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IoT-Based Personal Safety Band

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Abstract : *Personal safety is a crucial factor in emergency situations, accidents, and situations in which immediate help is needed. In such situations, it may be impossible for someone to make a phone call and inform their family members or emergency contacts. This study presents an IoT-based personal safety band for immediate emergency assistance using an embedded wearable device. This system features a main microcontroller (ESP32). It features an MPU6050 accelerometer/gyroscope to detect any abrupt, unusual, or potential fall situations. There is also a manual SOS button for the user to immediately trigger the emergency alert. If an emergency situation is detected, the user location will be obtained via the NEO-6M module and the emergency alert with user location will be sent to registered contacts via the SIM800L module. Local emergency alerts are given via the buzzer and LED. The safety band is designed to be portable, light weight and can be worn by a variety of users. Including women, elderly and children. The system helps reduce the time taken to obtain emergency assistance.*

Keywords: Internet of Things, ESP32, personal safety, MPU6050, GPS, GSM, emergency alert, wearable

I. INTRODUCTION

Personal safety has become an essential need in everyday life. Accidents, falls, and emergency situations can occur at any time. During an emergency, it may be impossible for the person to make a phone call. Delaying the time of communication can increase the time taken to get assistance. Traditionally, emergency situations rely on the person being able to make a phone call using their mobile phone. However, during falls, accidents, and situations with sudden dangers, this may not be possible. Using embedded systems and IoT technologies, it is possible to create a wearable device that can automatically detect emergency situations and communicate with others. The sensors constantly monitor the users movements, and the communication modules communicate the emergency. The personal safety band uses an ESP32 microcontroller, MPU6050 sensor, GPS module, and GSM module. The MPU6050 detects any abrupt or unusual movements and potential falls. There is also a manual SOS button. If an emergency situation is detected, the location will be obtained using the NEO-6M GPS module. The emergency alert with location information is then sent to registered contacts using the SIM800L GSM module. Local alerts are provided via the buzzer and LED. This system detects movement, manually triggers an emergency, obtains location data, and communicates wirelessly. This system provides a practical solution for personal safety.

II. RELATED WORK

There are many wearable and embedded systems that can help with personal safety. These systems typically have sensors to detect movements or physical changes and modules to communicate emergencies. Wearable safety systems can be very useful if the user cannot manually communicate with others. Using motion sensors, it can detect any sudden movements or potential falls. GPS can then be used to find the location of the user. Modules such as GSM can be used to communicate emergencies to designated contacts.

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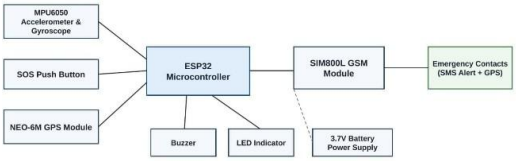
However, a good personal safety system should include automatic and manual emergency detection. The SOS button can be used to create alerts. The system includes both automatic and manual emergencies. The system uses an ESP32, MPU6050, GPS, GSM, and SOS button. This system focuses on creating a wearable system that can detect potential emergencies, obtain the user's location, and communicate the emergency to registered contacts. This project was specifically designed for women, elderly people, children, patients, and lone or industrial workers.

III. SYSTEM ARCHITECTURE

A. Hardware Components

The personal safety band includes embedded and communication components.

BLOCK DIAGRAM



• ESP32 Controller: This is the main controller of the system. It takes information from the sensors and controls the modules. It takes information from the MPU6050 regarding the users movements and controls the emergency alert.
• MPU6050 Accelerometer/Gyroscope: This detects any sudden movements and potential falls. It provides acceleration and gyroscope data to the ESP32. The movement data are processed to detect any unusual or sudden movements.
• NEO-6M GPS Module: This provides the user's geographical location during an emergency
• SIM800L GSM Module: This provides communication with registered emergency contacts. Emergencies can be sent as SMS using this module.
SOS Button: This provides a manual method to trigger an emergency alert.
Buzzer: This provides an audible alert for emergencies.
• LED: This provides an indicator of the system/emergency.
• 3.7V Rechargeable Liion Battery: This provides a power source for the wearable safety band
• On/Off Switch & USB Changing: This provides power control to the system and can be used to charge batteries.

B. Software Architecture

The ESP32 receives constant information from MPU6050. This detects any sudden or unusual movements. The controller detects potential emergencies. The system will constantly monitor the SOS button. When it is pressed by the user, it will be recognized as an emergency by the ESP32. Once an emergency is detected, the system triggers the emergency. The GPS module obtains the user's location. The ESP32 then coordinates with the GSM module to send an emergency alert with location information to registered contacts. The buzzer and LED provide local alerts.

IV. CORE CONCEPT AND DESIGN PRINCIPLES

The core concept of this system is to provide automatic and manual emergency detection capabilities. There are two main methods for detecting an emergency in this system. Automatic Emergency Detection and Manual SOS Trigger. The MPU6050 constantly monitors the user's movements. Any sudden or unusual movements indicate a potential fall or dangerous situation. The SOS button can be pressed by the user at any time they need immediate assistance. Once an emergency has been detected, the ESP32 will control the emergency sequence. The GPS module obtains the user's location, and the GSM module communicates the emergency to registered contacts. Overall, the system can be expressed as Users Movements MPU6050 ESP32 Emergency Detected GPS Location GSM Alert Registered Contact
Manual Trigger: SOS Button ESP32 GPS Location GSM Alert Registered Contact This system was designed to be portable and provide fast emergency communications. It is a wearable device.

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OPERATIONAL WORKFLOW

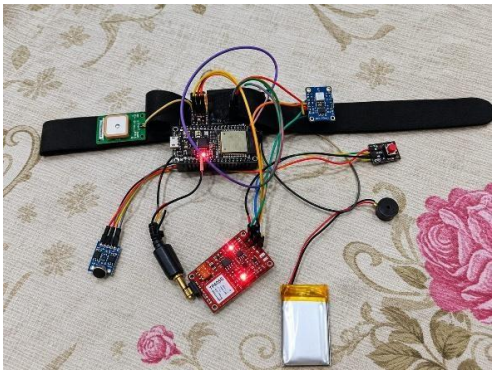
The operation of this safety band is as follows:

- Turn On – The rechargeable battery will provide power to the safety band. The On/Off switch will be used to turn the system on.
- Monitor Users Movements – The MPU6050 constantly provides movement data to the ESP32.
- Detect Unusual Movements – The ESP32 will process the movement data. Any sudden or unusual movements will be detected, indicating a potential fall or dangerous situation.
- SOS Button – The system also monitors the SOS button. The user can manually trigger an emergency alert.
- Emergency Detected – If a potential fall/emergency is detected or the SOS button is pressed the emergency will be triggered.
- Obtain Location – User location was obtained using the NEO-6M GPS module.
- Emergency Alert – The ESP32 communicates with the SIM800L GSM module to send an emergency alert with location information to registered contacts.
- Local Alerts – The buzzer will provide an audible alert, and the LED will provide a visual alert.
- Emergency Assistance – The registered contact will receive emergency information and location, which will allow assistance to be provided quickly.
- Give Warning – When the power crosses the selected limit, the LED and buzzer indicate the condition so the machine can be checked.

V. IMPLEMENTATION AND RESULTS

A. Prototype

The prototype was created as a wearable personal safety band. It uses an ESP32 microcontroller, MPU6050 sensor, NEO-6M GPS module, SIM800L GSM module, SOS button, buzzer, LED indicator, rechargeable battery, On/Off switch, and USB charging. The MPU6050 is connected to the ESP32 to monitor the user's movements. The SOS button can be used to manually trigger an emergency. Once an emergency has been detected, the ESP32 will trigger the emergency sequence. The GPS module obtains the user location, and the GSM module communicates the emergency. Local alerts are provided via a buzzer and an LED. The system was designed to be a portable wearable.



B. System Performance

There are two ways to trigger emergency assistance. The MPU6050 can detect any sudden movements or potential falls. The SOS button can be manually triggered by the user. Once an emergency is triggered, the user location is obtained via the GPS module. The emergency is communicated using the GSM module. Overall the system will provide the required functions that are needed. The system will detect emergencies, manually create an alert, obtain location data, and communicate the emergency.

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As stated in the project content, the system successfully provided a wearable solution for personal safety. The MPU6050 can detect falls or emergency situations, and the SOS button can be used to manually trigger an emergency.

VI. DISCUSSION

The personal safety band provides a fully integrated system for detecting emergencies. The MPU6050 can be used to monitor the user's movements and detect potential falls. An important aspect of the system is the manual SOS button. Not all emergency situations can be detected automatically so providing this button gives the user an extra way to request assistance. The GPS module can be used to obtain location data. This means not only informing the emergency contact that there is a problem but also telling them where the user is so that assistance can be provided. The GSM module can be used to communicate emergencies. The buzzer and LED provide local alerts. This system can be very useful for women, elderly people, children, patients, industrial workers, and people involved in trekking/adventure activities. As stated in the project presentation. The system can be worn meaning it is portable. The system can be improved by adding health-monitoring sensor, cloud connection, AI fall detection, and a mobile application.

VIII. CONCLUSION

The IoT-based personal safety band provides a wearable solution for detecting emergency situations and communicating the user's location to registered contacts. The system uses an ESP32 as the main controller. The MPU6050 detects any sudden movements or potential falls. The SOS button can be manually triggered by the user. If an emergency situation occurs, the user location is obtained using the NEO-6M GPS module. An emergency alert with the location is sent to registered contacts using the SIM800L GSM module. Local emergency alerts will be provided using the buzzer and LED. The system can be triggered using automatic movement detection and a manual SOS button. This can provide many ways to trigger emergency assistance. This system can be very useful for women, elderly people, children, patients, industrial workers, and other users who may need fast emergency assistance. Overall, the project combined embedded systems, GPS location, GSM, and wearable technology to provide a simple solution for personal safety. The system can be improved by adding heart rate and SpO_2 monitoring, IoT Cloud connection, AI fall detection, mobile application, and better battery life.

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