerns regarding women's safety in India and around the world. By incorporating advanced technologies such as GPS and GSM modules, the device allows for real-time tracking and immediate communication with authorities or guardians when a panic situation arises. The ability to automatically broadcast the user's location and make calls to police and guardians provides a vital tool in preventing and addressing cases of violence, such as physical abuse, molestation, or rape. This smart device offers a discreet and effective way for women to protect themselves, enabling immediate action in critical situations, all while remaining hidden from potential abusers.

FUTURE SCOPE:

The future scope of this project holds significant potential for further enhancement and wider impact. One key development could be the integration of smart device with mobile applications, allowing real-time notifications to family members and friends, and providing a more comprehensive safety monitoring system. Additionally, the inclusion of advanced sensors that can detect signs of distress, such as sudden movements or falls, could allow for automatic alerts to authorities, even without the need for the user to press the panic button. Incorporating voice recognition technology and AI could also enhance the system's ability to distinguish between a normal conversation and an emergency, helping to prevent false alarms. Furthermore, expanding the device to work internationally with different languages, emergency numbers, and geographic locations would make it a global solution for women's safety.

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