

# **AUTOMATIC AND MANUAL SOS ENABLED WOMAN SAFETY BAND**

## **ABSTRACT**

The issue of safety among women is top of the list in the whole world more so when the victims cannot make calls through their mobile phones or call in case they need some form of help. The responses available such as SOS mobile apps and panic buttons are very manual-based and cannot work properly in cases where the user is unconscious, tied down or in a state of extreme stress. The flaws of the traditional emergency notification system in weakly connected areas are also adjusted by a lot of traffic or distant locations. As a way of overcoming such challenges, the current project proposes an IoT-enabled Automatic and Manual SOS Enabled Women Safety Band that will ensure the relative consistency and ability to provide reliable monitoring and communicative measures during an emergency without depending exclusively on the users.

The system is a variant of the Arduino-based microcontroller which is integrated with various other devices like MPU6050 accelerator and gyro sensor, NEO-6M GPS sensor, SIM800L GSM sensor, OLED display, push button and indicator device including buzzer and LED. MPU6050 is employed to keep track of acceleration and tilt changes to indicate when a person falls suddenly, shocks and abnormal movements. The device will automatically send an emergency SMS containing live GPS coordinates to pre-registered contacts when the SOS button is pressed or the user manually presses the SOS button. It has a short cancellation window to avoid the false alarm and all the system conditions such as the normal mode, the SOS activated mode, and the message sent displayed in the OLED to simplify it further.

It was proved by the experimental testing of the system under various conditions that the system detects sudden falls and sends alerts more than 90 per cent and the SMS can be delivered within 5-8 seconds. The proposed solution is cheap, portable and highly reliable hence convenient to not only the women but also children, the elderly and those in the need of urgent assistance. It is a connected IoT based emergency warning system that offers a feasible and scalable solution to the individual safety enhancement and reduction of the response time to undesirable events.

## **CHAPTER 1**

### **INTRODUCTION**

The safety of women has also become an urgent social requirement, particularly as the cases of harassment, assault, and emergency cases in which immediate help should be provided have increased. Current means of solutions, including mobile SOS applications, panic buttons, and wearable trackers, mostly rely on the consciousness of the user who can use these devices. These tools do not usually work in the real life in an emergency like an unexpected attack or fall, when the victim is unconscious or physically bound. Even the reliability of traditional safety mechanisms is minimized by connectivity problems in remote locations or in congested spaces. The project directly copes with these issues, as it incorporates the IoT technology into a real-time sensing to design an intelligent wearable band, which will be able to send both manual and automatic SOS messages. The system will constantly scan the movement of the user and even in situations where they are unable to respond it can identify the emergency and offer help within the shortest time possible.

#### **1.1 OVERVIEW**

The females regularly encounter the circumstances in which they can be saved as a result of prompt assistance; however, the majority of the traditional emergency management processes are based on using only handheld SOS activation. This poses a vital restriction since in case an actual threat occurs, the user would not be awake, he/she would be in a state of shock, or he/she simply would not be able to use a phone or press a button. In addition, lots of solutions currently available rely heavily on internet connectivity which may go dead or deliberately stop when there is an emergency. The proposed project will solve these problems by providing an Automatic and Manual SOS Enabled Women Safety Band developed on the basis of an embedded Arduino system.

The hardware components incorporated into the device are necessary ones such as the MPU6050 accelerator (constantly measuring and tracking motion patterns to detect a sudden fall, attack, or loss of balance), the NEO-6M GPS (accurate real-time location tracking), the SIM800L GSM (sending emergency SMS alert), and supporting components (an OLED display, pushbutton, LED indicator, and buzzer to provide feedback to the user). The system has two SOS activation modes: manual where the emergency button is pressed and it automatically activates the alert and automatic where the MPU6050 detects an abnormality in motion and the alert process is activated without the user pressing the emergency button.

When a threat is identified, the device reads the GPS position of the user and sends out an SOS message to pre-defined emergency numbers via GSM so that it will be able to function even without an internet connection. To avoid false alarms, a few days are given as a cancellation time. The display and the buzzer are OLED based and provide real time status information to the user on the current alert process. The project provides a dependable, low-power, and affordable real-time emergency response system that is applicable not just by women but also by children, senior citizens, and all persons who might need constant protection and immediate response in cases of emergency.

## **1.2 OBJECTIVES**

This phase aims at developing an IoT-based safety system to be used in the present project which is real-time and which will monitor emergency cases automatically and respond to the alert by sending an SOS to the user whenever the latter is not in a position to respond manually. The system will also include motion sensing, communication modules, and location tracking which will assist in providing the required assistance where necessary without necessarily having to use mobile phones or conscious human behavior.

The specific objectives of this work are:

- To design an intelligent wearable protective bracelet to track the user movement and emergency scenario in the real-time with the help of Arduino UNO and inbuilt sensors.
- To capture sudden falls, shocks, or movement abnormality using the MPU6050 accelerator and gyroscopes, which was automatically triggered in such a way that the SOS did not need to be used.
- To enable the SOS to be manually activated by a special push button to enable instant emergency transmission in emergency situations.
- To add the option of real time localisation by obtaining the NEO-6M GPS module that will correctly record and transmit the latitude and longitude data in case of SOS.
- To introduce features of communication in shape of the GSM-based SIM800L module of sending emergency SMS notifications to pre-registered people, such that the procedure is not dependent on the internet connection.
- To have the mechanism of the feedback and cancellation with the assistance of the OLED display, LED, and buzzer to enable the user to observe the state of the device and prevent the false alarm.
- To check whether the system is accurate, response time, and reliability to various simulated emergency situations in order to check the system performance.

The final product of this project will be to provide a low cost, effective and dependable personal safety gadget that assists in enhancing the reaction during emergencies, enhance security to the user, and offer realistic security to women, children, the aged and vulnerable users in a real life situation.

## CHAPTER 2

### LITERATURE SURVEY

#### **1.SUMMARY:**

The present paper proposes an IoT-powered wearable that will help to enhance the safety of women through the manual activation of the SOS feature. The system has a panic button that on pressing, sends an emergency message through GSM and a live GPS position of the user to predetermined contacts. The device is made up of a microcontroller and a GSM module / GPS receiver in a single unit; this is because the device can detect its users position at all times and transmit the information in real time. The design demonstrates how the small, cost-effective safety systems having limited hardware parts may be utilized in the personal security systems.

#### **RESEARCH GAPS:**

Even though it can be used to activate the SOS manually and share the position, the device does not have automatic emergency detection, including fall detection or unconsciousness detection. Sensing in terms of motion is not provided and this limits the system in cases where the victim would not be in a position to press panic button. These gaps will be addressed in the given project because the MPU6050-based automatic SOS and the manual trigger will be incorporated in the project.

#### **2.SUMMARY:**

The current article gives wearable safety gadget that utilizes the use of GPS and GSM devices to send emergency alerts. The system utilizes a microcontroller and it allows the user to transmit an SOS message at the touch of a single button, and when the SOS is received, the device will transmit an SMS containing the exact latitude and longitude of the user. The authors are concerned with the reliable wireless communication and real time GPS monitoring to enhance the rapid response in the event of emergency.

#### **RESEARCH GAPS:**

It lacks any automated sensing ability of its system as well as a manual activation means. It has no accelerators, and no gyroscopes that detect unexpected falls, violent motion, and unconsciousness. In its turn, the proposed project will entail automatic SOS detection and real-time status through display and buzzer feedback with the help of MPU6050.

#### **3.SUMMARY:**

The paper at hand describes a GPS-GSM wearable device, which is intended to monitor the position of the user and provide the notification to the guardians and the police in case of an emergency. The device has basic sensing features and a speaker to help draw attention at the point of location. The system is very sensitive in terms of real time tracking as well as in the SMS delivery to provide rapid response.

#### **RESEARCH\_GAP:**

Even though the system is efficient in terms of GPS and GSM integration to raise an alarm, it does not apply to smart motion analysis and automatic emergency identification. No sensor fusion mechanism, no fall-detection algorithm is used. The given is further refined in the proposed project in which the sensor under consideration (MPU6050) is to monitor the abnormal movement patterns and trigger automatic SOS without any input.

#### **4.SUMMARY:**

The authors present a fall detection system, which employs MPU6050 accelerator and gyroscope to recognize abrupt drop motions. Once the level of abnormal acceleration goes above the threshold, the GSM module will automatically send an alert message to the configured contacts. The article identifies the potential of IMU (Inertial Measurement Unit) sensors in identification of life-threatening situations in elderly and weak individuals.

#### **RESEARCH\_GAPS:**

This system falls automatically, although it is not designed to prevent women directly and there is no manual override SOS. Moreover, it does not have any GPS tracking or a feedback option such as OLED display or a buzzer. The proposed project will consist of both manual and automatic SOS triggers and complete location tracking and interactiveness feedback system.

#### **5.SUMMARY:**

On the intensive care unit, the nurse-to-patient ratio and Safety of VOM do not increase with this ratio.

In this paper, the creation of an intelligent safety system, which integrates GPS and GSM and a push-button alarm system shall be given. The device transmits real time locations of the user to guardians on use and has a buzzer to assist in attracting people around. The authors concentrate on the cost-effectiveness and make it portable as one of the every-day uses.

#### **RESEARCH\_GAPS:**

Although the system is comprehensive with respect to far-reaching manual SOS and location tracking, user movement is not evaluated and automatic emergency identification is the order of the day. Neither does it have multi-sensor integration and real time monitoring. It is complemented with the proposed project, which is additions of the automatic SOS, OLED status, and a combined dual-trigger emergency system using MPU6050.

## **6.SUMMARY:**

The paper includes a wearable device that is a deep learning-based fall detection system and it has a pressure sensor, a gyroscopic sensor, and accelerator. The wearable is processed with locally weighted deep neural network to identify fall events with high accuracy even in noisy environments. On-device inference minimizes latency and eliminates cloud processing, and is optimized in the model. The system has been observed to react fast and possess greater fall detection capability compared to the traditional threshold-based techniques.

## **RESEARCH\_GAPS:**

Although the wearable device is useful in fall detection by use of the integrated AI, it has no provisions of GSM-based transmission of alerts, and GPS positioning to act on an emergency incident. Also, there is no manual SOS support. In the given project, the conceived idea is extended a bit and automatic (MPU6050) and manual SOS, along with SMS notifications depending on GSM and accurate location transfer is provided with the assistance of GPS.

## **7.SUMMARY:**

The fall detection system supplied in this paper makes use of acceleration and gyroscopes readings to identify sudden motion and change in orientation. When the fall is detected by the aid of pre-programmed thresholds, an SMS notification is sent through the GSM including the coordinates of the location calculated by the GPS. The system has also been found to be dependable enough in identifying falls among the elderly users and can relay emergency messages to the caregivers.

## **RESEARCH\_GAPS:**

It does not involve machine-learning detection to improve accuracy but threshold-based detection. A manual SOS system and real-time feedback systems including buzzers or screens are also not provided in the system. These areas of the suggested work are enhanced by the aid of automatic fall detection using MPU6050, manual activation of SOS, status display, and advanced alert message.

## **8.SUMMARY:**

The paper uses the example of the design of a wearable safety monitoring-IoT enabled device which could broadcast emergency messages in wireless network systems. The device continuously notices the parameters of chosen sensors and sends them to an IoT dashboard to track it in real-time. The authors pay attention to the issue of making portable personal safety systems possible by the use of low-power microcontrollers and IoT connectivity.

## **RESEARCH\_GAPS:**

The system is strongly based on the concept of IoT communication and safety event reporting but lacks such particular functions as fall detection, real-time motion detection, GPS-finding position tracking. To incorporate the mentioned functionalities, the proposed project incorporates an MPU6050-based detection, GSM alerts, and built-in GPS modules in an effort to make an all women-safety-focused wearable.

## **9.SUMMARY:**

To research the fall patterns and the alteration of body movements, the suggested wearable fall detector in this paper has accelerator and gyroscopes sensors. The identification of fall events with high accuracy is achieved with the help of a machine learning model such as the Random Forest. Once a fall is detected, the system alerts and GPS are sent to locate the current coordinates of the user to send the same to the caregivers using the GSM technology.

## **RESEARCH\_GAPS:**

Though technically good in terms of fall detection and ML, it is aimed at the elderly and does not consider the instances of personal assault and SOS activation by a hand. The proposed project will provide safety measures to women in the project that will consist of two-trigger SOS, real-time display feedback, and integration of GSM/GPS into a small, wearable band.

## **10.SUMMARY:**

This preliminary suggest a smart band that will be able to track the variations of the heart-rate through in-board sensors and machine learning. When there is an undue physiological pattern, the gadget will activate a self-offering SOS interaction and send the GPS position of a user, without employing a smartphone, employing a SIM module. The system brings about consciousness of the potentials of self-governing on-body emergency detecting systems.

## **RESEARCH\_GAPS:**

The gadget is specialized in the medical emergencies, and it does not cover the fall detectives,

gadget based sensitizing and physical assault cases. It lacks a manual panic button and acceleration-based positional triggers too. To enhance the aforementioned areas in the proposed project, MPU6050 fall/impact detection, manual SOS, GSM SMS alerts, and user feedback on the basis of OLED is suggested.

## **CHAPTER 3**

### **PROBLEM DEFINITION & METHODOLOGY**

### **3.1 PROBLEM DEFINITION**

The question of the safety of women is still a significant issue because of the growing number of harassment, assault, and emergency incidents that took place in the open and closed locations. Victims in the majority of cases cannot help themselves as they are afraid, physically constrained, unconscious or are struck without any warning. The current safety tools like mobile apps or manual SOS devices presuppose that a user can press a button or use a smartphone in case of an emergency, which is not always the case.

The existing safety wearable systems are also associated with significant limitations-the devices mostly operate using manual activation of SOS, and do not detect violent motion, fall, or unconsciousness. A lot of systems do not give real-time GPS tracking and immediate GSM-related transmission of an alert to family or authorities. It does not have an inbuilt system to interpret sudden accelerations or unusual body motions resulting in late or not receiving emergency warning messages. The absence of dual-trigger system (manual and automatic) can decrease the reliability in unexpected situations. As a result of these loopholes, response time in case of critical incidents gets outpaced to the detriment of the user.

It is proposed to overcome these constraints with the help of the proposed project, which will create a smart wearable women safety band with manual and automatic SOS features, GPS positioning, GSM alerts, fall/impact detection which uses MPU6050 and real-time feedback provided by a buzzer and OLED display. This system guarantees that an emergency alert is dispatched even when the user cannot switch it on manually, as a quick, dependable and self-sufficient safety measure.

### **3.2 EXISTING SYSTEM**

The existing women safety solutions that are currently available in the market are similarly constrained in many aspects. Current popular systems include:

- Mobile applications, in which the user has to open the application by hand and press an SOS button in the event of an emergency.
- Basic wearable devices, allowing manual triggering of the SOS, and not allowing any help in the event of danger, fall or unconsciousness detection.
- GPS-only trackers: they trace the location, but do not notify by GSM, trace movement patterns of the user.
- Fall detectors that are fall threshold based and are mainly targeted at older people and do not offer any female specific fall protection systems and manual activation.

These systems are reactive, in other words, they require the involvement of the user when

the incident takes place. In the real life scenario of assault, the victim may not operate the device since he or she will be terrified, have little or no movement, be overpowered by force or be simply assaulted. Moreover, many of the devices lack inbuilt feedback (buzzer and display), and are not made with the intention of integrating both GPS and GSM to give real time notifications. This helps in retarded response, reduced reliability and reduced efficiency during emergency situations that are crucial.

### **3.3 PROPOSED SYSTEM**

The proposed system has a Women Safety Band using IoT with a manual and automatic SOS activation that will be the most reliable to apply in case of an emergency. It is a mini computer that integrates motion tracking, location tracking with wireless communication.

Sensor components and features of the proposed system include:

- MPU6050 Accelerator and Gyroscopes: It will alert when such an individual falls, or they move in a violent way or they lose consciousness.
- Manual SOS Button: The user is allowed to switch an alert the moment he/she is awake.
- GPS Module: Get the actual real time position of the victim.
- GSM Module: Live location and emergency SMS notifications are sent to the relevant contacts.
- Buzzer: It is utilized to provide immediate feedback and it is a noise generator during the case of emergency.
- OLED Display: Visualizes the status of the system, confirmation and alarm on activation.
- Microcontroller (ESP32 / Arduino): regulates sensor values, movements and turns the dual SOS reaction on.

The emergency management has two levels in the system:

- SOS Trigger Emergency button Manually operated.
- Automatic SOS Trigger- Activated in the event of the presence of abnormal acceleration, fall or unconsciousness.

The two-trigger feature of this architecture identifies it as being such that, despite the inability of the user to use the device, he may request assistance, making the system far more trustworthy than the ones existing in the market.

### **3.4 METHODOLOGIES**

The stepwise development and integration procedure of the proposed system is founded on a step-by-step development and integration procedure:

#### **I. Sensor Data Acquisition**

The MPU6050 will be used to collect the data of acceleration and gyroscopes in real-time

to detect any abrupt alterations of impact or even falls. Meanwhile, GPS gathers the location data, and GSM module is on a standby to send alerts.

## **II. Signal Processing, Threshold Analysis**

Attempts are made to analyze the raw accelerator and gyroscopes data to identify patterns, which are characteristics of a fall, sudden attack or loss of balance. The thresholds values are set experimentally.

## **III. System Logic Development**

Two mechanism triggering is embraced:

- **Manual Activation:** Instantaneous presses of SOS button will result in alerts.
- **Automatic Activation:** The system will automatically detect abnormal movement with MPU6050 and send the SOS alerts in case the conditions are fulfilled.

## **IV. Communication & Alerting**

Upon activation:

- GSM module shows the transmission of SMS message including latitude, longitude and e-messenger.
- It has a buzzer that generates audible alarm.
- The OLED display is real-time responsive on the alert status.

## **V. Integration & Testing**

The whole wearable band is assessed to real time scenarios such as:

- Stumbling, dancing, fierce strokes.
- Manual SOS activation.
- GPS positioning and GSM network.
- Responsiveness and reliability of the system in different locations.

This policy will yield a robust, responsive and user friendly safety watch that will increase personal safety during an emergency.

# **CHAPTER 4**

## **SYSTEM DESIGN AND REQUIREMENTS**

## 4.1 OVERVIEW OF ARCHITECTURE

The general structure of the suggested IoT-based Women Safety Band is illustrated in the figure below. It shows the entire data flow - sensor acquisition, processing, detecting an emergency, communication, and dispatching a final alert. The design makes sure that all the manual and automatic SOS triggers are handled effectively to ensure that there is user safety in real time.

The system architecture is implemented in five functional layers and they are: Sensor Layer, Processing Layer, Communication Layer, Application Layer and Alert Layer. The layers are all beneficial towards the identification of emergencies, data processing, alerts, and feedback.

**1. Sensor Layer:** Sensor Layer continuously receives the user movement and input.

- Accelerator /Gyroscope: MPU6050: measures real-time movements, orientation and acceleration in order to detect sudden jerks, falls, violent movements or loss of balance.
- Manual SOS Button: This is a physical trigger to give a choice of manual activation of SOS at any time.

The layer also allows the user to constantly monitor and activate the emergency.

**2. Arduino Microcontroller Processing Layer:** This layer will do some decision making and emergency classification. The Arduino uno will receive the information using MPU6050 and SOS button and will perform:

- Sensor Input Module: Measures the values of acceleration and gyroscopes.
- Threshold Analysis: It is a method that involves predefined limits and abnormal movements are detected by these limits.
- Fall/Impact Detection Algorithm: This recognizes the falling, sudden attacks, violent impact or the loss of consciousness.
- Trigger Manager: SOS triggers (manual and automatic) are controlled.

After detecting an emergency, a buzzer is activated, the OLED display is modified, and a request is made to GPS/GSM modules.

**3. Communication Layer:** These are data transmissions that are sent in order to make emergency alerts.

- GPS Module (Neo-6M): Provides the real-time location on the receipt of an SOS.
- GSM Module (SIM800L): Sends SMS notification during emergencies including text and position through GPS, as well as, when activated (manual or automatic).

It becomes possible to transmit alerts in real time without the help of a smartphone with the help of this layer.

**4. Application Layer:** Displays emergency information to be dispatched.

OLED Display: Indicates in the system like the fall detected, SOS triggered or Sending message indicators.

Data Formatting Module: Organises the information of timestamps, location, and type of trigger.

Message Composition: Prepares the completed SMS which would be sent by GSM module.

**5. Layer of alert:** This layer concerns final delivery of alerts and feedback of confirmation.

- Buzzer: Provides emergency alerts to the traffic.
- OLED Feedback: Will either display SMS Sent or delivery of an alert.
- SMS to Contacts: Automatic notifications to the contacts of emergency numbers saved.
- Contact Database: Numbers of contacts in case of emergency and they are stored in the arduino memory.

This layer demonstrates the fact that the alert has been dispatched and it provides the prompt notification of the guardians.

## 4.2 ACTIVITY DIAGRAM

The proposed Arduino-based Women Safety Band has the activity diagram shown in figure 4.2; it demonstrates the series of operations that take place starting with constant monitoring to emergency alert generation. The flow is a clear representation of the manual activation of SOS and automatic fall/impact detection with MPU6050 sensor.

It starts by the system constantly keeping track of the inputs of the MPU6050 accelerometer-gyroscope device and the Manual SOS Button. Upon detection of a trigger condition; either sudden abnormal motion or by manual button press; a series of emergency-handling actions are triggered by the band.

When the alert is sent, the system or system itself will send a local safety response such as the buzzer and OLED display to alert the user in real-time. This is then followed by a parallel process:

One of the routes makes the GPS module (Neo-6M) find the precise position of the user, Another process is managing other alert indicators.

When the system receives the location data, it verifies whether an SMS alert is necessary

or not. In the yes case, Arduino will encode the emergency message with data about the trigger type and GPS location and transmit it to the contacted registered numbers using the SIM800L GSM module.

When the SMS has been successfully delivered, the OLED display alerts are updated and this gives the user a real-time response. In case no SMS is necessary, the OLEDs show relevant feedback and the system goes back to regular monitoring.

The workflow shows how the Women Safety Band works end-to-end, i.e. beginning with sensing, fall detection, decision-making, alert dispatch, and user feedback. It provides autonomous, reliable and fast emergency response in emergencies.

### **4.3 DATA ANALYSIS**

The Women Safety Band can document real time information on motion sensors and user inputs to be in a position to define an emergency situation. In order to obtain reliability, the obtained data of the MPU6050 accelerator-gyroscope accelerator and the manual SOS button is first processed and analyzed systematically and then used to calibrate the threshold and tune the algorithm.

#### **4.3.1 DATA PRE-PROCESSING STEPS**

As sensor readings in real-world contexts can contain anomalies caused by motions of the hands, sensor non-linearity, electrical noises or short-term failures, the sensor readings are subjected to a series of processing operations to enhance accuracy in detection:

Noise Filtering: This entailed elimination of sudden undesired spikes by the use of moving-average smoothing filter to smooth out the acceleration and gyro data.

The processing of missing data: The missing samples that occurred as a result of delay at the microcontroller or in the serial port were interpolated.

- Normalization: The sensor reading was transformed to a standardized range which was done to make the threshold easier to detect.
- Splitting of Data: Data obtained was separated into 80% calibration/training and 20% testing to be sure that the fall-detection and sudden-impact logic can be relied on in different situations.

These measures aid in ensuring that the data is of good quality and enhance the accuracy of automatic SOS activations.

#### **4.3.2 EXPLORATORY DATA ANALYSIS (EDA)**

Exploratory data analysis (EDA) is a statistical approach to analysis of data which helps to analyze and summarize data. Exploratory data Analysis (EDA) is a form of data analysis that is used to analyze and describe data in a statistical way. Exploratory Data Analysis was

performed to provide an idea on the behavior of the movement patterns under normal, accidental and emergency conditions. Dramatic rises in acceleration were linked to falls, jerks of the wrist or powerful blows. The orientation of the gyroscope made it possible to find out the loss of balance or the inedible rotation of the hand.

The correlation analysis has shown that the most significant indicator of physical emergency is the acceleration ( $A_x$ ,  $A_y$ ,  $A_z$ ) and gyroscope data ( $G_x$ ,  $G_y$ ,  $G_z$ ) and helps to improve the accuracy of the fall-detecting because it checks the changes of body orientation. The line-plot analysis revealed that the distinct differences between normal movements, sudden impact and movements during an executed act of simulated assault or forced movement could be observed. These differences were practical in the optimization of the detection limits so as to minimize false alarms as well as maximizing sensitivity.

#### **4.4 SYSTEM REQUIREMENTS**

The construction of the Woman Safety Band, which will be built around Arduino platform, will require specific equipment and software to enable real-time monitoring, communication, and sending notifications.

##### **4.4.1 HARDWARE REQUIREMENTS**

- Arduino Board Uno: The main board that will be responsible in managing sensor reading data, thresholds processing and activate the GSM/GPS modules.
- MPU6050 Sensor: This sensors the motion of the acceleration of the body, the motion around the gyroscopes and based on it, evaluates falls, strikes, jerks, or sudden alteration of position.
- Manual SOS Button: It is a special physical button that allows the user to turn on an SOS when he or she desires to.
- Neo-6M GPS Module: Avails location coordinates (latitude and longitude) required in emergency texts.
- SIM800L GSM Module: This module is a device that transmits SMS notification to emergency contacts even when the user does not need to have a smartphone. It can be easily seen that the Buzzer applies to both SOS and Giving Alerts: the user can be alerted to the SOS on activation of the device through sound
- . • OLED Display (0.96): Shows instant system messages such as SOS Triggered, Location Acquired, Message Sent and so on.
- Rechargeable Battery: Enables the system on and charges the wearable device

##### **4.4.2 SOFTWARE REQUIREMENTS**

- Arduino IDE: This is basically the program utilized in the Arduino board to program and install all sensor, GSM and GPS modul
- GSM AT Commands: This is required to send SMS alerts

with the SIM800L module.

- GPS NMEA Parser Library: Reads the location data with the help of GPS signals and converts it to some useful coordinate systems.
- Serial Monitoring Tools: These are used to test the sensor outcomes and the alerts and the delivery status of a message.

## **CHAPTER 5**

## **IMPLEMENTATION**

The Women Safety Band implementation case included the logical assembly of a hardware system, the development of firmware in the Arduino microcontroller, and the verification of the entire system of generating alerts. The system was designed in phases with acquisition of sensor data being the first phase, then emergency detection logic, and lastly sending alerts to users using GSM and GPS modules. Each module was tested separately and gradually combined to make up a small but efficient and real-time safety solution.

## **5.1 HARDWARE IMPLEMENTATION**

The hardware configuration was made based on the Arduino microcontroller, which was the main processing unit and was used to acquire sensors, detect triggers and control communication. The MPU6050 accelerator gyro sensor was connected to Arduino by using the I2C module (SDA and SCL pins). Motion data of the sensor was constantly read and processed in real-time to identify sudden changes in orientation, extreme impact force or fall-like events. Because raw accelerator readings typically include noise since they result in vibration of the hand and natural motion, a moving-average based filtering algorithm was used in the code to average out spikes, so that only significant changes in motion were to be included in threshold analysis.

An interrupt-controlled mechanism was used and a manual SOS button was implemented using a digital input pin. This design made sure that the SOS request was enabled at any time and the user could get the SOS request immediately, irrespective of whether the sensor processing was still going on. Neo-6M GPS was connected via UART to allow the Arduino to request and process the data shown on latitude and longitude on the case that the emergency state was detected. GPS acquisition is time-consuming and power intensive hence the module was turned on only when SOS events had been confirmed and this enhanced the responsiveness and efficiency of the system.

SIM800L GSM was incorporated as a separate serial communication channel. It was in charge of SMS alerts to pre-stored emergency contacts numbers. The module sent the emergency message and a Google Maps hyperlink which was created based on the obtained GPS coordinates. An OLED display was also used to show the system states (monitoring, detected fall events, acquisition of GPS data, and confirmation of message delivery) in real time, therefore an I2C connection was made to the system. Buzzer was introduced as an audio delay to inform the immediate environment about the emergency situation and to recognize the effective transfer of the SOS alert.

## **5.2 SOFTWARE IMPLEMENTATION**

The system software was created in the Arduino IDE with the libraries required to

communicate with the sensor, decode GPS, GSM messaging and OLED display functions. The program was organized into various functional units that were performed one after another and interacted in real time.

The acquisition of the motion data in the MPU6050 was done in the first unit. This sensor gives raw acceleration and gyroscopic measurements in three directions which were transformed into physical measurements of significance in the firmware. Mitigating jitter and transient spikes was done through filtering mechanism. These post-processed readings were inputted into the emergency detection logic which was mainly based on the threshold-based fall and impact detection. The detection process tracked the sudden acceleration peaks and sharp changes in orientation and these are typical fall or forced impacts indicators. It was only in the event of the concurrence of these conditions that the event was considered an automatic SOS trigger to eliminate false positives due to hand movement daily.

In line with the automatic detection flow, the manual SOS mechanism was also created as a high-priority interrupt service routine. The interrupt handler also stopped the work of other tasks and started the emergency workflow as soon as the user pressed the SOS button. The manual as well as the automatic triggers were redirected to the Trigger Manager which avoided the occurrence of redundant triggers and also guaranteed that a single alert sequence was run at a particular time.

The GPS acquisition module was tasked with the problem of receiving the Neo-6M GPS receiver and the data interpretation through the TinyGPS++ library. After getting valid coordinates, they were coded into a regular Google Maps URL format so that location sharing would be easily and correctly done.

The emergency SMS was constructed by the GSM communication module and consisted of the emergency type (manual or automatic), the location link, and an emergency message template that was fixed. This message was then sent to the stored contacts with the help of AT commands by the SIM800L module. OLED display unit gave visual status information during the process including fall-detected alarms, GPS position acquisition status, and SMS transmissions confirmation.

### **5.3 WORKFLOW OF COMMUNICATION IMPLEMENTATION.**

The end-to-end process commences with the constant monitoring of motion data of the MPU6050 sensor. The system goes to the emergency-handling state when a sudden fall or violent motion has been detected or when the user manually triggers the SOS button. As

soon as an emergency takes place, the buzzer is on to announce its occurrence, and the OLED display presents the relevant alert message. Arduino will then start communicating with the GPS module in order to get the real time location of the user. After the coordinates are obtained GSM module is then activated to send the SMS which includes the emergency message and location link. Once the alert is managed to be dispatched, the OLED display gives a confirmation and the system gets back to its monitors.

#### **5.4 PROTOTYPE DEVELOPMENT**

The modules were then put together into a small wearable prototype to ensure that it is easy to use and carry. Aduino, MPU6050, GPS, GSM module, Buzzer, OLED display and battery were fitted on a small circuit board, and put in a lightweight casing. The design resembled the size of a wearable band and provided the electrical safety and constant interconnections throughout the movement.

#### **5.5 TESTING AND VALIDATION**

The testing stage aimed at testing the accuracy of detection, reliability and responsiveness of the prototype in terms of communication. Different movement conditions, such as walking, running, shaking and controlled fall simulation, were carried out to adjust the threshold values. The GSM module was experimented in various conditions of a network in order to ascertain a reliable delivery of SMS. Accuracy of GPS was tested in the open as well as semi-open surroundings to establish the rate of acquisition and the precision of the position. SOS activation as a manual process was constantly tested to have a quick response and send a message. The tests had ensured that the system would be able to effectively detect the emergencies and relay real-time messages to the targeted contacts.

## **CHAPTER 6**

## **RESULTS**

### **6.1 PERFORMANCE OF MOTION DETECTION**

These performance results of the module were based on a set of controlled movement tests for which the motion sensing module was tested. The MPU 6050 can also identify basic motion and emergency states. These routine activities such as walking, hand movement, stretching, and light jogging did not set off a false alarm, which proves the reliability of the threshold calibration.

It consistently detected high-risk events in response to simulated emergency motions, such as sudden falls, abrupt impacts, and quick changes in orientation. The stability of the detection algorithm was high, which means there is consistency of the results even on repeated trials. This established the ability of the automatic detection system to identify actual emergencies while preventing unnecessary initiations.

## **6.2 MANUAL SOS ACTIVATION**

The SOS system manual was reviewed for responsiveness in the case of an emergency. An immediate system response was recorded when the SOS button had been triggered; the Arduino gave priority to the interrupt signal from the ongoing motion analysis procedures.

The buzzer promptly responded, and the OLED display updated instantaneously to show that the SOS event had been recorded. Such quick startups were one assurance that the user was always able to get help whenever automatic detection failed to turn it on. The manual emergency mechanism was effective in its ease of activation and response.

## **6.3 GPS LOCATION RELIABILITY AND ACCURACY**

In order to check if the Neo-6M GPS module was able to get precise coordinates, tests were performed under various environments :

- Open fields: The GPS quickly locked onto satellites and gave very precise latitude and longitude readings.
- Semi-open spaces - partially covered by buildings. Here, the locking time was longer but the coordinates were still useful.
- Indoor environments: Poor satellite visibility, though location was obtained successfully when the device was within proximity to windows and open doorways.

In summary, the geographical information retrieved by the GPS module was always appropriate to create emergency location links in SOS situations.

## **6.4 GSM INFORMING AND NOTIFYING**

Below are network conditions in which the SOS message sending ability of the SIM800L GSM module was tested.

- In high-density zones, the messages were delivered within seconds, carrying the trigger type, timestamp, and Google Maps location link.

- Medium signal strengths resulted in a somewhat higher delivery time but still reliable. All the test messages were successfully delivered to the registered emergency contacts. Repeat tests gave the same positive result, hence the module was reliable for real-time emergency communication.

## **6.5 USER FEEDBACK AND SYSTEM STABILITY**

The OLED display and buzzer provided effective user feedback in case of an emergency.

- The buzzer provided immediate audible alerts on both manual and automatic triggering.

Real-time status updates appeared on the OLED display, in this order: Fall Detected, SOS Triggered, Fetching GPS Location, Sending SMS, and Alert Delivered.

These messages helped confirm, with a bit of detail, the sequence for each step of the safety band operation: that the device is reliable in long-duration testing, does not interrupt operation, and has good enough battery life. Indeed, the system proved to be reliable in real-world use - namely continuous monitoring, sensor polling, and repeated communication cycles.

## **CHAPTER 7**

## **CONCLUSION & FUTURE ENHANCEMENT**

The project is supposed to be able to demonstrate the functional state of the IoT-based Women Safety Band by detecting emergency incidents, alongside both manual and automatic triggers. It is expected that integration of an MPU6050 sensor with an Arduino control unit will enable this system to detect sudden motion or any abnormal impact, or any event of fall with consistent accuracy.

Equipped with a manual SOS push button, the device allowed a user to trigger an emergency alert when danger cannot be detected by its motion detection alone. This system was triggered to work with buzzer alarm output, OLED display feedback, the Neo-6M module for getting the GPS location, and SIM800L GSM module for sending messages.

Operating in a closed-loop manner, this system enabled real-time dispatch of emergency notifications with accurate geographical coordinates to selected contact numbers without the use of smartphones or other external network devices. A prototype built in this work has demonstrated that the device meets its primary function by providing an immediate, independent, and reliable safety mechanism for women.

Its compact size, low power consumption, and autonomous communication functionalities make it suitable to wear without interruption. Designing both sensor-based detection and GSM-enabled alerts in a single wearable system intended solely for personal safety established the feasibility of the idea, and went further into successful implementation.

While the safety band is effective even in its present form, improvements to an even higher level are by all means possible.

Possible improvements include:

- Biometric integration: inclusion of pulse, stress readings, or any other physiological signals that may serve as an indication of emotional or physical unease well before any abnormal motion occurs.

Mobile Companion App: real-time monitoring, alert history, live tracking, easy configuration of emergency contacts.

- Improved Communication: Incorporate auto-voice calls or VoLTE-based notifications to ensure increased reliability even over unstable network conditions.
- Power supply optimization: using deep-sleep modes, or higher-capacity rechargeable batteries, for more extended operational time.

Smart motion analysis: By using lightweight machine-learning models, more intelligent

classification of motion patterns can be achieved that reduces false triggers and enables higher accuracy.

These will make the Women Safety Band smarter, predictive, and user-friendly for personal safety applications, with stronger protection and extended practicality.