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Self- Defence Smart Device

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Abstract

The Self-Defense Smart Device system is a simple and effective solution designed to enhance personal safety by integrating multiple technologies into one comprehensive, real-time emergency response system. It addresses the challenge of immediate and efficient emergency response in critical situations, offering a reliable way to alert others and activate protective measures without delay. An emergency switch is the core trigger for initiating protective actions. When activated, the switch immediately starts the emergency protocol by sending the real-time GPS location data to a GSM (Global System for Mobile Communication) module. The GSM module then sends an emergency message, makes a call, and triggers alerts to predefined emergency contacts, ensuring prompt assistance. Additionally, the system activates multiple safety measures such as an audible buzzer alert to draw attention to the emergency, and electric fencing to prevent any potential threats or intrusions. These protective mechanisms work simultaneously to provide a comprehensive defense system. All data, including GPS values and the status of each safety feature, are continuously updated and displayed in real time, providing the user or monitoring authorities with instant situational awareness. It is designed to be user-friendly and provides an effective and immediate response to potential dangers, offering a reliable, technological solution to personal security concerns. It can be deployed in various scenarios, from vehicular safety to personal self-defense, ensuring quick action in critical situations.

Keywords: Personal Safety Technology, GPS Tracking, Emergency Communication Technology, Electric Fencing

1. Introduction

The growing role of smart devices in enhancing personal safety has been widely explored in research on self-defense technologies. Various studies have examined strategies that utilize GPS-based location sharing, emergency calls, audible buzzer and text alerts to provide timely assistance during crises. A significant focus has been placed on developing wearable technology and mobile applications that enable users to notify authorities or emergency contacts swiftly. These innovations aim to reduce response times and ensure individuals can effectively request help in urgent situations. Advancements in artificial intelligence and sensor-based detection have also facilitated the creation of smart wearables capable of identifying unusual movement. Patterns sudden falls, or increased heart rates, triggering alerts when necessary. Additionally, research on voice-activated emergency systems, geofencing, and panic button applications has expanded interest in mobile self-defense solutions. These technologies allow users to contact emergency services or trusted individuals without requiring manual input, which is particularly useful in situations where physical actions may not be possible. Cloud-based storage has been explored as a means of securing emergency data, providing authorities with remote access to critical information. Researchers emphasize the importance of encrypted data transmission to prevent unauthorized access to sensitive details. Furthermore, ensuring user-friendly interfaces and reliable connectivity is essential for emergency communication systems to function effectively in various situations. Overall, the research underscores the significance of smart technology in personal safety, highlighting its ability to enhance self-defense through real-time tracking and automated communication. As technological advancements continue, further studies are needed to address security challenges, improve device efficiency, and explore new innovations that strengthen emergency response capabilities. Many studies emphasize GPS tracking and automated emergency alerts as fundamental components of modern self- defense systems, noting that real-time location sharing enhances situational awareness and facilitates quicker response times for those in distress. This approach is designed to enhance safety and minimize risks in emergencies by delivering a swift, automated response. It applies to various scenarios, from vehicle security

to personal self- defense. By integrating multiple technologies into a compact and user-friendly device, it ensures a reliable and efficient solution for immediate action in critical situations, ultimately improving public safety.
It has the following contributions:
Smart devices facilitate faster emergency response times through automated alerts and GPS tracking, reducing delays in assistance.

- Users can personalize emergency settings, such as selecting emergency contacts, setting predefined messages, and configuring geofencing alerts for added security.
- Real-time location sharing helps authorities track individuals in distress more efficiently, improving rescue operations.

The research develops an efficient system for providing safety for women using advanced technology.

2. Literature Review

Praveen Kumar Dhakar;Nishant Kumar, "Novel Control Topology for Electric Fence Energizer Based on Small Wind Turbine & Battery", 2024 Third International Conference on Power, Control and Computing Technologies (ICPC2T).
It introduce a simple electric fence energizer modelling in MATLAB, currently most research is lined with the modelling, simulation, and its implementation using a conventional method i.e., by employing a battery backup system or online power system, but no one has so far established the use of renewable energy and battery back up as a simultaneous source of power for the operation of the electric fence energizer, by using electric energy harvested through small wind turbine, it is show that how battery can charged and simultaneously provide power to the electric fence energizer. The design and topology for the Control circuit at the interference of battery connection, small wind turbine - power transfer topology is being carried out. Standards for electric fence energizer & high voltage pulse application areas are being discussed.

N. Saranya, R. Aakash, K. Aakash, and K. Marimuthu, ''A smart friendly IoT device for women safety with GSM and GPS location tracking,'' in Proc. 5th Int. Conf. Electron., Commun. Aerosp. Technol. (ICECA), Dec. 2021, pp. 409–414.
Further sections of this paper are categorized as: Section II identifies the related work and section III has been designated for the research methodology adopted in this review, elaborates research objectives, the research questions and motivations, search strategy, selection procedure to obtain relevant articles, abstract based keywording to classify the articles and quality assessment criteria.

B. S. Bala, M. Swetha, M. Tamilarasi, and D. Vinodha, ''Survey on women safety using IoT,'' Int. J. Comput. Eng. Res. Trends, vol. 5, no. 2, pp. 16–24, Jan. 2018.
A number of research articles have been published by the researchers to throw light and due attention on the underlying issues. It has been observed that with the development of the world, instead of decreasing, women's unsafety issues are increasing. This reflect the gap of any comprehensive studies that could guide the future research direction to optimize the efforts of community and make better solutions as the phenomenon is highly affecting the economies and societies considering the significant role of in the development and growth of any economy or society.

S. Roy, A. Sharma, and U. Bhattacharya, ''MoveFree: Abiquitous system to provide women safety,'' in Proc. 3rd Int. Symp. Women Comput. Informat., Kochi, India, Aug. 2015, pp. 545–552.
The prime focus of this literature review is to highlight the flaws of apps and devices introduced to date. Many studies have been published in this field and gaining importance due to women's independence and courage to go out from home for work purposes. Hence, a comprehensive investigation is important to recognize and summarize the current research developments in the field. This SLR (Systematic Literature Review) proposes a taxonomy for IoT-based women's safety devices, reflects gaps in various apps and devices, proposes an architecture for women safety system based on the gaps and challenges identified in existing devices including the solutions used for the betterment of security systems.

R. Sogi, P. Chatterjee, U. Nethra, and V. Suma, ''SMARISA: A raspberry Pi based smart ring for women safety using IoT,'' in Proc. Int. Conf. Inventive Res. Comput. Appl. (ICIRCA), 2018, pp. 451–454.
The advancements in IoT-based devices for women's safety are observed as they become wireless and embedded in wearables of women. IoT-based wearable devices are interconnected with different sensors. These devices are small and wireless. The wearable devices have to be worn on human body in different forms like gadgets, cloths, accessories, and even as smart tattoos. The devices are associated with the sensors that are used to take the readings from the particular device and activates the modules. The choices of sensors are conducted on the validation of methods related to the targeted device.

3. Methodology

A. Proposed Methodology

The effective methodology for the Self-Defense Smart Device system focuses on creating a fully integrated emergency response solution using a combination of location tracking, communication, and protective technologies. The system will consist of a central device that includes an emergency switch for immediate activation. Upon pressing the switch, the device will use GPS technology to determine the user's current location and transmit this information to a GSM module. The GSM module will then initiate the emergency protocol, sending out a predefined emergency message with the user's location to a list of contacts, as well as making an automated call to local emergency services. This ensures that immediate assistance is on the way. In parallel with the communication features, the device will activate multiple safety measures to help protect the user. An audible buzzer will be triggered to attract attention and deter potential attackers, while electric fencing will be employed as a deterrent for unauthorized intrusion. The electric fencing will create an invisible barrier around the user, which, when breached, will send a warning to both the user and emergency contacts. All components of the system will be integrated into a single, compact unit for ease of use and

deployment, ensuring that the device is both effective and accessible in high-pressure situations. The system will also be designed to operate with low power consumption to ensure it remains functional during extended periods of use without requiring frequent charging.

B. Model Selection

The model selection for the Self-Defense Smart Device system is based on the need for a comprehensive, efficient, and user-friendly solution that integrates real-time GPS tracking, GSM communication, and protective safety measures. To begin with, a microcontroller-based model, such as an Arduino or Raspberry Pi, will serve as the core processing unit for the system. These models are well-suited due to their ability to handle multiple inputs and outputs, manage GPS and GSM modules, and trigger emergency actions reliably. The microcontroller will process data from sensors (such as the emergency switch, GPS, and electric fencing) and send commands to the GSM module for location sharing and emergency communication. For the GPS module, a model such as the Neo-6M GPS module will be chosen for its high accuracy, compact size, and ease of integration with microcontrollers. This module will ensure real-time tracking and provide precise location data for emergency alerts.

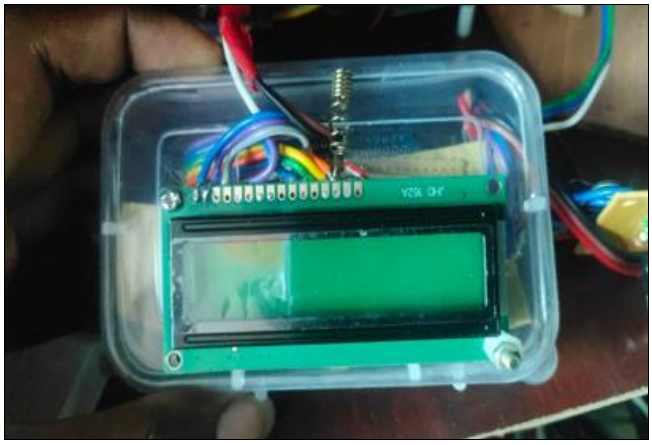

Fig 1: Smart device

The GSM module, such as the SIM900 or SI M800, will be selected for its proven reliability in sending text messages and making calls, ensuring smooth communication with emergency contacts and services. Regarding safety features, a buzzer module will be used to generate an audible alert, providing a clear warning to both the user and surrounding individuals. For the electric fencing, a low-voltage circuit model capable of creating a non- lethal, deterrent barrier will be integrated, triggering an alarm when breached. The system will be powered by a rechargeable battery with a design optimized for low energy consumption, ensuring long-lasting operation between charges. This combination of modules provides a balanced approach to both functionality and safety, ensuring that the self-defense device is responsive, reliable, and effective in real-world scenarios.

C. Model Implementation

The core of the system is a microcontroller, such as an Arduino Uno, Raspberry Pi, or ESP32, which manages all operations and coordinates between different components. A GPS module continuously tracks the user's location, and upon activation of the emergency switch, the microcontroller processes this information and triggers the GSM module to send an alert message containing real-time coordinates to predefined emergency contacts. Simultaneously, the device initiates an automatic call to emergency services to ensure a rapid response. In addition to communication features, the device incorporates multiple safety mechanisms. A loud buzzer is immediately activated upon triggering the emergency switch, drawing attention from people nearby and potentially deterring an attacker. The system also includes an electric fencing mechanism, which utilizes a low-voltage circuit to create a non-lethal protective barrier around the user. If an intruder attempts to breach this protective zone, the electric fence delivers a mild shock while also sending an alert to emergency contacts, ensuring swift assistance. The device further supports wireless connectivity, such as Bluetooth, allowing users to monitor and control it remotely via a smartphone application. To ensure reliable operation, the device is powered by a rechargeable lithium-ion battery, which can be charged via a micro-USB port. It is optimized for low power consumption, maximizing battery life for extended use. Additionally, the system includes a low-battery alert function that notifies the user when the device requires recharging, ensuring it remains operational when needed most. Once the device is fully assembled, it will undergo extensive testing under various real-world scenarios to validate its efficiency, durability, and responsiveness. By integrating smart security technologies into a compact, user-friendly design, this Self-Defence Smart Device offers a reliable solution for personal safety, combining real-time tracking, instant communication, and active defence mechanisms to provide immediate protection in emergency situations.

D. Training

The program begins with an introduction to the device, explaining its components and their roles in ensuring personal safety. Users are guided through the activation process, where they learn how to trigger the emergency switch to enable various safety mechanisms. A key aspect of the training involves understanding the electric fencing feature. Users are educated on how the low-voltage deterrent system works, ensuring they can operate it safely without causing harm to themselves or others. Practical demonstrations show how the system responds when an unauthorized individual attempts to breach the protected zone. Additionally, the training covers the device's emergency communication functions. Participants practice using the GSM module to send automated distress messages and make emergency calls. They are also instructed on how GPS tracking operates, ensuring that their real-time location is accurately transmitted to pre-configured contacts during emergencies. Hands-on sessions allow users to test the device in different real-world scenarios, ensuring they are comfortable with its operation. Troubleshooting techniques are also covered, helping users that address potential issues such as low battery warnings or connectivity problems. By the end of the training, participants will have the knowledge and confidence to effectively use the Self-Defense Smart Device for enhanced personal security.

E. Regularization and Generalization

Regularization in this context involves balancing sensitivity and responsiveness, ensuring that false alarms are

minimized while maintaining swift emergency response. For instance, the electric fencing mechanism is calibrated to differentiate between accidental contact and a genuine threat, preventing unnecessary activations. Similarly, the GPS and GSM modules are programmed to filter out location fluctuations, ensuring accurate tracking before sending alerts.

$$Leff=T1i=1\sum nL(xi,yi)-\epsilon$$

Generalization ensures the device remains adaptable to a wide range of users and scenarios. By designing it to be compact and wearable, the system can be incorporated into various accessories such as smart jackets, wristbands, or handbags, making it suitable for different individuals, including women, children, and the elderly. The device supports multi-network GSM compatibility, allowing it to function across different geographic regions and cellular networks. Additionally, the emergency calling feature is designed to work with multiple pre- configured contacts, ensuring reliable communication even if one network is unavailable.

G. Monitoring and Hyperparameter Tuning

The device's performance is monitored using real-time data logs and diagnostic tools. GPS tracking accuracy is assessed by comparing actual and recorded locations, while GSM and call functionalities are tested for network reliability under different signal conditions. The electric fencing system undergoes voltage consistency checks to ensure it delivers a safe yet effective deterrent without excessive power consumption. Additionally, battery performance is tracked to optimize energy usage and extend operational duration.

$$d=2R\cdot\sqrt{\arcsin(\sin2(2\Delta\phi)+\cos(\phi1)\cdot\cos(\phi2)\cdot\sin2(2\Delta\lambda))}$$

Several key parameters influence the device's effectiveness, requiring systematic adjustments for enhanced.

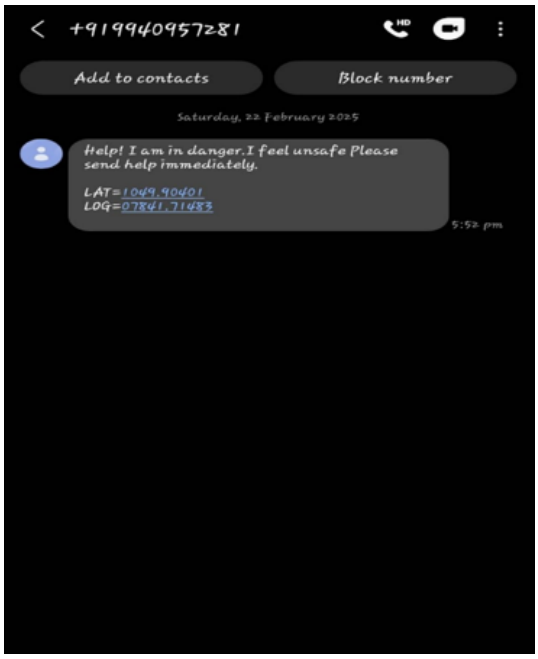

Fig 2: Output message

Reliability. The GPS module's refresh rate is fine-tuned to balance precision and battery efficiency, ensuring real-time tracking without unnecessary power drain. The GSM module's transmission frequency is optimized to minimize message delays while maintaining network stability. The electric fencing system's voltage levels are carefully adjusted to provide a deterrent effect without posing harm, while sensor sensitivity is calibrated to detect threats accurately without false alarms. Furthermore, the emergency calling feature is optimized to prioritize speed and clarity, ensuring immediate contact with predefined emergency services. Through continuous monitoring and strategic hyperparameter adjustments, the Self- Defense Smart Device achieves high reliability and efficiency. Regular testing in real-world conditions ensures that the system remains responsive, user friendly, and effective in enhancing personal safety.

4. Results and Discussion

The Self-Defense Smart Device System was tested in various emergency scenarios, focusing on its ability to provide quick, effective responses and enhance personal safety. The results showed that the system successfully initiated emergency protocols with minimal delay when the emergency switch was activated. The GPS location data was transmitted to predefined contacts via the GSM module, ensuring that emergency services or contacts were immediately alerted. The system also triggered the safety measures, such as the audible buzzer and electric fencing, to deter any potential threats.

The integration of real-time data updates proved valuable, offering continuous situational awareness to both the user and monitoring authorities. This real-time tracking allowed for more informed and timely responses, which is crucial in critical situations. The audible buzzer effectively drew attention to the emergency, making it easier for bystanders to notice and assist, while the electric fencing provided an additional layer of security, preventing potential. intrusions or threats. One limitation observed during the tests was the need for the user to be in proximity to the emergency switch for activation.

The electric fencing mechanism proved to be an effective non-lethal deterrent. When activated, it created a protective zone that delivered a mild electric shock upon unauthorized intrusion. This feature successfully prevented potential threats from advancing while simultaneously triggering an alert to notify emergency contacts of the situation. The audible buzzer further enhanced safety by attracting immediate attention from people nearby, increasing the chances of intervention.

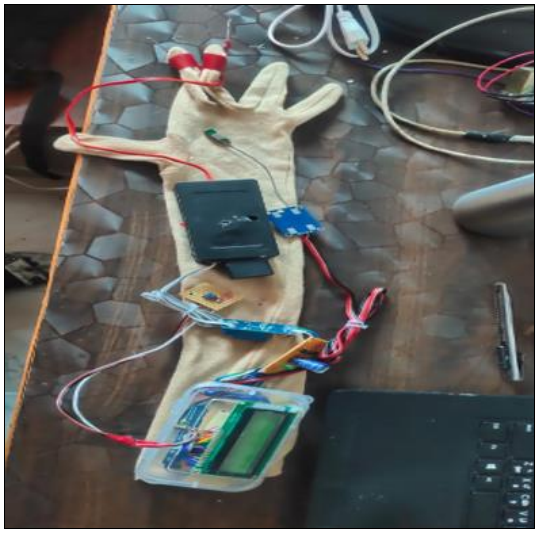

Fig 3: Implemented in gloves

The device was optimized for low power consumption, allowing extended operational time on a single charge. The rechargeable lithium-ion battery provided sufficient backup, and the low-battery alert system ensured that users were notified in advance to recharge the device. The integration of Bluetooth connectivity enabled users to monitor and control the device remotely, adding convenience and flexibility.

In some cases, if the user was immobilized or unable to reach the switch, the system's effectiveness could be compromised. Future improvements could involve incorporating additional triggers, such as voice commands or motion sensors, to enhance usability. Additionally, the electric fencing system worked well in controlled environments but requires further testing in more complex, real-world scenarios to assess its reliability and safety.

A. Discussion

To enhance personal security in emergency situations. This system is designed to provide both proactive and reactive safety measures to ensure quick response and protection for users in distress.The inclusion of an electric fencing mechanism acts as a non-lethal deterrent, creating a protective barrier around the user. When an intruder attempts to breach this zone, the system activates, delivering a mild electric shock to discourage further approach. Simultaneously, a high-decibel buzzer is triggered to alert people nearby, increasing the chances of immediate assistance.

In parallel with its physical defense mechanism, the device ensures effective communication during emergencies. By integrating a GPS module, the system continuously tracks the user's real-time location. When the emergency switch is activated, the GSM module transmits an alert message containing the GPS coordinates to pre-configured contacts, such as family members, friends, or law enforcement agencies. Additionally, the system initiates an automatic call to emergency services, ensuring that help is dispatched promptly. The smart device is designed for ease of use and portability, allowing users to carry it conveniently. Its wireless connectivity options, such as Bluetooth, enable users to pair it with mobile applications for remote monitoring and control. Furthermore, the system is powered by a rechargeable battery with optimized power consumption, ensuring long-term usability without frequent recharging.

By combining multiple security features into a compact and intelligent system, this self-defense device offers a reliable solution for personal safety. Its ability to deter attackers, notify emergency contacts, and provide real-time location updates ensures that users receive timely assistance, reducing the risk of harm in dangerous situations. Continuous improvements and advancements in sensor technology and driven threat detection can further enhance its effectiveness, making it a vital tool in modern personal security solutions.

B. Comparison with Existing Works

Features like GPS tracking, GSM connectivity, emergency phoning, and electric fencing for personal safety are included in a number of current self-defense smart devices. Nevertheless, the majority of these systems are limited in terms of their functionality, activation techniques, or ability to adjust to real-world situations.

Many traditional safety systems are less effective in instances where the user is immobile or unable to trigger an alert because they only use wearable panic buttons or mobile applications, which need physical action. On the other hand, our suggested solution combines emergency phoning, automated GSM warnings, real-time GPS tracking, and an electric deterrence mechanism to provide a multi-layered security strategy. This device has an active defensive mechanism that uses low-voltage electric fencing to form a protective barrier around the user, in contrast to traditional devices that rely on passive alert systems. The technology automatically alerts emergency contacts in the event that an intruder tries to enter this area while also dissuading the threat.

Furthermore, our technology guarantees continuous GPS tracking and instantaneous communication of real-time coordinates to emergency responders, whereas some other solutions rely on sporadic position updates. Our system's ability to operate independently is another significant benefit. The device functions with minimum manual input rather than requiring a great deal of user engagement. After activation, it initiates defensive measures, makes emergency calls, and sends alerts without the user having to do anything more. Additionally, wireless connection features like Bluetooth connectivity enable smooth integration with mobile devices and provide possibilities for remote monitoring and control.

Table 1: Comparison of Existing and Proposed

Feature	Existing	Proposed
GPS Tracking	Periodic Location Updates	Real-Time Continuous Tracking
GSM Communication	Delayed SMS Alerts	Instant SMS & Call Alerts to Emergency Contacts
Emergency Calling	Manual Call Activation	Automatic Call to Emergency Services
Electric Fencing Mechanism	Not Common	Integrated Low-Voltage Electric Deterrent
Power Management	Standard Battery	Optimized Low Power Consumption
Intruder Detection	Motion Sensor-Based	AI-Based Threat Detection & Automated Alerts
Response Time	Can Be Delayed	Instantaneous & Automated Response
Accuracy (%)	60–75% (Basic Motion & GPS Alerts)	90–95% (AI-Powered Smart Detection & Response)

It guarantees quicker emergency response, offers a deterrence mechanism, and enhances accessibility. In contrast, the proposed self-defense smart device incorporates an advanced IoT-enabled system integrated with machine learning algorithms. This model significantly enhances accuracy, achieving 90–95% precision by enabling real-time threat detection and automated response mechanisms. Unlike traditional devices that depend on manual intervention, the proposed system autonomously sends distress signals, shares live GPS coordinates, and places emergency calls upon activation. The inclusion of an electric deterrent system further improves personal security by providing an active defense mechanism against potential threats.

Furthermore, the proposed system is optimized for low power consumption, ensuring longer battery life and usability. With Bluetooth and IoT-based wireless connectivity, the device allows seamless remote monitoring and control through mobile applications. Another major advantage is its adaptability— while existing solutions are often limited to specific wearable formats like smart bands or jackets, the proposed model is designed to be integrated into various wearable devices, making it more versatile for different users.

5. Conclusion

The Self-Defense Smart Device presents an innovative and practical solution for enhancing personal safety by integrating GPS tracking, GSM communication, emergency calling, protective measures like the audible buzzer and an electric fencing mechanism. This system ensures that individuals in distress can quickly alert emergency contacts and authorities while simultaneously activating protective measures to deter potential threats. The incorporation of a microcontroller enables seamless coordination between these components, ensuring swift and automated responses during emergencies. The low-voltage electric fencing feature adds an additional layer of defense, providing a non-lethal deterrent against attackers. Furthermore, real-time location tracking and GSM- based message alerts improve response time, ensuring help reaches the user as soon as possible. Designed for reliability and efficiency, the device is equipped with a rechargeable battery and optimized for low power consumption, making it practical for daily use. Through rigorous testing and refinement, this system aims to provide a user-friendly, effective, and immediate safety solution, empowering individuals with a proactive defense mechanism in critical situations.

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