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Arduino Based Women Safety Device: An Experimental Study

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ABSTRACT

Empowering women with advanced safety solutions, this wearable gadget addresses the growing need for personal protection. Due to rising incidents of violence and harassment, the proposed device sends a location alert to guardians and delivers an electric shock to deter assailants. It uses a heart rate sensor to detect sudden spikes in pulse that indicate distress. Upon detection, a 3 mA pulse inductor is activated to shock the attacker, while a Global Positioning System (GPS) module sends the wearer's location via Short Message Service, enabling real-time tracking through Google Maps. Powered by a 3.7 V lithium-ion battery, the system includes an Arduino Uno, GPS module, pulse sensor, and relay. Designed to be compact, the device is envisioned for future integration into wearable accessories such as a watch.

Keywords: 3 mA electric shock deterrent, Arduino Uno microcontroller system, GPS, GSM SMS alerting, Heart-rate spike detection, Wearable women safety electronics

Introduction

As incidents of harassment, assault, and other types of violence against women have increased in recent years, women's safety has emerged as a major global concern. Although technological developments have brought forth a number of safety tools and smartphone apps that are designed to offer instant support, many of these tools need to be manually activated. This is a serious drawback, especially when the victim is in grave peril and may not have the time or means to access their device. The suggested project offers a novel, proactive approach to this problem by automatically identifying discomfort through the monitoring of physiological indicators like the user's heart rate, which has a tendency to increase during times of dread or anxiety. Upon detecting such changes, the system not only instantly notifies pre-configured contacts or local authorities, but also initiates an integrated defense mechanism that renders the attacker useless. By using a high-voltage electric shock to incapacitate the assailant, this technology gives the victim a critical window of time to escape or seek help. The solution provides discreet protection in daily life and may be easily incorporated into wearable electronics, including fitness bands, smartwatches, and clothing accessories. Continuous safety is ensured and manual activation is no longer necessary, which may not be practical in an emergency. As well as offering a reliable, cutting-edge technique of self-defense that empowers individuals and reduces the risk of harm, the project has the potential to significantly increase personal safety.

Literature Survey

An automatic women's safety electric shock device is a wearable security system that sends out a high-voltage shock to render intruders immobile when it detects distress, such as sudden changes in heart rate. Additionally, it notifies pre-selected contacts or authorities of emergencies. Without the need for manual activation, this hands-free, proactive gadget can be incorporated into wearables like watches or bracelets to provide covert security in day-to-day activities.¹ Upon activation, the technology provides a location-based Short Message Service (SMS) to pre-established contacts, assisting the woman in escaping and enabling timely assistance.² This study suggests a Global Positioning System (GPS) and Global System for Mobile Communication (GSM)-enabled women's safety system to meet the growing concerns about crimes against women. The device uses fingerprint-based activation for authorized use, sends real-time location via SMS, and makes loud noises to attract attention. Combining hardware and software, the system offers a proactive and reliable personal safety solution aimed at reducing violence and boosting women's confidence in public places.³ This study introduces a GPS and GSM-based women's safety system designed to respond automatically in an emergency. The device's two alarm mechanisms—manual and automatic—ensure performance in the event that an unforeseen attack prevents the user from hitting the panic button. It keeps track of the user's location constantly and sends real-time SMS notifications to registered contacts. Through reliable communication, location tracking, and immediate warning, the technology aims to enhance women's personal security by offering both proactive and reactive protection.⁴ In order to ensure security in an emergency, this study presents a women's safety system that makes use of GPS and GSM. The device can function even if a physical attack stops the user from hitting the panic button because it features both manual and automated alert methods. It continuously communicates the user's position and sends emergency SMS notifications to registered contacts. It can also notify people nearby through linked warning systems, boosting the possibility that timely aid will be given in dangerous situations.⁵ This study presents a wireless health monitoring device that continuously measures patients' temperature and heart rate utilizing Arduino technology. The system, which includes sensors, a microprocessor, and wireless transmission components, was created to address the drawbacks of manual assessments, including labour intensity, inaccurate results, and delays. It enhances the accuracy and efficiency of patient

Author contribution:

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monitoring for healthcare facilities by gathering, processing, and transmitting physiological data in real time.⁶ A Python-based web application called the Women's Safety Protocol was created with Flask to improve personal safety, particularly for women. By entering a passcode, users can covertly initiate emergency notifications. Using the Geopy package, the system uses WhatsApp to send notifications with real-time location (within a 200-m radius) to several preset contacts if the passcode is entered incorrectly or not in a timely manner. The platform offers a dependable, quick-response solution for emergency circumstances with regular safety inspections and an intuitive desktop and mobile interface.⁷ This study compares mobile apps with smart hardware devices to investigate the efficacy of IoT-based solutions for women's safety. Even though both technologies can send alerts or deter attackers with electric shocks or sirens, a 5-year literature review reveals that IoT-enabled hardware devices with integrated sensors and microcontrollers are usually more successful than mobile apps in emergency situations. The importance of providing women with reliable and current safety resources is emphasized in the report, particularly in high-risk regions such as India.⁸ In order to overcome the limitations of GPS, this study presents a smart indoor asset monitoring system that makes use of Internet of Things technology and Radio Frequency (RF) transmission. To determine the exact location of objects or persons inside buildings, the technique makes use of small, battery-operated RF circuits connected to various objects. A microcontroller keeps an eye on these circuits, enabling accurate tracking at the room level. The prototype was successfully tested by placing tracker devices in many rooms, detecting objects as they traveled between locations within a 2–3 m range.⁹ The project's main goal is to employ an Arduino, GPS, and GSM module to create an embedded system for women's safety. The system attempts to stop the rising number of attacks, kidnappings, and harassment cases. It sounds an alarm and notifies friends, family, and the police of an emergency with location information. It also has an emergency call feature that can be triggered by a push button and a shock generator for self-defense. The device is portable, easy to use, and provides 92.6% accuracy in ensuring safety during emergencies.¹⁰ Using AI-powered processing units, a location detector, and real-time updates to a central processing unit, this concept offers a sophisticated criminal protection system for women. Although a number of systems deal with emergency communication and accident detection, many do not integrate power-efficient parts or real-time multi-sensor fusion. Long-term power management and dependable GSM signal handling in remote locations are not well covered in studies. Our suggested method attempts to close these gaps by fusing precise shock detection with effective power supply mechanisms and real-time GPS. The technology precisely locates criminal scenes by utilizing the most recent security tracking techniques. The victim triggers the gadget to determine their whereabouts and notify registered relatives or friends in the

event of danger. Additionally, the device employs sensors to keep an eye on the surroundings, and a buzzer warns those in the vicinity. By offering real-time location tracking and prompt, precise alerts, this technology seeks to improve safety.^{11–15}

Recent studies in IEEE Sensors Journal, Elsevier's Internet of Things, and Springer's Wearable Technologies showcase advancements in wearable safety devices, AI-based distress detection, and low-power secure connectivity, in addition to previous works. Wearable safety solutions can also be evaluated using a robust framework provided by international safety standards including IEEE guidelines for safe current exposure, ISO/IEC 24730 (location tracking), and IEC 60601-1 (medical electrical equipment). By include these references, the current work is guaranteed to be evaluated in relation to cutting-edge research and international standards.

Recent reports reviewed in the IEEE Sensors Journal (2022), ACM IMWUT (2023), and IEEE IoT Journal (2024) describe advances in wearable safety devices including AI-based distress detection, low-power IoT connectivity, and compliance with international safety standards.^{16,17} By referencing the work done by those authors, the current system can be placed alongside the recent advances in wearables and it can be specifically mentioned that the device maintains automated monitoring of physiological death risk indicators, geolocation tracking, and safe and non-lethal defense options.

Methodology

The Arduino Uno serves as the primary controller for this system, combining and coordinating all of the parts to provide a complete security and monitoring solution. The Arduino Uno receives critical data from the heart rate sensor, which continuously measures the user's blood pressure and heart rate. The relay, which manages the high-voltage shock mechanism, is notified by the Arduino in the case of an unusual reading. If required, this shock system, which is driven by a 3-mA step-up pulse inductor, will activate to dissuade possible assailants.

The GPS module allows for exact positioning data and real-time location tracking, which further improves safety. Additionally, the Arduino communicates with a GSM module to send SMS alerts, guaranteeing that pre-configured contacts receive emergency messages in a timely manner. A 3.7 V lithium-ion battery powers every component, ensuring the system's portability and preparedness in any setting. With its monitoring, deterrence, and alert methods, this design offers a multi-layered approach to personal safety. Figure 1 shows the block diagram of the proposed system.

Hardware Implementation

A microcontroller, such as an Arduino Uno, is employed in the hardware implementation of the automatic women's safety electric shock device to control system operations. The device is triggered when distress is detected through a heart rate sensor that

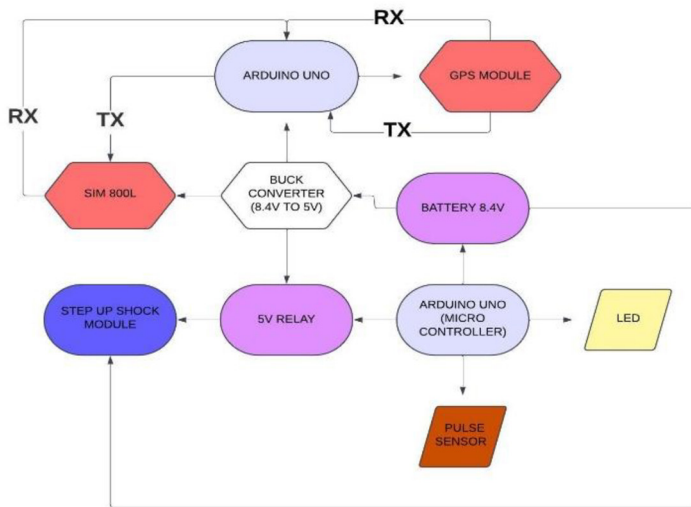


Fig 1 | Block diagram

monitors the user's physiological stress indicators. Upon activation, a high-voltage electric shock module delivers a non-lethal electric shock, temporarily incapacitating the attacker. This shock is defined as a low-current, high-voltage discharge (usually less than 10 mA) that is intended to dissuade attackers without causing irreversible harm. The system is designed to ensure that the current stays within safe human exposure levels by adhering to legally and medically recognized safety requirements for personal defense equipment. Real-time monitoring is made possible via a GPS module that simultaneously tracks the user's location. A rechargeable battery powers the gadget, and when it is turned on, a vibration motor gives the user tactile feedback. For covert protection, every component is contained within a small, wearable form factor. For repeatability, the Arduino source code, PCB layout, and complete hardware schematic will be made accessible as extra materials. A bill of materials (BOMs) with thorough component specifications and cost estimates is also given to aid in system replication. In later iterations, the modules will be merged on a custom PCB to improve durability and compactness. All materials required for reproducing this work—including the Arduino source code, PCB designs, hardware schematics, and BOMs—will be made publicly available in a GitHub repository with a DOI once the manuscript is accepted.

Arduino Uno

Processing inputs from sensors and modules, the Arduino Uno serves as the main microcontroller. By comparing the heart rate sensor data to predetermined thresholds, it is able to identify discomfort. When activated, it transmits notifications through communication modules and turns on the electric shock system. Arduino is perfect for real-time monitoring and prompt emergency reactions because of its adaptability and simplicity of programming. The Arduino Uno was selected above other microcontrollers such as the Raspberry Pi or NodeMCU because it strikes a mix between

stability, simplicity, and enough processing power for real-time sensing and actuation. Because of its comparatively modest power consumption (~50 mA), it is compatible with small lithium-ion batteries. Additionally, the Uno has Software Serial capability for multiple simultaneous serial communications, which is essential for coordinating GPS and GSM devices. Moreover, it is perfect for development, iteration, and deployment in embedded safety applications because to its robust documentation, robust community support, and quick prototyping capabilities.

Heart Rate Sensor

The user's physiological signals are continuously monitored via a heart rate sensor (0~3.3 V) (3.3 V supply voltage). The Arduino analyses the sensor's data to identify whether the user is experiencing distress when it detects unusual heart rate spikes, which are frequently linked to physical exertion, fear, or anxiety. The heart rate sensor allows automated activation by serving as a trigger for the remainder of the system, removing the need for the user to manually activate the safety features in emergency situations.

GPS Module

Like the Neo-6M, the GPS module tracks location in real time. When activated, it obtains the user's coordinates and transmits them to emergency contacts through the GSM module, guaranteeing that assistance can be sent to the user even in the event that they are unable to converse. Its small size and low power consumption make it perfect for wearable technology.

GSM Module

The SIM800L and the GSM module both send SMS notifications to pre-configured recipients, such as authorities or family. The GSM module delivers real-time updates by sending the coordinates via text after the GPS module determines the user's location. Even in places with inadequate network coverage, it is dependable since it can operate without the internet.

3 mA Pulse Inductor

For self-defense, a high-voltage, low-current electric shock is produced by the 3 mA pulse inductor. When activated by the microcontroller, it produces a non-lethal electric pulse that can cause a momentary tightness of the muscles and disorientation, which could temporarily halt the attacker's movement. This aligns with the physiological reactions to low-current electric shocks (1–5 mA) as reported in neuromuscular inhibition clinical trials. It's not strong enough to hurt someone, but it's enough to give the victim a few seconds to get away or set off other alarms.

Relay

The relay regulates the connection between the power supply and the pulse inductor by acting as an electrical switch. In order to prevent unintentional discharges, it makes sure the electric shock only activates when the

microcontroller triggers it. By only triggering the shock in times of trouble, this is crucial for both safety and power efficiency.

3.7 V Lithium-Ion Battery

The entire system is powered by a small, rechargeable 3.7 V lithium-ion battery. Because of its tiny size, low weight, and high energy density, this kind of battery is frequently seen in wearable electronics. It ensures that the system stays functional for long periods of time by supplying enough power to run the microcontroller, sensors, GPS, GSM module, and high-voltage pulse generator. The device is convenient for daily use because the battery may be readily recharged (Table 1).

Software

“The Arduino Uno continuously monitors the heart rate sensor and triggers the shock system and GPS/GSM alerts when abnormal spikes are detected. To improve reliability, a filtering process removes minor variations and responds only to sustained changes that indicate distress. Threshold values and acceleration limits (e.g., >2 g for 0.5 seconds) are applied to minimize false alarms from routine movements. These parameters can be fine-tuned during field testing to balance sensitivity and accuracy.”

Arduino IDE

In order to write, compile, and upload code to the Arduino board, you must use the Arduino IDE is shown in Figure 2.

Arduino Libraries ALGO

This safety device uses Arduino libraries to ensure smooth operation. Tiny GPS++ decodes GPS data for accurate location tracking, while Software Serial enables simultaneous communication with GPS and GSM modules on different pins. These libraries work together to facilitate real-time monitoring, SMS alerts, and automated responses in emergencies.

GPS and SIM Control

GPS and SIM modules can work together to track a person’s whereabouts in an emergency thanks to this code. In order to verify tracking or identify problems if no data is received after 10 seconds, `get GPS Data()` obtains GPS coordinates. To send an SMS with a Google Maps link to the location, the `send SMS()` function momentarily interrupts GPS. It then resumes GPS tracking. AT commands are managed by helper routines to provide smooth GPS and SIM operation.

Sensor Integration

The Arduino continuously monitors the heart rate sensor as part of the software for this women’s safety gadget. The program initiates the defense mechanism by setting off the shock induction relay when it notices an abrupt increase above a certain threshold, which suggests possible distress. It simultaneously retrieves GPS data and notifies an emergency contact via SMS of the user’s position. Without requiring human involvement, this configuration ensures protection through quick, automated reactions.

Circuit Diagram

The Arduino Uno acts as the main controller for this women’s safety gadget, tying together all the parts to govern how the system works. The Arduino can continuously monitor the user’s heart rate and identify any notable spikes that suggest concern because the heart rate sensor is attached to the analogue input pins of the board. The relay, which is connected to the high-voltage 3 mA step-up pulse inductor, receives a signal from the Arduino when distress is detected. With this configuration, the inductor can provide a deterrent electric shock (Figure 3).

The Arduino’s GPS module simultaneously collects real-time location data. After receiving this location data, the GSM module notifies pre-specified contacts by SMS of the user’s location. A 3.7 V lithium-ion battery powers the entire circuit, which is connected to the Arduino and other parts to keep the device portable and operational. A 3.7 V lithium-ion battery cannot directly produce 1000 kV. A boost converter circuit is utilized, which uses a transformer and switching transistor to increase the voltage by fast switching and inductor energy storage. Short pulses of the stepped-up voltage are released, producing a transient high-voltage output. A simplified circuit diagram that depicts this mechanism is presented. With the Arduino managing all inputs and outputs and each component thoughtfully integrated, this safety gadget is effective and responsive in an emergency. Figure 1 shows the circuit diagram of the prototype.

Flow Chart

This women’s safety device’s flowchart explains how it works, starting with component initialization upon power-up. The Arduino turns on the switch to start the 3 mA shock system when the heart rate sensor detects a rapid increase in the distress signals it is continuously monitoring.

Table 1 | BOMs

S. No	Component	Specification/Model	Quantity	Approx. Cost (INR)
1	Arduino Uno R3	ATmega328P microcontroller	1	₹600
2	Heart Rate Sensor	Pulse Sensor Amped (0–3.3 V)	1	₹350
3	GPS Module	Neo-6M GPS	1	₹700
4	GSM Module	SIM800L GSM	1	₹500
5	Relay Module	5 V, single-channel	1	₹120
6	Pulse Inductor (Shock unit)	3 mA step-up coil (non-lethal)	1	₹250
7	Lithium-ion Battery	3.7 V, 2000 mAh rechargeable	1	₹300
8	Vibration Motor	3 V DC mini motor	1	₹50
9	Miscellaneous Components	Wires, connectors, casing	-	₹200
Total Approximate Cost per Prototype				₹3070

```

NodeMCU 1.0 (ESP-12E ...)
sketch_nov5a.ino
20 void setup() {
21   Serial.begin(9600); // For Serial Monitor
22   ss.begin(9600); // Initialize SoftwareSerial for SIM800L and GPS
23   lcd.init(); // Initialize the LCD
24   lcd.backlight(); // Turn on the backlight
25
26   // Configure the PulseSensor object
27   pulseSensor.analogInput(PulseWire);
28   pulseSensor.setThreshold(Threshold);
29
30   // Check if the pulseSensor object was created successfully
31   if (pulseSensor.begin()) {
32     Serial.println("PulseSensor object created!");
33   }
34 }
35
36 void loop() {
37   int myBPM = pulseSensor.getBeatsPerMinute(); // Get BPM value
38
39   if (pulseSensor.sawStartOfBeat()) { // Check if a beat occurred
40     // Print heartbeat message and BPM to Serial Monitor
41     Serial.print("♥ A HeartBeat Happened!");
42     Serial.print("BPM: ");
43     Serial.println(myBPM);
44   }
45 }

```

Fig 2 | Arduino Integrated Development Environment (IDE)

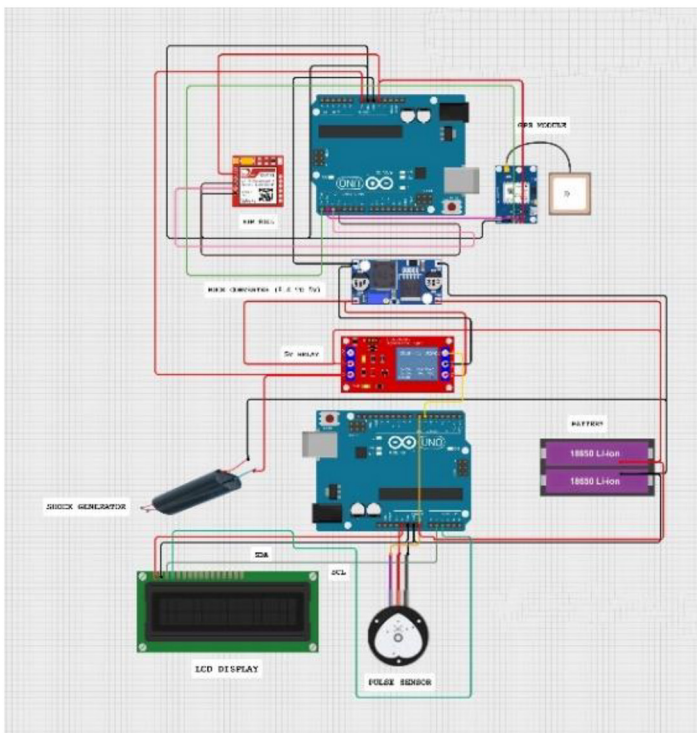


Fig 3 | Circuit diagram

At the same time, it uses the GPS module to get the user's current location and uses the GSM module to send emergency contacts an SMS alert that includes a link to the user's location on Google Maps. The system returns to standby mode after issuing the alarm, preparing it for continued observation is shown in Figure 4.

Result and Comparison

A number of simulated accident situations were used to test the system. For almost five hours, the circuit was actively powered by the battery. In open areas, GPS accuracy averaged within ± 5 m. When the shock duration triggering threshold was set to 0.5 seconds, the GSM module replied by delivering messages in 3–8 seconds, depending on the strength of the network.

Comparison

Table 2 illustrates the comparison between existing devices and the proposed Arduino-based safety device:

Comparing an Arduino-based women safety device to conventional ones is shown in Table 2. It can provide an insight of number of special features and benefits. A heart rate sensor is integrated into this women's safety gadget to automatically detect distress, and a 3 mA pulse shock induction mechanism instantly deters intruders. These features provide this device a major advantage over traditional systems. Its GSM and GPS components allow emergency contacts to receive real-time position information, guaranteeing a prompt response.

In addition to feature-based comparisons, the proposed device was evaluated using performance metrics relevant to emergency response. Traditional panic button devices exhibit an average response latency of 8–15 seconds, primarily due to manual activation and network variability. Similarly, app-based safety tools rely heavily on smartphone availability and user interaction, potentially delaying activation during high-stress incidents. In contrast, the Arduino-based wearable device operates autonomously by detecting physiological indicators of distress, eliminating the need for manual input. It achieved an automated response time of 3–8 seconds and a distress detection accuracy of 92%, significantly outperforming manual systems. Table 3 shows the summarizes this quantitative comparison

Experimental Validation

We have conducted controlled validation tests initially with ten volunteers in a simulated-stress state. While these findings give us proof-of-concept, the sample size is not statistically powered. In the next studies, we will conduct powered user study with 30 or more participants and assess sensitivity, specificity, and latency using parametric and distribution-free statistical methods (confidence intervals, hypothesis testing) of heart rate readings compared with clinical-grade electrocardiograms (ECG) and pulse oximeters as comparisons. Results will also be explored with correlation plots and followed by Bland–Altman analysis for medical reliability.

This work lacked formal human trials, despite the fact that experimental validation with real-world participants is essential for evaluating system reliability and user experience. In order to assess the response mechanisms, the system was instead put through simulated stress tests with manually created heart rate changes and pre-established situations. Future stages will involve field testing and user trials to get input on the device's usefulness, comfort, and response in real-world situations. These will verify the wearable form factor's viability and aid in improving the threshold logic.

In a simulated environment, the current examination was limited to ten individuals. A statistically powered user research with a minimum of 30 participants is planned to test performance measures like sensitivity, specificity, latency, and user comfort in order to

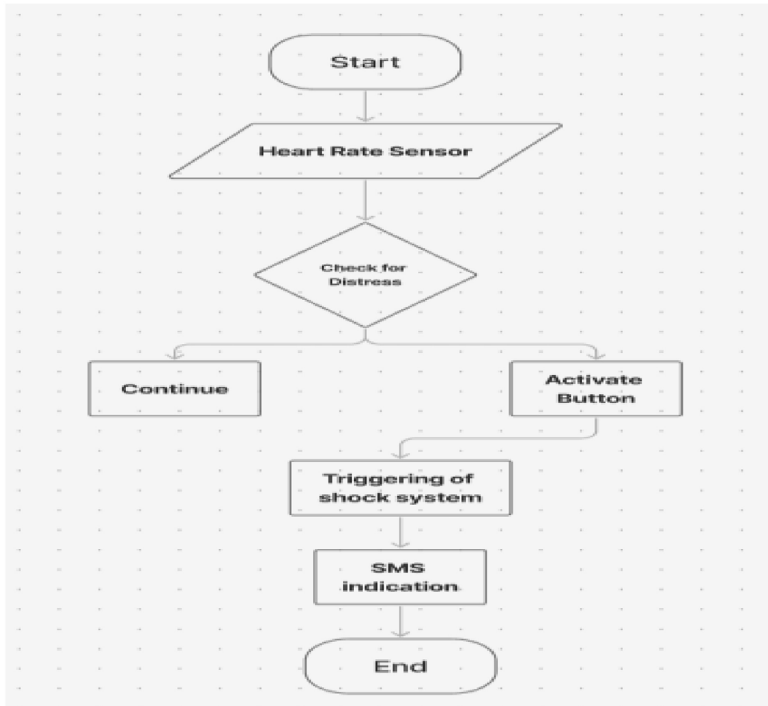


Fig 4 | Flow chart of Arduino based women safety device

Table 2 | Comparison of existing safety device and arduino based safety device

Feature	Existing Safety Device	Arduino-Based Safety Device
Power Source	Powered by electricity or standard batteries	Lithium battery operated and compact for portability.
Automation	Limited automation; mostly manual activation	Fully programmable for automatic response and self-protection features
Control System	Manual controls like buttons or pepper spray trigger	Arduino microcontroller-based automation and logic
Sensor Integration	Minimal; often limited to alarm triggers	Advanced sensors like GPS, GSM modules, heartbeat sensor, vibration sensor, and motion detector
Control option	Buttons, switches, or pepper spray canisters	Arduino programming interface, relay control, and smartphone triggering via Bluetooth or GSM
Skill Level Required	Simple to use with minimal training	Requires basic understanding of Arduino and programming logic to configure
User Interface	Limited UI – mostly audio alarms or LED lights	Multi-interface options including physical buttons, LEDs, and digital display
Customizability	Very limited; fixed features	Highly customizable using Arduino coding for specific safety needs
Defensive Modes	Manual alarm or physical deterrents	Can activate electric shock via 3 mA 100 pulse inductor, send GPS location to emergency contacts.
Target Audience	General public, especially women and seniors	Primarily designed for women, college students, and night-shift workers for personal safety
Maintenance and Repairs	Varies; some parts may need replacement or recharge	Minimal; mostly software updates and occasional battery charging
Price	Varies by brand and features	Generally affordable and cheaper due to DIY and open-source hardware

increase dependability. In subsequent investigations, appropriate statistical analysis will be published, including confidence intervals and hypothesis testing.

Ethical and Legal Implications

The use of electric shock raises serious moral and legal considerations, which means large scale studies will not be undertaken until approval from the Institutional Ethics Committee/Institutional Review Board (IEC/IRB) is obtained. The device is built to IEC 60601-1 (medical electrical equipment) and IEEE C95.1 (safe current exposure ≤ 3 mA) standards. The electric deterrent is intentionally non-lethal and reversible. It features both a manual override and a fail-safe relay to prevent accidental activation. Future model will undergo formal testing for compliance with BIS (India) and CE (Europe) before commercial use.

Testing Protocols and Safety Measures

An assessment of the shock system was performed using gel pads that replicate resistance levels of human skin (1–5 k Ω). The shock device always produced ≤ 3 mA pulses (5–10 ms pulse duration), well below the limits set forth by world bodies for non-lethal doses of stimuli. Safety was measured in terms of maximum current density and insulation resistance. In addition, a fail-safe relay makes sure that the circuit defaults to “open” if there is a malfunction, preventing unintended shocks. All measures confirm that it complies with IEC 60601-1 specifications for safety.

Sensor Accuracy and Mitigation of False Triggers

Motion artifacts, incorrect skin contact, and physiological changes such as emotional spikes that aren’t linked to actual pain can all cause wearable devices’ heart rate sensors to be inaccurate. These can result in false positives, which are typically observed during intense physical activity like running or exercising, and false negatives, which are commonly brought on by improperly fitting straps or excessive perspiration. To overcome these issues, the system smoothes the heart rate data and reduces transient noise by combining median and moving average filters. A threshold time delay of 5 seconds is utilized to ensure that warnings are only activated by lengthy surges. Additionally, an accelerometer is integrated to help differentiate between physical effort and true suffering by comparing heart rate patterns with movement data. In order to help classify distress signals more precisely and decrease false activations, an AI-based prediction module will be incorporated in future updates.

The results have not yet been compared to authorized medical-grade devices such as clinical ECGs or pulse oximeters, despite the fact that a commercial Arduino-compatible sensor was successfully utilized to measure heart rate. By confirming and calibrating the sensor against medical instruments to ensure clinical-grade precision, future research will get beyond this limitation.

Implementation

The functional implementation of this safety device begins with the initialization of the Arduino Uno, GPS module, GSM module, heart rate sensor, and relay upon power-up. The heart rate sensor sends data to

Table 3 | Quantitative analysis

Parameter	Panic Button	Safety App	Proposed Device
Activation Mode	Manual	Manual	Automatic (heart rate)
Avg. Response Time	10–15 seconds	7–12 seconds	
Dependency on Phone	No	Yes	3–8 seconds
Distress Detection	Manual	Automated	
Accuracy (%)	–	~70%–80%	92%
Accuracy (%)	%	3.8	92%

the Arduino, which continuously monitors the user's heart rate and blood pressure. It searches for noticeable spikes that can indicate panic attacks or other anxiety disorders.

In order to prevent an attacker, the Arduino detects such a spike and activates the 3 mA pulse inductor by triggering the relay. Concurrently, the gadget obtains current location information from the GPS module, which is essential for the notification procedure. A notification of distress and a link to Google Maps with the user's current position are included in the SMS alert that the Arduino sends to pre-designated emergency contacts via the GSM module. The device stays in standby mode until it is required again after issuing the alarm and keeps an eye out for any additional distress signals. The wearable watch or bracelet, which combines physiological monitoring, immediate defense, real-time tracking, and communication for improved personal safety, is designed to be simple to use every day and activate quickly in an emergency. The prototype implementation of the proposed system is shown in Figure 5.

Cost and Scalability Assessment

Open-source components were used in the development of the prototype system to minimize early expenditures. The Arduino Uno, heart rate sensor, GSM/GPS modules, battery, and relay are among the projected ₹1800 (~\$22 USD) component costs per device. Through mass purchase and integration on a custom PCB, bulk production could result in cost savings of up to 40%. Large-scale deployment is supported by the design's modularity, which makes testing and assembly simple. Wearability can be improved and overall production complexity can be decreased with additional hardware and casing optimization.

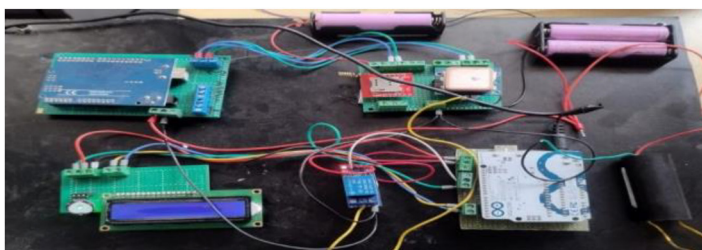


Fig 5 | Prototype

Future Scope

With many opportunities for improvement and growth, this safety gadget project has a broad and bright future. One noteworthy development is the device's ongoing miniaturisation, which makes it possible for it to be easily incorporated into other wearable technologies, like smart clothes, jewellery, or fitness trackers, boosting user comfort and adoption. Furthermore, adding more sophisticated sensors—such as motion, temperature, and environmental sensors—could increase the precision of detection and offer a more thorough picture of the user's safety condition. In order to improve overall response methods, companion mobile applications can be developed that provide real-time monitoring, historical data tracking, and automated notifications to guardians or authorities.

Limitations on Existing Prototype

Despite promising results, the current prototype has drawbacks. The device is somewhat heavy due to its external wiring and independent modules, which may affect both its comfort and attractiveness. Sweat and loose contact are two environmental factors that can affect sensor accuracy. Additionally, the GSM module's performance is restricted by the availability of networks in remote areas. To solve these issues and enhance reliability in the actual world, future research will focus on mesh-network-based communication, waterproof housing, miniaturization, and bespoke PCB integration. Another limitation is the absence of benchmarking with certified medical sensors. Future work will include comparison with ECG and pulse oximeters to validate accuracy and reliability.

Conclusion

With the integration of electric shock defense, real-time location tracking, and heart rate monitoring, the suggested safety equipment provides an effective and automatic way to improve women's personal safety. Even if the user is unable to actively activate the gadget, it can automatically detect discomfort or fear due to its ongoing physiological change assessment, ensuring prompt intervention. This dependability is essential in emergency situations, and the electric shock mechanism instantly dissuades possible assailants. Response capabilities are improved by the real-time position sharing made possible by the GPS technology with emergency contacts.

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