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IoT-Based Nerve Stimulator for Women's Safety

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Abstract - Women deserve a right to live free from intimidation, mistreatment, unfair treatment, and eliminating hurdles from a hazardous workplace can help them reach their maximum potential both personally and as contributions to economies, societies, and the workplace. Physical, emotional, and environmental safety have a variety of effects on wellbeing, including stress management, emotional stability, and physical health. The Women Safety System with Nerve Stimulator is a comprehensive system that integrates essential components for women's safety using an Arduino Uno microcontroller. It has an SOS button for emergency activation, a temperature sensor for environmental monitoring, a pulse oximeter for tracking health, a buzzer for auditory warnings, a relay for controlling other devices, a 5V DC vibration motor for tactile feedback, and a rechargeable battery for mobility. In an emergency, the Nerve Stimulator draws attention from nearby by producing controlled vibrations, which improves security. Ongoing global positioning system (GPS) monitoring guarantees accurate position awareness, and a buzzer warns users and anyone in the vicinity of possible hazards. The relay for controlling remote equipment adds to the system's versatility, while the SOS button triggers emergency actions like GPS location sharing. Rechargeable batteries provide continuous functioning, which in turn guarantees the dependability and efficacy of the system in protecting women's safety.

Keywords— GPS Module, SOS Button, Vibration Motor, Relay, Pulse Oximeter Sensor, Temperature Sensor

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1. INTRODUCTION

The National Crime Records Bureau (NCRB) 2022 report states that there were 4,45,256 incidents of crimes committed against women recorded in India in 2022—a 4% rise over a year earlier and about 51 first information reports (FIR) per hour. Women have a right to a life free from assault, harassment, and discrimination [1]. Eliminating the obstacles of a dangerous workplace can help women reach their full potential as people and as contributors to their jobs, communities, and economies. Women's safety is endangered in today's world, particularly in India. The number of crimes committed against women is rising alarmingly rather than falling, with harassment, molestation, eve-teasing, rape, kidnapping, and domestic abuse being the most common types. Numerous preventative measures have been put in place by the government to stop these disruptive behaviors, but they haven't had any effect on the rise in criminal activity. The Nirbhaya Fund was established by the government to support programs aimed at ensuring the protection and security of women [2]. The Ministry of Women and Child Development is the official body in charge of assessing and approving proposals and initiatives that will receive funding out of the Nirbhaya Fund. In the current year budget allocation, the fund has been raised as double for ensuring women's safety by this scheme [3].

In the modern world, protecting women's safety and security is crucial and requires immediate action. In both public and private settings, women are frequently the targets of threats and difficulties that can range from physical assault to harassment. To effectively address these issues and offer safety and assistance, creative solutions that take use of technological breakthroughs are needed. The phrase "Internet of Things," or "IoT," refers to a system of physically connected things that communicate and gather data. IoT sensors and gadgets can be deployed to monitor and react in real time to possible safety threats in the context of workplace safety. IoT gadgets such as wearables, smart cameras, environmental sensors, and equipment monitoring devices are examples of those utilized for security in the workplace. Through continual monitoring and notifications, preventative care, employee monitoring, enhanced compliance, and better productivity, IoT contributes to a safer workplace [4],[5]. Certain apps indicate safe/hazardous areas and indicate that women's protection is guaranteed. Disguised as watches, bracelets, pendants, key chains, and other items, there are smart gadgets that can detect threats and notify the designated emergency contact lists [6],[7],[8].

While previous studies have looked at how technology may be incorporated into safety solutions, such as environmental monitoring, emergency warning systems, and GPS tracking [9], there is still a need for complete and specially designed safety procedures for women. Prominent works like “One Touch Alarm” have made significant contributions to this field's breakthroughs and insights [10]. The devices for women security rely on an internet connection to track the user's whereabouts via GPS. These are restricted to educated women exclusively and can only be used with Android cell phones. It may not be long until the woman opens her cell phone, opens the smart app, and presses the SOS button. Further it is determined that the application is used to operate the women's alert system. The SOS number is included in the applications for security reasons, alerting the victim's family. There are some drawbacks to this as well: (i) The victim's cell phone could go missing, and (ii) A dead battery

In order to close this gap, the Women Safety solution with Nerve Stimulator combines several technologies into a unified, functional solution through annotating physiological signals into account. The system integrates essential elements including temperature and pulse oximeter sensors, a 5V DC vibration motor for tactile feedback, an SOS button, a buzzer for aural alerts, and an Arduino Uno microprocessor. A Nerve Stimulator raises the security ante by producing controlled vibrations in an emergency to draw attention from surrounding areas. It is designed to a portable gadget, such as a belt, that, in an unsafe circumstance, activates automatically whenever the pressure differential exceeds the limit set by the threshold. The woman is continuously monitored by a variety of sensors that are interfaced with an Arduino board. The physiological parameters are continuously measured and can be stored on the board for potential future use by the individual. The moment the woman presses the button, it comes on. To save lives, the device uses GPS and the IoT to broadcast the victim's present position in relation to the nearest police control room or use registered mobile numbers.

1.1 Scope of The Work

This initiative aims to create a comprehensive system that integrates IoT, AI and nerve stimulation in order to increase women's safety. It encompasses AI systems capable of building nerve stimulation technologies, incorporating IoT gadgets, and spotting dangers. With strong security features and intuitive user interfaces, the system aims to provide women with a reliable choice for personal safety.

1.2 Problem Definition

The project aims to address the issue of women's safety concerns and hazards in a variety of settings. This involves the possibility of violence, harassment, and assault, which can cause damage to the mind and body. The goal of this project is to provide a preventative safety solution that empowers women and gives them the means to improve their own security and well-being by utilizing cutting-edge technologies.

The structure of the paper is discussed here. Section 2 provides an explanation of the literature review on particular areas. The proposed technological features are discussed in more detail in Section 3. There is also a description of the software and hardware utilized. Section 4 discusses the findings. Section 5 concludes the report and outlines the future direction of this endeavor.

2. LITERATURE REVIEW

2.1 Wearable Sensors

As the primary data sources for monitoring user actions and physiological indicators in real-time, wearable sensors are crucial. Integrated into women's clothing or accessories, these sensors collect a range of physiological data and movement patterns to assess safety risks and initiate appropriate responses.

Gyroscopes and accelerometers track a subject's movements and posture, searching for any sudden changes or irregularities that can indicate discomfort or danger. Heart rate monitors and galvanic skin response sensors are examples of biometric sensors that track physiological signals indicating stress or anxiety levels. Location-tracking sensors also provide geolocation-based safety features and emergency response capabilities by continuously providing updates on the user's locations. Examples of these sensors include GPS and inertial measurement units (IMUs).

For the safety of women, Yadlapalli et al. [11] suggested a bracelet. A pressure switch on this device can be used to activate it, causing a cloud of tear gas to explode and an immediate safety warning to ring. Once the threat has been identified, the alarm will notify the nearest police station of the position.

A smart security band was developed by Kiran et al. [12]. It is linked via Bluetooth from the client's phone and has multiple sensors, including an integrated temperature sensor (LM35) to measure the victim's temperature and a heart rate sensor to detect heartbeat. Additionally, the smart band has a built-in database of human responses and behaviors from a variety of scenarios. Additionally, the user phone or linked mobile continuously recorded the body's movement, heart rate, and temperature—all of which are pre-installed in the mobile. When the pulse rate increases and danger is detected, a text message will be sent to a mobile device via the global system for mobile communication (GSM), and GPS will be used to figure out the location.

A safety device has been implemented by Akram et al. [13]. First, the device scans and stores the user's fingerprint. When the user starts examining the finger, the digital fingerprint is recorded for a duration of one minute. In the event that the fingerprint is not scanned, the device sounds an alert siren for the general public and sends the position and MSG to the family and police. In addition, a group messages (MSG) is sent and a shock wave generator is included for her protection. Audio is recorded by a sound sensor and sent to all contacts that have been stored on the mobile device. Wearable technology has been deployed by Kalpana et al. [14]. This system uses a number of sensors, including temperature, heart rate, flex, and sound sensors. If any four of these five sensors fire, it is deemed a threat scenario and the location is sent.

2.2 Real Time Monitoring and Alerting

In this study, the real-time surveillance system continuously examines data from the environment monitors, wearable sensors, and security cameras as a vigilant steward. As new data is received, advanced computational methods swiftly scan and identify any irregularities that could endanger public safety. As soon as something is detected, the system notifies the user and the appropriate authorities in a timely manner, guaranteeing that action is taken. Depending on the amount of threat, preset actions may be activated, such as making emergency calls or turning on nerve stimulation systems. This makes quick assistance and assurance possible. Because of its proactive surveillance and fast reaction times, the real-time monitoring system is an essential tool for guaranteeing women's safety in a range of situations.

Imtiaz Hanif et al. [15] suggested putting in place an integrated self-security platform based on the IoT. The gadget will be powered by a (li-poly) rechargeable battery that has a two-push trigger option. First, repeatedly press the alert button to initiate an automatic call to emergency mobile numbers and pre-saved relationships including family and friends. The general packet radio services (GPRS) and GSM sim800l modules will obtain the target's present position's coordinates if a single press is made. The data will then have been transferred via hypertext transfer protocol (HTTP), using the server locations and the attention instruction, to the relevant application. The speaker and microphone are extra features that are used to transmit voice messages from the safety device to the agency that is being protected. The application server continues to instantly use the SMS system to provide the relative's geolocation and emergency cell phone number.

2.3 User Controlled Activation

An essential component of this work is user-controlled activation, which gives consumers direct control over their safety. In reaction to perceived dangers, users can actively activate nerve stimulation mechanisms using user-friendly interfaces such as wearable devices or mobile applications [15]. This function makes it possible to quickly activate safety precautions, guaranteeing prompt aid in an emergency. Users may personalize activation settings using customization choices like recording criminals voice and video, which helps as evidence in filing case against them [16], [17]. User-controlled activation gives people the ability to take charge of their safety and improves their sense of security and confidence in a variety of circumstances.

2.4 Predictive Analysis

A key component of the research is predictive analysis, which uses historical information in conjunction with real-time readings of sensors to predict safety hazards. The patterns in customer conduct and environmental factors are found using machine learning algorithms, which allow the system to anticipate any dangers beforehand [18],[19],[20],[21],[22]. When elevated risks are detected, the system generates alerts and triggers preventive actions, such as activating nerve stimulation mechanisms or recommending alternative routes. Continuous refinement based on feedback ensures the accuracy and effectiveness of the predictive analysis, empowering women with proactive defense measures and enhancing their safety in diverse environments.

The summarization of significant efforts in this domain is captured in Table 1.

Table 1. Summary of Significant Efforts

Author	Security Device	Sensors	Alert Mode
Yadlapalli et al. [11]	Smart Bracelet	Pressure	Tear gas
Kiran et al. [12]	Smart Band	Body's movement, Heart rate and Temperature	Text message
Akram et al. [13]	Scanner	Fingerprint	Siren
Kalpana et al. [14]	Smart Belt	Temperature, Heart rate, Flex and sound sensors	Alert Message with location

3. RESEARCH METHODOLOGY

The Figure 1 shows a cleanly constructed visual representation of the proposed system's whole process. Our suggested solution is made up of sensors and an Arduino sensor tool that uses the IoT to continuously monitor the user. We suggested a belt-like portable device that, in an unsafe scenario, activates immediately when the pressure differential exceeds the threshold. In this project, we detect irregularities using temperature, vibration, and heartbeat sensors. The wearer can receive both automated and manual assistance from the safety wrist band. The accelerometer, heart rate sensor, and stress sensor on the wrist band are the sensors that make this feasible. The chip has the ability to record continuously measured physiological indicators, which could be beneficial to the individual in the future. The entire mechanism in this case is controlled by an Arduino UNO. Positioning is determined by the GPS. The gadget can transmit the assault victim's geolocation in relation to the nearest police headquarters or registered cell phone numbers in order to save their life.

3.1 Components of the Proposed Device

In aligned with the schematic diagram of proposed system, the following parts are utilized by the prototype:

- Pulse-rate Detector: A Pulse Sensor is a low-cost, plug-and-play heart rate monitor that measures pulse rate.

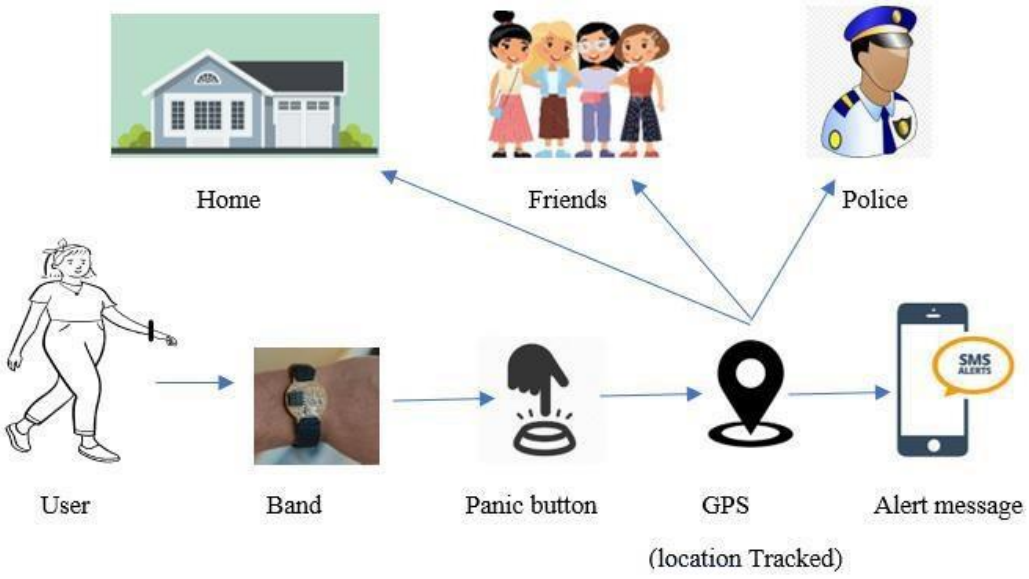

Figure 1. Schematic Representation of The Proposed System

- Pressure Sensor: The second sensor is the pressure sensor, which consists of a force-sensitive resistance with a circular sensing zone that contains a 0.5″ diameter. The force-sensitive resistors exhibit a linear response to applied pressure. Resistance and force applied are inversely correlated.
- Temperature Sensor: Compact and inexpensive, the NTC Thermistor temperature sensor module measures ambient temperature remarkably well. The environmental temperature of the surrounding atmosphere is measured by this sensor. The temperature range that can be detected is between 20 and 80 degrees of Celsius.
- Push Button: Whenever the button is pressed, two of the points come into contact, in order to activate the alert system.
- Relay: Relays enable low-power embedded systems to manage circuits that require significantly more power than the board itself is capable of providing. Although they are also utilized in homes, autos, and other electric applications, they are mostly used in industrial settings to regulate high power circuits.
- GPS module: GPS tracks a person's location in real time. We are using GPS in our project to track the victim's current location. The four pins that make up the GPS module are 5V, TX, RX, and GND.
- Vibration Motor: All industrial machinery that requires vibration energy, such as those in the agricultural, livestock production, and flour industries, the construction industry's required water tunnels for subways, roads, and hydroelectric power stations, and the metallic and a wooden concrete mold used to produce a ready-made concrete elements, use vibration motors. It can be powered by the integrated regulator on the board or by an external source of energy, such as a battery pack.
- Buzzer: A printed circuit board (PCB) may be used to mount this passive, 5V buzzer. Audio Alert is included into electrical designs through its use. The coil element uses a 5-volt source to generate an audible tone.
- Microcontroller: The Node MCU microcontroller is utilized in our project to control serial operations depending on a program that receives data through any of the four available ports and output. The Node MCU is capable of carrying out WiFi-related tasks. It is as well-liked as a WiFi module for this reason.

- Power supply: A 12 V renewable lithium-ion batteries powers the controller, which in turn provides the necessary power for each of the gadgets and modules that are connected to it.

3.2 Threat Detection and Prediction

Anomaly detection and predictive analytics algorithms are two examples of machine learning models that analyze data to find abnormalities and anticipate possible safety concerns. When safety concerns are identified or anticipated, thresholds are programmed to initiate pre-programmed reactions and alarms. Constant feedback from real-world events allows models to be improved over time, guaranteeing proactive danger identification and reduction and improving women's safety and security in a variety of settings [23],[24].

3.3 Alert Generation and Response

When abnormalities exceed certain thresholds, threshold-based alerts are set off, informing consumers through wearable devices, SMS, or smartphone notifications. Neural stimulation techniques are triggered either automatically or manually in the event of an impending attack, rendering prospective assailants momentarily immobile.

Emergency calls are made simultaneously to pre-arranged contacts or law enforcement, giving them access to GPS position monitoring and real-time information for prompt help. Users affirm that they have received notifications, reaffirmed their safety or asking for more assistance [22]. Strong security protocols protect system integrity and user privacy, guaranteeing efficient emergency responses and improving women's safety in a variety of settings.

3.4 User Interface and Interaction

Web portals and smartphone applications can be used to visually portray and browse safety data with ease. Real-time alerts can be provided by SMS, email, or via push notifications on smartphones and tablets, and users can personalize their safety requirements with adjustable settings. Activation controls provide quick reaction by making it easy for users to start nerve stimulation or calls for assistance. While accessible features assure inclusivity, robust security procedures maintain user privacy. Through user-centric design, the project gives women flawless control over their safety, encouraging trust and proactive participation in many scenarios.

3.5 Security and Privacy Measures

To ensure the integrity and security of user data transmitted via the IoT network, robust authentication and encryption methods are employed. Access control methods enhance user privacy by limiting unauthorized accessibility to private information and services. Emergency practices are also established to allow for quick action in emergency situations. These procedures contain preset actions for activating nerve stimulation equipment and contacting law enforcement or authorized contacts in case of an emergency. Programs for user tutorials and instruction are also conducted to familiarize users with safety protocols and give them the resources they need to effectively utilize the system's capabilities. Through these comprehensive security measures, program aims to give women a dependable and efficient way to improve their own well-being and personal security.

4. RESULTS AND DISCUSSIONS

The Women Safety Solution using Nerve Stimulator (see Figure 2) experiment's positive results show how well the system works to increase women's safety and security. Through the meticulous integration of key components such as environmental monitoring sensors, health tracking mechanisms, tactile and aural alert systems, and GPS tracking capabilities, the system provides total protection against a range of potential risks. Table 2 discusses the permissible sensor values.

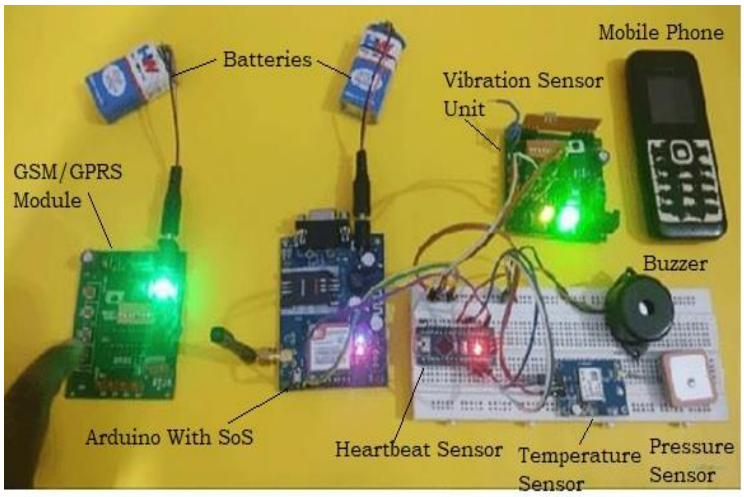

Figure 2. IoT based Nerve Stimulator

Table 2. Permissible Values of Sensors in Nerve Stimulator

Sensors	**Values**	
	Normal (≈)	**Abnormal (>)**
Vibration Sensor	0	1
Temperature Sensor	31C	40C
Heartbeat Sensor	60-90 beats per minute (bpm)	100 bpm
Pressure Sensor	1003 hectopascal (hPa)	1010 hPa

According to the results, the system makes it possible to quickly identify issues with user health and environmental circumstances, which promotes early action. Whilst SOS - emergency button and audio alarms offer quick means to express concern, the tactile feedback technique ensures enhanced situational awareness (See Figure 3). Furthermore, the ongoing GPS monitoring feature improves position awareness and allows for quick aid in an emergency. By drawing attention to the user's discomfort, the Nerve Stimulator's presence strengthens security even further. The Women Safety System with Nerve Stimulator has the ability to greatly enhance the protection of women by giving them with a proactive and dependable safety mechanism, as demonstrated by the project's overall results.

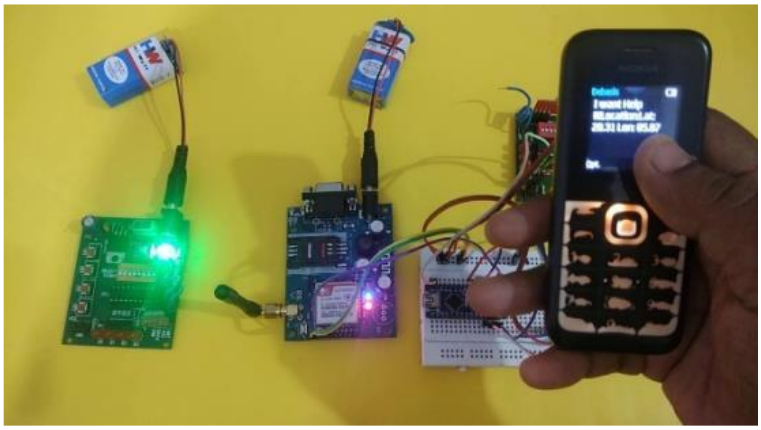

Figure 3. The Display of Alert Message

Rapid reaction times to safety events have been attained by real-time monitoring and alarm systems, guaranteeing prompt intervention. Machine learning algorithms have been used to precisely identify anomalies and possible dangers, giving women prevention strategies to avoid dangers. The incorporation of nerve stimulation and user-controlled activation methods has promoted self-efficacy and self-assurance. Strong privacy safeguards have preserved user confidence, and scalability guarantees accessible for a wide range of users. High user satisfaction, as indicated by early feedback, highlights the efficacy and dependability of the system. All things considered, the initiative shows encouraging progress in using technology to protect women in different settings.

Two wearable devices are provided by the proposed work: a smart wristband with physiological sensors to continuously monitor a person's health and a smart belt with a pressure sensor to automatically provide alert messages. This is intended to be used by women across all ages and educational levels. Learning and practicing this doesn't involve any stress. The design is incredibly user-friendly, straightforward, and transparent. The user only is required to put on it to be protected, and she can go wherever without worrying.

5. CONCLUSION

The proposed Women Security System using Nerve Stimulator is a significant advancement through the use of technology to the safety concerns of women. In order to improve women's safety and well-being, this device incorporates a number of contemporary components, such as a body temperature sensor, pulse oximeter sensor, buzzer, nerve stimulator, vibration motor, GPS, SOS button, relay, and rechargeable battery. The nerve stimulator's integration provides a unique form of protection that can help draw attention to the user's situation and deter potential assailants by providing controlled vibrations when unforeseen circumstances. A GPS receiver ensures real-time movement tracing in a situation of emergency, enabling timely assistance and response. The buzzer emits an immediate, loud alarm to alert the user and anybody nearby of any potential dangers.

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AUTHOR CONTRIBUTIONS

K. Revathi: Data Curation, Methodology, Writing – Original Draft Preparation;
W. Gracy Theresa: Conceptualization, Validation, Supervision, Writing – Review & Editing.

CONFLICT OF INTERESTS

No conflicts of interests were disclosed.

ETHICS STATEMENTS

The paper follows The Committee of Publication Ethics (COPE) guideline.

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