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Leveraging IoT Technology to Develop Innovative Safety Solutions for Women

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ABSTRACT
In 2023, the challenge of ensuring women's freedom and safety remains a significant issue in our society. Reports of physical violence, abuse, and other forms of violence against women persist, with an alarming increase in incidents, particularly in urban areas. Despite the advancements in surveillance technology such as CCTV, identifying perpetrators at the time of an attack remains difficult. To address these concerns, proposes the development of a Smart-Safety Device for Women leveraging Internet of Things (IoT) technology, with a focus on utilizing the A9G board. This initiative aims to empower women by providing a technological solution that enhances their safety and promotes self-sufficiency. The proposed device integrates multiple technological components to offer improved protection and response capabilities for women in vulnerable situations. Ensuring women's safety remains a pivotal issue in modern society. This research introduces the development of a personal safety device utilizing Internet of Things (IoT) technology, built around the A9G microcontroller platform. The proposed system aims to serve as a reliable and intelligent safety tool, enabling women to navigate public spaces with greater confidence. The device incorporates a variety of components and technologies, including GSM modules, pressure-sensitive resistors, impact sensors, Bluetooth connectivity, displays, resistors, transistors, diodes, light-emitting diodes, Arduino microcontrollers, and audible alerts. It also incorporates essential components such as PCBs, breadboards, transformers, switches, an Arduino compiler, and the Neo6MV2 GPS module to ensure comprehensive functionality and connectivity.

Keywords— Women Safety Device; IoT; Beat sensor,A9Gboard, Ladies Security, GPS module, GSM module, Drive resistive sensor.

I. INTRODUCTION

In recent years, technology has increasingly become instrumental in addressing societal challenges, with women's safety emerging as a critical concern. The rising incidence of harassment and violence against women underscores the urgent need for innovative solutions focused on personal security. In response, propose an innovative initiative: the development of a Smart Safety Device for Women employing Internet of Things (IoT) technology The Smart-Safety Device offers a comprehensive solution to address women's safety concerns. By harnessing the IoT capabilities of the A9G board, the device provides real-time tracking, instant alerts, and multimedia recording. These features are designed to enhance security and offer peace of mind for users in various settings. This innovation marks a significant advancement in utilizing technology to enhance societal safety. The proposed Smart Safety Device offers an effective, efficient, and portable solution designed to support women in leading safe and independent lives.

The Smart Safety Device is designed to be more than a mere gadget; it represents a comprehensive system aimed at empowering women by providing a dependable and efficient tool for ensuring their safety across various scenarios. By harnessing the capabilities of IoT, this device integrates seamlessly into the digital landscape, offering features such as real-time monitoring, communication, and emergency response to enhance personal security and confidence. Despite its status as a global power with substantial economic development, our country continues to grapple with numerous crimes against women. To address this issue, we introduce "FEMME," a specialized security device designed to support women in distress. "FEMME" leverages advanced technology to provide enhanced safety and prompt assistance in critical situations. By integrating cutting-edge features tailored to women's security needs, this device aims to significantly mitigate the risks and challenges associated with personal safety. Through its innovative approach, "FEMME" seeks to offer a proactive solution

to improving women's security and well-being. [13]. In an era where safety is of utmost importance, technological innovations are crucial in addressing societal challenges. One pressing concern that requires immediate attention is the safety of women. In response to this critical issue, we propose the development of an innovative solution: a Smart Safety Device for Women, leveraging the advanced capabilities of the A9G development board within the Internet of Things (IoT) framework. The A9G board, featuring robust functionalities such as GPS, GSM, and various sensors, forms the core of our smart safety device. This integration of advanced hardware and IoT technology enables the creation of a comprehensive safety solution specifically designed to meet the needs of women, offering enhanced security and real-time response capabilities. The proposed system features dual-layer security, allowing users to request assistance and transmit their location via an emergency number. The device can operate in three distinct modes, adapting to different scenarios. The device can be activated using either an alarm or Bluetooth connection. Once activated, the device automatically initiates the heart rate sensor, GPS tracking, and cellular communication modules. It is also equipped to emit a persistent sound to notify nearby individuals and enable rapid intervention. To ensure reliability and durability, the device includes precision power management and protection mechanisms against misuse.

In comparison to traditional tools such as pepper spray and smart bracelets, this device offers a robust and effective solution for improving women's safety in various situations. Women continue to face distressing incidents such as molestation, rape, and acid attacks. While various programs and devices are available, many are ineffective because they require manual operation. In high-risk situations, a woman's mental state may impede her ability to operate these devices manually. Therefore, a solution is needed that eliminates the need for manual intervention, providing an automated response to enhance safety and effectiveness. The concept behind the device involves monitoring specific indicators to identify potential risk based on physiological changes, such as variations in temperature and pulse rate, that occur when an individual is in danger. The device is equipped with temperature and pulse sensors that continuously gather data and transmit it to the cloud for analysis. [10].

II. LITERATURE REVIEW

This section reviews various advancements in women's safety equipment.

Suraksha [2] is a personal safety device designed to respond to sound, motion, and impact. It is capable of detecting these events and sending alerts accordingly. Another notable tool, FEMME [4], integrates robotic technologies to enhance safety. Its primary functions include sending alerts in suspicious situations, recording audio and video for evidence, and detecting hidden cameras using an RF receiver to identify the radio frequencies emitted by surveillance devices. A different approach is represented by a security device developed using the ATmega 328 microcontroller [5]. This device functions autonomously, without requiring an Android application, and features a simple on/off switch along with pulse and force detection capabilities. Once activated, the device employs energy sensors to send the user's location information to designated contacts. Utilizing GPS and cellular technology, the device provides real-time tracking of the user's whereabouts, transmitting this data to family and friends. This functionality ensures that the victim's whereabouts are communicated to emergency personnel promptly. Additionally, the device features audio circuits that can play pre-recorded messages to alert the surroundings. Kumar et al. [3] describe SMARISA [6], a portable safety device for women. The device utilizes a Raspberry Pi Zero and includes components such as a Raspberry Pi camera, a buzzer, and an activation button. Upon button press, the device captures an image of the assailant using the camera and transmits the victim's location data. This data is then transmitted from the victim's phone to law enforcement or emergency hotlines.

Another suggested tool functions based on geofencing, creating a virtual boundary that sends alerts when someone enters or leaves a specified area. The device offers two methods for contacting the victim's family or friends and includes a feature that allows the device to emit a sound even when in silent mode. The smart movement tool [1] can be activated with a double-click on the screen. While in operation, the device transmits the user's GPS location to designated emergency contacts and the local police department. The device is also fitted with a heart rate monitor and an impact-activated energy sensor, which sends the victim's location when triggered. Additionally, the device features a piezoelectric buzzer and two metal contacts that can deliver an electric shock if needed. The focus is on creating an intelligent wearable device designed to improve safety for women, utilizing Internet of Things (IoT) technology. This device is designed for everyday use and can be activated during emergencies. Once activated, it sends GPS coordinates to a dedicated Android application, allowing real-time tracking and monitoring of the user's location [11]. Women’s safety is an increasingly urgent issue worldwide, with rising rates of crimes against women. To tackle this challenge, a technology-driven approach utilizing the latest advancements can be pursued. The goal is to create a wearable device powered by IoT technology that uses voice recognition to support women during emergencies[12].

Unlike many existing safety devices that require manual activation, such as pressing a button or holding the device, the proposed solution provides a more seamless approach by using finger-based sensors for activation and response.

III. ARCHITECTURE:

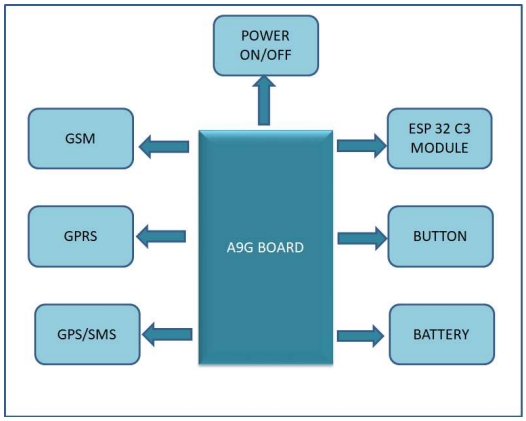

Fig 1. System Architecture

In fig.1 the A9G module, powered by the RDA8955 chip, is a highly versatile quad-band Gsm/gprs GPS module that offers a cost-effective solution for various IoT applications. GSM module serves as a vital intermediary for electronic devices to establish communication with one another via the GSM network. General Packet Radio Service (GPRS), commonly known as 2.5G, is a mobile data service that works on the second generation (2G) GSM network. It uses packet-switched technology to transmit data. Trilateration, on the other hand, is a technique used by GPS devices to pinpoint a location on Earth. This approach entails determining distances from several satellites by measuring the duration of radio signal travel from the satellites to the GPS receiver.

The ESP32 microcontroller series offers an affordable and energy-efficient option that integrates both Wi-Fi and dual-mode Bluetooth functionalities. Developed by Espressif Systems, a company based in Shanghai, China, the ESP32 series utilizes Tensilica cores and includes built-in amplifiers, filters, and power control modules. This microcontroller, made with a 40nm process technology by TSMC, succeeds the ESP8266, providing enhanced features and performance compared to its predecessor. The discussed women's safety equipment is designed to address critical issues related to personal security, providing a reliable solution for women who may encounter threatening situations. This device is engineered to be versatile and responsive, capable of activating under various circumstances to ensure the user's safety and prompt assistance.

IV. PROPOSED METHODOLOGY

The device's primary function centres on the Atmega 328 microcontroller, which acts as the main processing unit. This microcontroller is crucial for the device's operation, allowing for the seamless integration and coordination of different components necessary for efficient personal safety management.

A key feature of the device is its Global System for Mobile Communications (GSM) module. This module plays a vital role in real-time communication, enabling the device to send instant alerts to designated contacts, like family or friends, during an emergency. This capability ensures that the user's location and emergency signal are quickly communicated to individuals who can offer assistance. Additionally, the device is equipped with an auditory alert system, including a ringtone designed to draw attention in the surrounding environment. Fig. 2 illustrates the complete flow and functionality of the women's safety device.

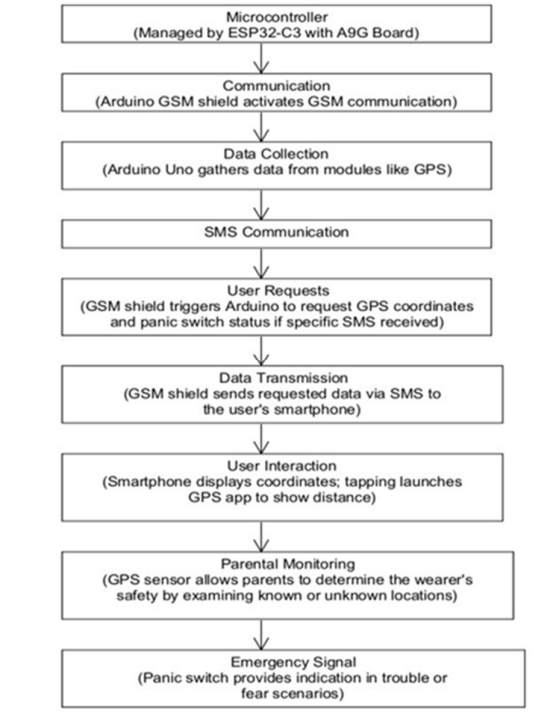

Fig 2. Data Flow Diagram

This feature is particularly useful in situations where the presence of a distress signal might deter an attacker or attract assistance from nearby individuals. The ringtone acts as an immediate auditory cue that something is amiss, prompting a swift response from those within earshot. For added protection, the device incorporates shock absorbers intended for self-defence. These shock absorbers are designed to deliver a non-lethal electric shock to an assailant, offering the user a means of defending themselves if they are physically attacked. The inclusion of this feature underscores the device's comprehensive approach to safety, addressing both prevention and protection.

Fig 3. illustrates the hardware configuration of the security device, highlighting the integration of these components. The configuration shows how the Atmega 328 microcontroller orchestrates the various elements of the device, ensuring that each component functions harmoniously to provide an effective safety solution. The design of the device reflects a thoughtful approach to women’s safety, combining advanced technology with practical features to address real-world concerns. The GSM module facilitates communication and alerts, the ringtone provides immediate environmental notifications, and the shock absorbers offer a defensive measure. Together, these components create a robust system capable of responding to a range of emergency scenarios, thereby enhancing the overall safety and security of the user.

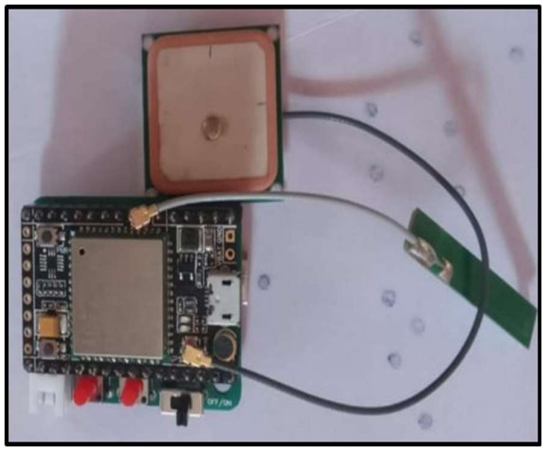

Fig. 3 Hardware Design for Enhancing Women's Safety

The device functions in the following manner:

1. Define the Project Requirements: Clearly define the functionalities you want your device to have, such as an SOSbutton, GPS tracking, sending alerts, etc.
2. Assemble the Hardware: Gather the necessary hardware components, including the ESP32-C3 microcontroller, GPS module, buttons, battery, and othersensors or peripherals you need.
3. Prepare the Development Environment: Install required software tools and libraries, including the Arduino IDE with ESP32-C3 support.
4. Design the Circuit: Create a circuit diagram for your hardware setup. Connect the ESP32-C3, GPS module, SOS button, and other components according to your design.
5. Write Firmware/Software: Write the firmware for yourESP32-C3. This involves programming the microcontroller to handle button presses, interact with the GPS module, and send SOS alerts. Implement power management to ensure efficient battery usage.
6. SOS Button Functionality: Implement the SOS buttonfunctionality. When pressed, it should trigger an alert, whichcould include sending a distress message and/or activating a loud alarm.
7. GPS Tracking: Integrate the GPS module to obtain location information. You can use the NMEA sentencesprovided by the GPS module to get latitude and longitude data.
8. SOS Alerting Mechanism: Decide how you want to send SOS alerts. You can use Wi-Fi, mobile networks, or both. Implement protocols like MQTT or HTTP forcommunication.
9. Server-Side Backend: Create a server-side backend to receive and process SOS alerts from the device. This could be a cloud-based server or a self-hosted server.
10. Alert Notifications: Set up a system to notify designated contacts when an SOS alert is received, such as sending text messages, emails, or push notifications.
11. Power Management: Optimize power consumption toprolong the device's battery life. This may involve putting the ESP32-C3 into sleep mode when not in use.
12. Conduct Testing and Debugging: Perform comprehensive testing to verify that all device functionalities operate correctly. Identify and resolve any issues, and optimize the code as necessary.
13. Enclosure Design: Design or select an appropriate enclosure for the device to make it portable and durable.
14. User Interface: Create a user-friendly interface for configuring the device, setting emergency contacts, and checking the status of the device.
15. Compliance and Certification:

Depending on your region, you may need to meet regulatory requirements for safety and wireless communication.

16. Deployment and Distribution: Ready the device for deployment, whether for commercial release or personal use. The circuit design includes three primary stages:

    - Power Supply
    - Oscillator
    - Voltage Amplifier

When the battery reaches full charge, it supplies power to the oscillator stage. The transformer then amplifies the oscillation frequency, functioning as an inverter. The transformed output is directed to the capacitor, which stores the electrical current and later releases it to deliver a shock to the attacker. Additionally, the design includes an Android interface for enhanced women's safety. The application offers a range of supplementary safety features.

1. Use this app to send group messages from thedevice to the victim's mobile phone.
2. The recorded information can serve as evidence for the victim against the perpetrator.

3. The mobile application will display a map indicating safe locations near the victim's current position, enabling women to navigate to a secure place from their present location.

Fig. 3 illustrates the design's effectiveness in addressing sensitive security concerns for women. because other devices are based on women pressing certain buttons or performing certain movements of the vehicle. But she failed because she didn't have time to respond. With this button method, if a woman is attacked from behind, she will also inform the neighbors and the police because the idea here is; if our devices use IoT authentication for one minute, it will automatically notify neighbors and police. In addition to sending notifications, the Android app can easily list victims and suggest nearby safe places.

V. RESULTS AND DISCUSSIONS

First, the GSM module needs to be installed and set up. Once the module is in place, the device will prompt the user to press a button to access it and verify their credentials. When the user activates the device by pressing the button, continuous monitoring is initiated, with the sensor being constantly checked for inputs. If the finger remains on the sensor for more than one minute, an audible warning will sound. At this point, the GSM module transmits a notification to all designated emergency (ICE) contacts, including the latitude and longitude coordinates obtained from the GPS module. Additionally, the Android application identifies and displays a safe location for the victim, as shown in the accompanying image fig. 4.

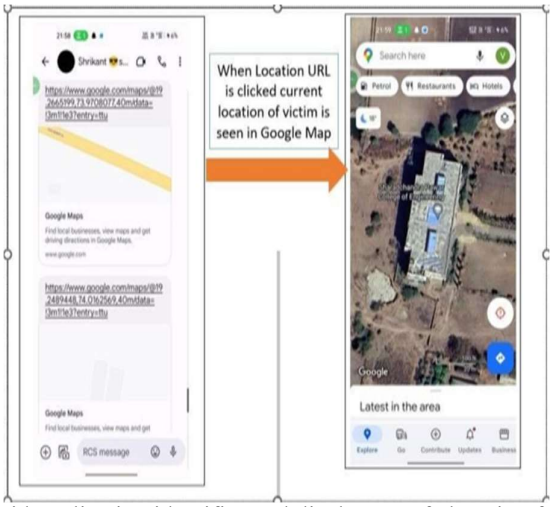

Fig. 4 Android application identifies and displays a safe location for the victim

VI. CONCLUSION AND FUTURE WORK

The recommended safety equipment for women is specifically designed to ensure their security in various situations. A Button serves as a unique identifier for the user, ensuring that alerts are only triggered in genuine distress situations, preventing the creation of false alarms. To enhance security, a buzzer is integrated into the design to alert nearby individuals in case of an emergency. The system also sends messages to inform next of kin and law enforcement of the victim's current location. Additionally, if a woman needs to defend herself, the device includes an electric shock feature to temporarily incapacitate the attacker.

A companion Android application offers additional security features, including group messaging, audio recording, and locating nearby safe places on a map. The companion Android application enhances security by offering a range of features designed for user safety. It enables group messaging, allowing users to quickly communicate with multiple contacts in case of an emergency. The app also includes an audio recording function, which can capture real-time audio as evidence or for personal safety. Additionally, it provides a feature to locate nearby safe places on a map, helping users identify secure locations quickly. These combined features make the app a valuable tool for personal safety, offering multiple layers of protection in potentially dangerous situations. This system presents a model of smart safety equipment for women, which should be further assessed using performance indicators to validate its effectiveness.

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