

Project name

Smart Safety Device using Arduino Mega, GSM, and GPS Module

Abstract:

The safety of individuals in today's world is a serious concern. This project aims to build a Smart Safety Device using Arduino Mega, GSM (SIM800L), and GPS (Neo-6M) modules. The device is designed to send an SOS message with real-time location to predefined contacts during an emergency.

The system includes a keypad for password protection, a panic button to trigger the alert, and an LCD to display the device status. When the panic button is pressed, the GPS module gets the current location, and the GSM module sends an emergency SMS with a Google Maps link. The device also prevents false alerts using a password system.

Compact, low-cost, and easy to use, this project is a practical solution for enhancing personal safety and can be used by anyone in distress.

Introduction:

This project is based on the development of a Smart Safety Device using **Arduino Mega 2560, GSM module (SIM800L), and GPS module (Neo-6M)**. The system is designed to send an SOS message with live GPS location to predefined mobile numbers in case of an emergency.

The device can store up to **two emergency mobile numbers**. A **4x4 matrix keypad** is used for selecting actions. The buttons **A, B, C, and D** are assigned specific functions. A **16x2 LCD display** shows the status of the system and the actions being performed, such as "SMS Sent" or "Calling...". The GPS module fetches the current latitude and longitude, which is then sent via SMS using the GSM module. The entire system is controlled by the Arduino Mega.

This compact and portable device is suitable for use in emergencies to alert family or authorities quickly and accurately.

System Design:

The Smart Safety Device is designed by integrating both hardware and software components in a structured way. The system is divided into two main sections.

1. Hardware Design:

The hardware system is centered around the **Arduino Mega 2560**, which acts as the main controller. It connects and controls all other modules and components.

1. **Arduino Mega 2560:**

- Acts as the brain of the system.
- Provides multiple serial ports (important for GPS and GSM working simultaneously).

2. SIM800L GSM Module:

- Used for sending SMS and making calls.
- Controlled using **AT commands** through UART (Serial communication).

3. Neo-6M GPS Module:

- Continuously fetches the current location in terms of latitude and longitude.
- Communicates with Arduino using UART.

4. 4x4 Matrix Keypad:

- Allows user to press one of the 16 keys.
- Only 4 keys (A, B, C, D) are used for this project:

2. Software Design:

The software is written using **Arduino IDE** in **C programming**. The logic is based on continuous monitoring of keypad inputs and taking action accordingly.

1. Initialization Phase:

- LCD, GPS, GSM, and Keypad are initialized.
- LCD shows "System Ready".

3. LCD Updates:

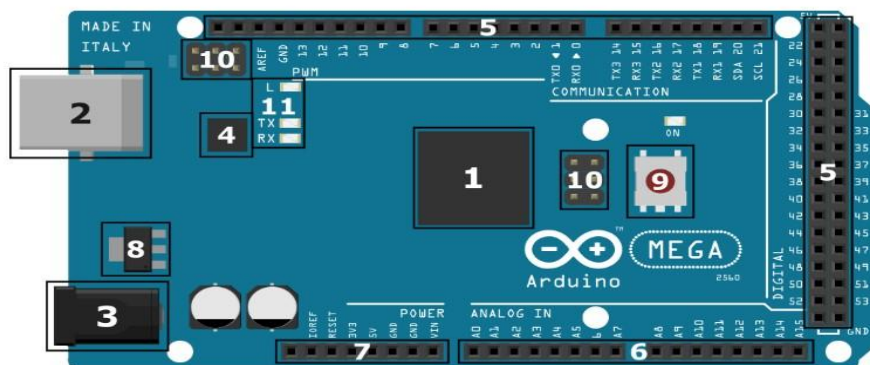
- Show appropriate messages
like: ○ "Sending SMS..."
○ "Calling Number 1..." ○
"SMS Sent Successfully"

Component Description:

1. Arduino Mega 2560:

The **Arduino Mega 2560** is an open-source microcontroller development board based on the **ATmega2560** chip. It is the **central controller** in this project, responsible for managing all

the components including the GSM module, GPS module, LCD display, and keypad. It processes user inputs, handles serial communication, and controls outputs based on programmed logic. The board operates at 5V and has a recommended input voltage range of 7–12V. It contains 54 digital I/O pins (15 of which support PWM), 16 analog inputs, 256 KB of Flash memory (8 KB used by bootloader), 8 KB SRAM, and 4 KB EEPROM. It also features four hardware serial communication ports (Serial, Serial1, Serial2, Serial3), making it ideal for communication-heavy applications like this one.



2. SIM800L GSM Module:

The SIM800L GSM module is a compact and low-cost GSM/GPRS module that enables devices to send SMS, make or receive voice calls, and access the internet over the 2G network. In this safety device project, the SIM800L plays a critical role by enabling wireless communication with pre-saved emergency contacts. Upon receiving a specific input from the keypad, the Arduino Mega sends AT commands to the GSM module to either send an SMS or initiate a phone call to the assigned mobile number.

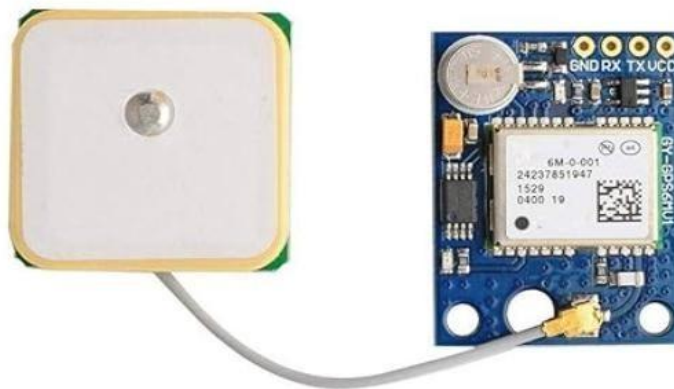
The module communicates with the microcontroller via UART (serial communication) and operates at a voltage range of 3.4V to 4.4V, with 4V being optimal.



3. Neo-6M GPS Module:

The Neo-6M GPS module is a powerful and reliable GPS receiver used to determine the realtime geographical location of the device. In this safety device project, it plays a key role by providing the latitude and longitude coordinates of the user's current position. These coordinates are then sent via SMS through the GSM module to the emergency contacts when an alert is triggered from the keypad.

The module uses satellite signals to calculate its position using the Global Positioning System. It communicates with the microcontroller through UART (serial communication) and typically operates at 3.3V. The Neo-6M module includes an onboard EEPROM for configuration storage, a ceramic patch antenna for signal reception, and a 3.3V voltage regulator for stable operation.



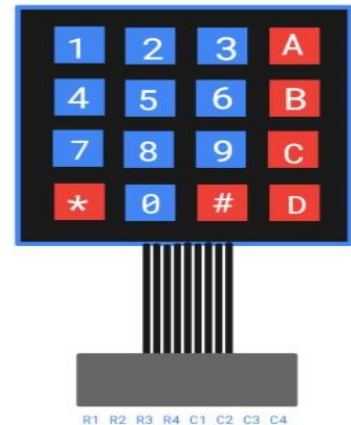
4. 3.7V Li-Po Battery:

The 3.7V Li-Po (Lithium Polymer) battery is a lightweight and high-energy-density rechargeable battery used to power the entire safety device. It is chosen for its compact size, high discharge rate, and ability to supply sufficient current to modules like the GSM (SIM800L), which can draw up to 2A during transmission. Li-Po batteries offer advantages such as **stable voltage**, **fast charging**, and **long battery life**, making them ideal for portable embedded systems

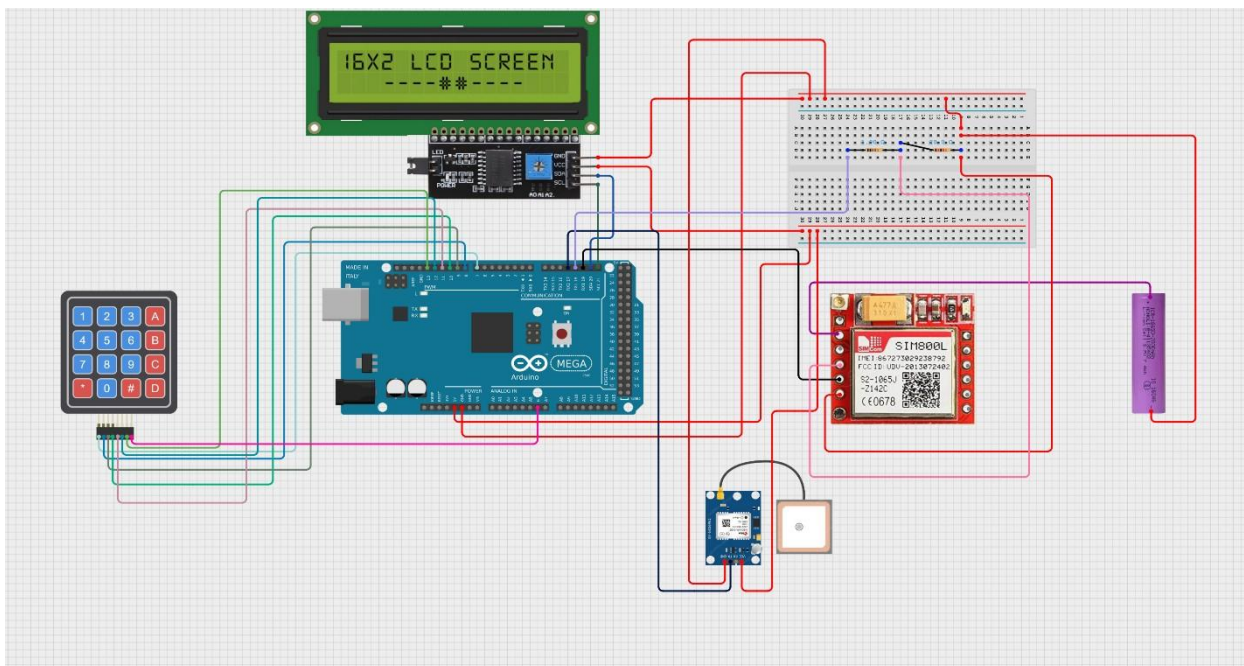


5. 4x4 Matrix Keypad:

The 4x4 matrix keypad is a tactile input device consisting of **16 buttons arranged in a 4-row by 4-column format**, making it suitable for multiple user inputs. In this project, it is used to trigger specific safety actions like sending an SMS or making a phone call. Each button can be programmed for a particular function. For example, buttons 'A', 'B', 'C', and 'D' are configured to immediately send alerts to pre-saved contacts.



Circuit Diagram:



The above circuit diagram represents a complete working model of a **portable safety alert device** built using an **Arduino Mega 2560** as the central controller. The design integrates multiple modules including a **SIM800L GSM module**, **Neo-6M GPS module**, **4x4 matrix keypad**, **16x2 LCD display (with I2C adapter)**, and a **3.7V Li-Po battery** to create a compact, standalone safety system.

The **Arduino Mega** acts as the brain of the system, interfacing with each component through its abundant digital and serial communication pins. The **4x4 keypad** is connected to eight

digital pins and allows the user to perform quick actions — for instance, pressing 'A', 'B', 'C', or 'D' sends an SMS or places a phone call to the stored emergency contact numbers. **two numbers** can be stored in this version.

The **SIM800L GSM module** is used to send SMS alerts or make calls via GSM network. It is powered directly by the **3.7V Li-Po battery** and communicates with Arduino via serial pins. The GSM module also provides feedback to the microcontroller.

The **Neo-6M GPS module** continuously provides real-time location data (latitude and longitude), which is included in the emergency SMS. It also uses serial communication to interact with Arduino. The **16x2 LCD display** (connected via I2C module to save pins) is used to display system status like “Location Found,” “SMS Sent,” or “Calling....”.

Advantages :

- **Quick Emergency Communication:** Sends location-based SMS or makes a phone call at the press of a button.
- **Portable & Battery-Powered:** No external power supply needed; works anywhere.
- **Real-Time GPS Tracking:** Accurate location sent to contacts.
- **Simple Interface:** Easy-to-use keypad for immediate response.
- **Modular Design:** Easy to upgrade or modify individual modules (like changing GPS or GSM)

Disadvantages :

- **Limited Contact Storage:** Limited emergency numbers can be saved due to memory constraints.
- **Battery Dependent:** Needs regular charging; may fail if battery drains.
- **Signal Dependency:** GSM and GPS may not work well indoors or in weak signal areas.
- **No Enclosure:** The open setup is vulnerable to physical damage, dust, or weather.

Working :

The safety device is powered by an Arduino Mega 2560. When the system is turned ON, all modules including the GSM, GPS, LCD, and keypad are initialized. The user can press any emergency key ('A', 'B', 'C', or 'D') on the keypad to trigger the alert.

On pressing the key, the GPS module fetches the current location of the user. The Arduino then sends this location via SMS using the SIM800L GSM module to the saved emergency contacts (maximum 2 numbers). It also initiates a phone call for added safety.

The 16x2 LCD shows system status like “Sending SMS” or “Calling...” during the process. The device is battery-powered using a 3.7V Li-Po cell, making it portable and ideal for emergency use.

Applications:

- Used as a personal emergency alert system for anyone in danger.
- Helpful for students, especially during travel or late hours.
- Can assist elderly or patients in sending quick alerts.
- Suitable for solo travelers in remote or risky areas.
- Useful during natural disasters to share location without internet.
- Can be used by outdoor workers like security guards or miners for emergencies.

Conclusion:

This safety device project demonstrates a simple yet effective way to send emergency alerts using embedded systems. With the help of an Arduino Mega 2560, SIM800L GSM module, and Neo-6M GPS module, the system allows a user to instantly send their real-time location via SMS and make a call to pre-saved emergency contacts by just pressing a key on the keypad.