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Development of a Smart Women Safety ID with Real-Time Gas Detection and Crime-Aware Emergency Alerts System

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Abstract.

In many parts of the world, women's safety in public, educational, and professional settings is still a major concern. Conventional safety measures frequently depend on wearable technology or smartphone apps, which aren't always reliable in an emergency or covert enough to keep potential criminals from spotting them. This study proposes a clever and affordable women's safety ID card that offers both proactive and re active protection to overcome these drawbacks. This cutting-edge gadget incorporates essential technologies like a Bluetooth module (HC-05) for short-range device pairing, a SIM900A GSM module for emergency communication, a GPS module for location tracking, and an MQ2 gas sensor for hazardous gas detection. To ensure smooth operation at companies, educational institutions, and schools, the system is controlled by an Arduino Uno (ATmega328P) and housed in a standard ID card form factor. To detect the presence of dangerous compounds, including LPG, alcohol, and an aesthetic gases, labelled gas sensor data was used to train a supervised machine learning model, more precisely, a Random Forest Classifier. The model produced dependable real-time predictions with a high classification accuracy of 98.75% and strong precision, recall, and F1 scores. Furthermore, the system classifies areas as red zones by using historical crime data, such as location, crime type, and coordinates. The Haversine distance method is used to assess the user's real-time GPS data and calculate how close they are to these high-risk areas. An automated alert is set off if the user goes inside a predetermined danger radius of four kilo metres. A manual SOS button is another feature of the safety system that allows users to send emergency alerts via SMS with their position and threat kind right away, even when there is no internet connectivity. Only authorized users, like guardians or institution leaders, can access critical data, track user movement, and receive alerts thanks to the secure dashboard and user authentication offered by the supporting mobile and online application. The interface, which was constructed with Gradio and Folium, provides real-time viewing of red zone boundaries, position, and gas detection status. This integrated system is an effective instrument to increase women's safety because it not only guarantees situational awareness but also makes quick emergency reaction possible. Because of its scalable architecture, open-source. technologies, and low-cost hardware, it can be widely implemented in a variety of industries. The Women Safety ID Card is a step forward in utilising artificial intelligence and embedded systems to create safer environments and give women the freedom, security, and self-assurance they need to go about their everyday lives.

Keywords: Women safety · Smart ID Card · MQ2 Gas Sensor· Random Forest Classifier · GPS Tracking· Green and Red Zone Detection · GSM Communication · Emergency Alert System

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1. Introduction

Women's safety is still a major concern worldwide, especially in areas with insufficient social and physical protections. Incidents of aggression, harassment, and assault against women continue to occur in both public and private settings, despite technological developments and heightened awareness[1]. While helpful, traditional safety measures like wristbands, pepper sprays, and smartphone applications have drawbacks. During emergencies, mobile phones could not always be available, and obvious safety equipment could unintentionally warn attackers, decreasing the efficacy of the solution. These issues call for the creation of more discrete, dependable, and comprehensive personal safety strategies. The Women Safety ID Card is a new, non-intrusive, and multipurpose gadget that combines cutting-edge smart technologies with the comfort of a conventional identification card to improve personal security. Designed to resemble a standard ID card used in offices, classrooms, or universities, it covertly conceals features like a GPS tracking module, an emergency SOS button, and optional Bluetooth/NFC communication capabilities cite [2]. When the card is activated, it can transmit real-time location information to safety control centres or pre-registered emergency contacts, facilitating prompt assistance and situational awareness. This guarantees that consumers can get assistance quickly, even if they are unable to use their phones or speak to others. The stealth of the ID card type is one of its main benefits. It is perfect for emergency use because it avoids drawing too much attention by imitating a typical access card or ID badge. Furthermore, its versatility eliminates the need to carry around different devices by enabling interaction with current institutional systems, such as access control in offices or campuses. In addition to being convenient, the card's dual role guarantees that it is always carried, increasing its usefulness in an emergency. There are several difficulties in putting such a device into use, though. Technical obstacles that must be overcome include durability, false activation prevention, connectivity dependability in low-network locations, and power management in a small form factor. Moreover, the effective and broad implementation of this new instrument depends on institutional and public approval [3]. Cost-effectiveness is still another crucial factor to take into account. This solution may become more affordable and available to a larger market with the help of mass production, low-power components, and possible government or sponsorship support. By examining the Women Safety ID Card's design principles, technical architecture, and practical Title Suppressed Due to Excessive Length 3 application, as well as current technological trends and research in IoT-based safety devices, this paper assesses how this proposed system differs in terms of usability, privacy, scalability, and integration. By empowering women with intelligent, subtly supportive technology, we hope to make a significant contribution to a safer environment.

2. Literature Survey

Sangeetha K et al.[3] propose an IoT-based safety device designed specifically for women in distress situations. The system integrates an Arduino Uno with a SIM808 module, piezoelectric and accelerometer sensors, a panic button, and a piezoelectric buzzer. The core functionality is based on monitoring threshold values from the sensors; if exceeded, the device sends an automatic alert message with GPS location to pre-registered emergency contacts. Additionally, a manual panic button triggers immediate alerts, ensuring safety even without sensor activation. The prototype, through a three-stage operation (activation, location detection, and messaging), demonstrates a reliable self-defence mechanism. This solution addresses limitations in existing safety technologies by offering real-time tracking and communication without dependence on smartphones or internet connectivity. The authors suggest future enhancements like integrating voice recognition and camera modules using nanotechnology for better effective ness. The proposed device is a promising step toward empowering women with accessible and wearable safety tools that ensure both immediate alerting and cost-effective deployment in real-life scenarios.

Saranya N. et al.[4] presented a comprehensive IoT-based solution titled "A Smart Friendly IoT Device for Women Safety with GSM and GPS Location Tracking" in the proceedings of the Fifth International Conference on Electronics, Communication and Aerospace Technology (ICECA 2021). Their work in troduces a wearable smart band equipped with multiple sensors, including a heartbeat sensor, temperature

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sensor, panic button, and voice recognition module, all interfaced with an Arduino Nano microcontroller. The system is designed to track the health and location of women in real time and alert predefined emer gency contacts through GSM and GPS modules in case of danger. It operates autonomously, even when the user is incapacitated, by triggering alerts via body sensors. The paper emphasizes reducing human dependency during emergencies and enhancing reliability using an IVR system and real-time tracking through IoT. The authors highlight India's urgent need for such safety mechanisms, citing alarming NCRB statistics. Their work is a significant step toward integrating smart safety systems for women, especially in public and isolated environments, providing both prevention and immediate response capabilities.

JIN LIU et al.[5] presented a novel framework in their paper "Deep Learning Based Reasoning With Multi-Ontology for IoT Applications" published in the IEEE Internet of Things Journal (Vol. 8, No. 11, June 2021). The authors ad dress the limitations of existing IoT applications in reasoning and semantic understanding due to heterogeneous data sources and isolated ontologies. To over 4 P. Chatterjee et al. come this, they propose a deep learning-driven approach that integrates multi pledomain-specific ontologies to enable intelligent reasoning across diverse IoT environments. The system utilises semantic embedding through graph neural networks (GNNs) combined with long short-term memory (LSTM) networks for temporal data analysis. Their architecture allows for enhanced interoperability and automated decision-making, which is crucial in smart city and healthcare IoT applications. Evaluation results demonstrate improved reasoning accuracy and inference speed when compared to traditional ontology reasoning models. The proposed model also shows resilience to noisy and incomplete data, making it suitable for real-world IoT deployments. This work significantly contributes to the field by offering a scalable, efficient, and semantically enriched reasoning mechanism for multi-domain IoT systems, bridging the gap between symbolic AI and neural learning in context-aware environments.

Hariharan S. et al.[6] propose a practical and user-centric solution in their work titled "A Novel and Reliable SOS Alert Band System for Women Safety" to address the increasing concerns regarding women's safety. The system is designed as a wearable band that integrates various technologies like GPS tracking, biometric sensors, vibration alerts, and Bluetooth or Wi-Fi communication to deliver real-time emergency support. At the core of the system is an SOS but ton, which, when triggered, sends immediate distress alerts along with the user's precise location to emergency contacts or local authorities. The device also detects abnormal movements like falls or struggles and can autonomously activate alerts. It supports silent alerts in scenarios where verbal communication may not be safe and works in tandem with a smartphone app to log, manage, and forward critical information. The authors emphasize its discreet design, long battery life, and durable, waterproof construction, making it suitable for continuous use. The system enhances women's security, reduces emergency response times, and boosts confidence in vulnerable environments. Its integration with real-time tracking and automatic detection ensures fast and effective response, thereby offering peace of mind and an added layer of protection in critical situations.

Harsha B. K. et al.[7] propose a multifaceted IoT-based women's safety de vice in their 2023 IEEE conference paper titled "Empowering Women's Safety: A Comprehensive GPS and GSM-Enabled Automated Anaesthesia and Pepper Spray Defence System." This work addresses the critical issue of increasing vi olence against women by developing a self-defence mechanism that integrates real-time tracking and automatic protective responses. The system incorporates an Arduino Uno, GPS and GSM modules, a DC motor-driven anaesthesia injector, a pepper spray mechanism, a solenoid valve, and a buzzer. When activated in distress, the device deploys anaesthesia and pepper spray to incapacitate an attacker while simultaneously sending emergency alerts and location data to pre-registered contacts. The paper emphasizes autonomous operation, rapid re sponse, and deterrence. It also includes an LCD display and real-time updates via Wi-Fi. The authors highlight India's alarming crime statistics as a motivation, and the results demonstrate the system's potential to enhance women's Title Suppressed Due to Excessive Length 5 safety in public spaces. The device prioritises prevention and protection, making it a promising advancement in smart wearable defence systems.

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K. Venkatesh et al.[8] propose a wearable IoT-based wristband designed to enhance women's safety through real-time alerts and tracking. The device inte grates components such as a GPS module, GSM module, microcontroller (AT mega2560), neurostimulator, buzzer, and vibrating sensor. In case of danger, the user can activate the wristband, which sends emergency messages and live location details to pre-registered contacts using GSM. The device also features an electric shock mechanism to deter attackers and an alarm system to attract public attention. An Android app connects with the hardware via Bluetooth to support alert transmission. The system also includes applications for children's safety in school buses using GPS and speed monitoring. Testing showed high accuracy in triggering alarms and sending alerts. Overall, the proposed model offers an affordable, portable, and reliable safety solution for women and chil dren by combining IoT technologies with real-time communication and tracking systems.

Preethu Daniel et al.[9] propose a wearable smart band designed for women's safety, addressing the rising concerns over violence and assault. The device in tegrates a heartbeat sensor, a GSM module, a Lilypad Arduino microcontroller, an OLED display, and a push button. When triggered, the system sends emer gency alerts, including real-time location details, to preregistered contacts and law enforcement via SMS. This smart band monitors abnormal heart rate vari ations as a sign of distress and activates only during emergencies, minimising false alarms. The system is discreet, resembling a regular watch, making it less noticeable to attackers. Unlike traditional safety apps or loud sirens, this de vice operates silently and efficiently, even in areas with limited connectivity, ensuring continuous support. The use of SIM800L GSM enables reliable com munication globally, while the OLED display ensures low power consumption. The system also supports multiple users, allowing emergency contacts to be up dated dynamically through predefined SMS formats. Its design is scalable and can be repurposed for children, elderly individuals, and those with disabilities. The device offers a cost-effective, low-maintenance, and energy-efficient solution to personal safety concerns, with the potential to reduce crime through rapid alerts and precise location tracking.

Ashok K et al.[10] present an IoT-based wearable wristband designed to en hance women's safety through real-time health monitoring and emergency alert systems. The device integrates various sensors, including pulse, temperature, and vibration sensors, along with GPS and ESP32-CAM modules, all connected via Arduino and NodeMCU platforms. The wristband continuously monitors the user's vitals and detects abnormal conditions such as elevated heart rate or un usual vibrations. Upon detecting distress, it automatically updates the data to the Blynk app, notifies emergency contacts, and initiates live audio-video stream ing of the incident. GPS coordinates are also sent to the concerned parties for immediate location tracking. One of the key innovations of this system is its passive activation—users need not press any button to trigger alerts, enhancing 6 P.Chatterjee et al. reliability in critical situations. The compact and portable design ensures ease of use in everyday life. By eliminating manual intervention, the system provides a timely response, especially in scenarios where the victim is unable to react. It proves especially beneficial for women, children, and individuals with disabilities. This cost-effective and accessible technology holds significant potential in miti gating harassment and violence, offering users a sense of security and autonomy in public spaces.

V. Ebenzer et al.[11] focus on women's safety in India, specifically addressing threats faced through social media platforms like Twitter, Facebook, and Instagram. It highlights the increasing abuse, harassment, and lack of effective protection mechanisms for women online. The study discusses how user-generated data, such as posts and tweets containing abusive content or threats, can serve as critical indicators for detecting unsafe environments. The authors explore how machine learning (ML), the Internet of Things (IoT), and Android-based applications can be jointly leveraged to analyse online behaviour and respond to threats in real time. The research emphasises the limitations of current safety technologies, which often require manual intervention, and suggests smarter, automated systems that utilise supervised learning, sentiment analysis, and GPS-enabled wearables. By reviewing various technological frameworks and case studies, the paper proposes an integrated system capable of monitoring threats, classifying sentiment, and alerting concerned

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authorities promptly. It stresses the need for a comprehensive solution that operates across multiple platforms to ensure women's safety both in digital and real-world spaces. This work serves as a foun dation for developing scalable, intelligent tools to prevent cyber harassment and protect women using real-time analytics and behavioural data from social media interactions.

Gowrishankar et al.[12] introduce an innovative IoT-based Smart ID Card system designed to enhance the safety of working women in public and private environments. This smart ID integrates sensors such as a camera, vibrator, GPS, and microcontroller to detect emergency situations and automatically send alerts. When activated through a discreet button press, the device captures a photo of the potential attacker and transmits it, along with the user's real-time location, to emergency contacts and police via WhatsApp and cloud based platforms. Using the MQTT protocol and Twilio API, the system ensures rapid communication during distress. The ID card continuously monitors the environment, enabling predictive alerts through machine learning algorithms. In addition to emergency response, the card also supports real-time tracking for employers or guardians, improving security in both workplaces and public transit. The system is compact, user-friendly, and integrates with existing infrastructure, making it accessible for daily use. Moreover, the research explores enhancements like integrating biometric authentication, better sensors, and data encryption for improved reliability and privacy. This smart ID card provides a promising, tech enabled approach to women's safety, aiming to reduce harassment incidents and empower women with a dependable tool for emergency response and prevention. Title Suppressed Due to Excessive Length 3 Proposed Model Fig.1. Prototype of The Women Safety Card System

3. Proposed Model

Fig.1. Prototype of the Women Safety Card System

The main objective of the suggested system is to improve women's security in public, professional, and educational settings by providing a strong and technologically sophisticated Women Safety ID Card, as shown in Figure 1. Within the small form factor of a traditional institutional ID card, this innovative ID card combines real-time gas detection, emergency alert systems, dynamic red zone detection based on crime data, and a secure data access interface. The card features an inbuilt MQ2 gas sensor, which is capable of detecting toxic or unconsciousness-inducing gases such as smoke, methane, LPG, or other anaesthetic

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compounds, as shown in Figure 2. After being preprocessed and scaled by a MinMaxScaler, the sensor's analog data are sent into a Random Forest ma chine learning model that has been trained to correctly classify different types of gas. By sending an SOS alert and the user's real-time GPS coordinates to pre-registered emergency contacts and a linked mobile application, the system automatically initiates an emergency response if a suspicious gas is detected. Along with gas detection, the card has a manual emergency button that the

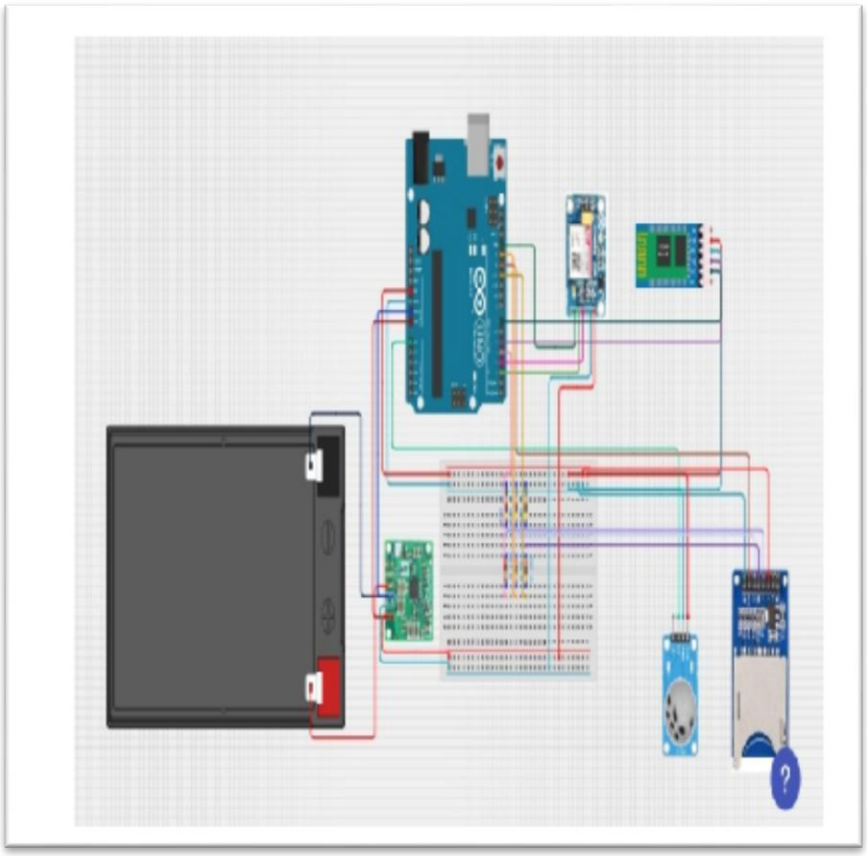

Fig.2. Circuit Diagram of a Women's Safety Card System

user may click to send out instant alerts in any emergency. The system makes sure that messages are retried until they are delivered, even in places with poor network or signal strength. User safety is greatly improved by this multi-layered detection and alert system against both anticipated and unexpected dangers. The model's location-based Red Zone Alert System, which provides an intelligent layer of prevention, is another essential element. "Red zones," or high-risk locations, including Central, North, and South Kolkata, are identified by the system using historical crime data that includes details about the type of incident, location, and timestamp. Any area that exceeds a predetermined crime threshold is designated as a red zone. Crime types, including theft, rape, and robbery, are aggregated per location. The system notifies the user and other authorised watchers in real time when they approach or come within a 4-kilometre radius of any such red zone centre, as determined by the Haversine distance. This Title Suppressed Due to Excessive Length 9 helps concerned authorities proactively monitor employee or student movement through secure access, in addition to enabling people to avoid dangerous areas.

The model employs a secure role-based access control mechanism to protect user privacy, limiting access to the data to those who have been verified and have valid login credentials (e.g., parents, guardians, or institution authorities). Using a web interface developed using Gradio and supplemented with Folium for

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interactive mapping, users can visually observe affected locations and verify the status of the red zone by entering coordinates. It is simpler to evaluate risk geographically with these maps since they are embedded with 4 km danger zone radii, based around recognized crime hotspots. Additionally, the ID card is made to serve as both a standard access card for attendance systems at work or school and a smart safety gadget. Because of its many uses, users are more likely to take it about regularly. Because of its subtle, affordable, and lightweight design, the technology may be widely deployed without interfering with daily life. All things considered, this approach combines real-time sensor intelligence, predictive analytics based on location and past crime data, and secure digital infrastructure to turn a standard identity card into a complete safety companion. By doing this, it not only guarantees a quick response in an emergency but also gives people the ability to take preventative measures depending on their environment. This idea has the potential to significantly improve women's safety and increase their involvement in the workforce and in education, particularly in rural or late-night locations. As a result, the system promotes the more general objective of creating a society that is safe, inclusive, and development-driven.

4. Methodology

A methodical combination of embedded hardware components, sensor-based environmental monitoring, real-time location tracking, GSM-based connectivity, and machine learning-driven analytics is used in the design of the proposed Women Safety ID Card System, as shown in Figure 3. The hardware implementation and data-driven technique utilised to create a small, smart, and preventive safety system are explained in detail in this part. The MQ2 gas sensor, GPS module, SIM900A GSM module, Arduino Uno (ATmega328P) microcontroller, Bluetooth module HC-05, and a 9V battery to power the circuit are the main hardware components cite l13. Assembled on a small PCB and encased in an ID card form factor, these parts are discrete and appropriate for everyday institutional use. For the detection of volatile and dangerous gases like LPG, methane, butane, smoke, alcohol, and anaesthetic gases, the MQ2 gas sensor is essential. It continuously checks the quality of the air, and the Arduino Uno processes its analog output. At certain intervals, the sensor values are read and sent via se rial communication to a smartphone or connected device for additional analysis. After that, MinMaxScaler is used to normalize these raw sensor values into a scale between 0 and 1, guaranteeing that machine learning algorithms can use them[14]. The normalised sensor value is used to classify the presence and kind of gas using a Random Forest Classifier model that has been trained on labelled gas datasets. An emergency occurs if the prediction indicates that a hazardous gas is present in excess of the safe threshold. The system simultaneously gathers current geographic coordinates, such as latitude and longitude, using a GPS module. In addition to tracking the user's current location, these coordinates are utilized to identify if the user is in or about to enter a Red Zone, which is a high-risk crime area. The SIM900A GSM module transmits the GPS data, sending pre-registered emergency contact numbers an SMS with the user's location and the type of emergency (manual SOS trigger or gas detection)[15]. The victim can be quickly located thanks to the emergency message's specific positions and timing. Retry techniques are incorporated in places with spotty GSM coverage to guarantee effective message delivery after connectivity is re stored. It has a discrete emergency push button built into the card, as well as automatic gas-triggered notifications. When the user presses the button, the sys tem immediately sends an emergency SOS and the current GPS coordinates to all designated contacts, bypassing the gas detection logic. When there is no gas detection trigger and the user feels frightened, this feature is quite helpful cite l16. The HC-05 Bluetooth module connects to an Android-based safety app via short-range communication. Real-time visualization of gas levels, location up dates, red zone status, and system health is all made possible by this link. If the user is not online, the Bluetooth capability also facilitates local storage synchronization, allowing data backup and upload upon reconnecting. This approach uses a dataset that combines information on crime and the environment. Location, Crime_Type, Date, Time, Latitude, Longitude, and Gas Detector Values are among its fields. Incidents classified as critical threats, such as robbery, theft, and rape, are included in crime reports[17]. The frequency of these incidents by region is calculated using the dataset to create a crime heatmap. Using this data, if a location's crime rate exceeds a predetermined threshold, it is designated as a Red Zone. Using the Haversine distance formula, the system

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determines the user's proximity to these zones. If the user is within 4 km of a red zone center, an alert is generated to alert the user and the app interface. The data preparation phase handles all preprocessing procedures, including date-time formatting, outlier elimination, coordinate validation, and label encoding. Accuracy, precision, recall, and the confusion matrix are among the metrics used to assess the Random Forest model after it has been trained on gas data with matching labels. Joblib is used to serialize the scaler objects and the final trained model, which are then included in the system for real-time inference. Python's pandas, numpy, and geospatial libraries are used to implement the red zone categorization logic and distance tests. Users can view red zones and their location on an interactive Folium map by entering live coordinates using a Gradio-based graphical user interface. To ensure data privacy and secure usage, the dashboard is only accessible to authenticated users with proper credentials. To give women prompt, intelligent protection in public places, workplaces, and educational institutions, this methodology offers a multi-layered safety system that combines real-time gas threat detection, dynamic red zone warning based on crime history, secure alert communication, and live tracking. The model is perfect for scalable adoption

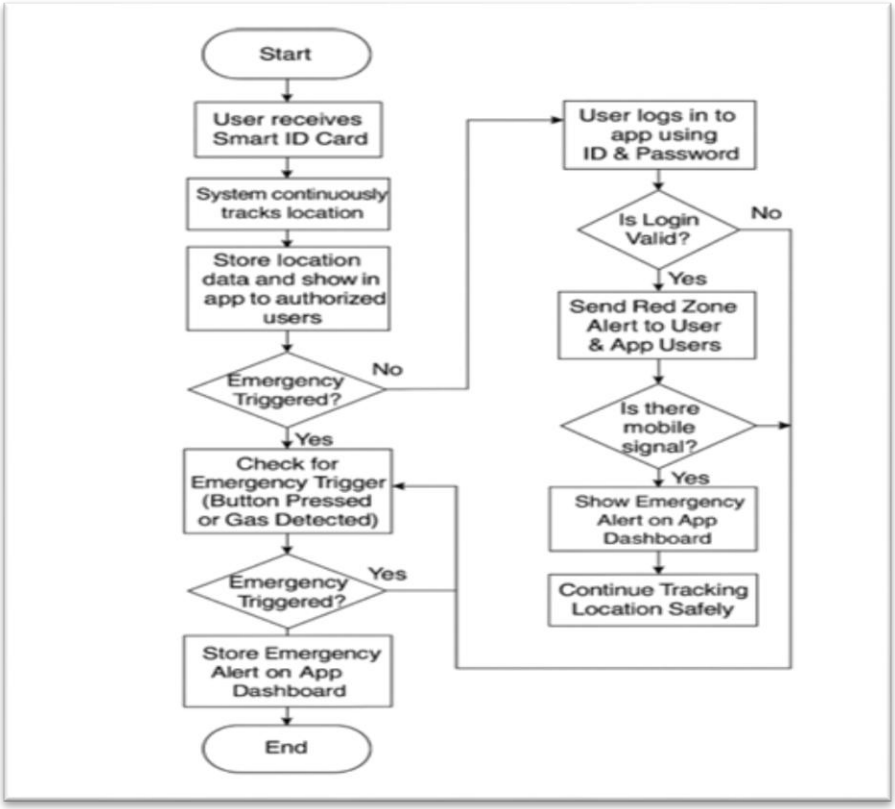

Fig.3. Working Flowchart of the Women Safety Card System

across various institutions because of its adaptability, low power consumption, and reasonably priced hardware components, giving women the assurance to work, travel, and study in a safer setting.

5. Result Analysis

The Women Safety ID Card was developed and implemented using a methodical process that included secure communication infrastructure, machine learning based classification, and hardware

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integration. This smart safety system integrates user authentication, intelligent alerting, and environmental sensing into a discrete, portable gadget that can be used in the real world. The MQ2 gas sensor, which can identify a variety of dangerous chemicals such as LPG, alcohol, and anaesthetics, is the basis for the system's real-time air quality monitoring. The analog numbers that the sensor produces fall between 0 and 1023. These values served as the foundation for a supervised learning dataset and were labelled based on the type of gas. MinMaxScaler was used as a preprocessing tool to standardise the dataset's values between 0 and 1. A robust classification model was constructed using an 80:20 train-test split. The Random Forest Classifier was used to categorize different types of gas because of its high accuracy, robustness against overfitting, and capacity to handle non-linear relationships. An ensemble learning method called Random Forest builds several decision trees and aggregates their results to provide predictions that are more accurate. The model's performance was assessed using common measures following training

Table 1. Assessment Metrics for the Random Forest Model

Performance Metric	Score
Accuracy	0.9875
Precision	0.9882
Recall	0.9875
F1-Score	0.9875

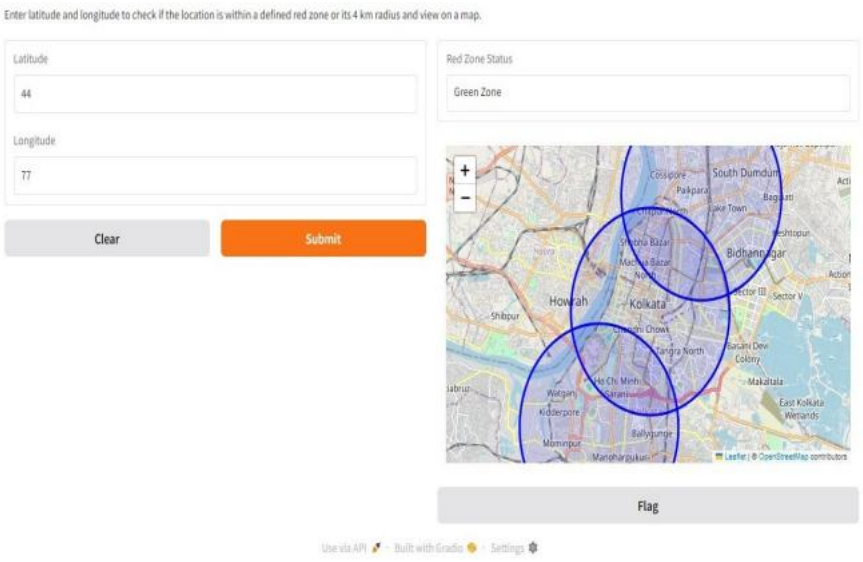

Fig. 4. Green/Red Zone Detection Based on the User Location

With an accuracy of 98.75%, precision of 98.82%, recall of 98.75%, and an F1 score of 98.75%, the outcomes were outstanding, as shown in Table 1. These numbers show that the model can identify dangerous gases with a high degree of accuracy and dependability, which makes it ideal for use in life-or-deat

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Fig. 5. Gas Detection Result using the trained ML Model

safety systems. For real-time predictions, the scaler (mq2_scaler.pkl) and trained model (mq2_model.pkl) were stored and incorporated into the card. In addition to gas detection, the system has a crime-awareness module that makes use of historical crime data, which includes geographic coordinates, dates, times, location names, and crime types. Robbery, theft, and rape were identified as high-risk crimes. After analyzing this data, the algorithm identified high-occurrence-rate areas, which were subsequently designated as red zones. A preventive alert is sent to the user and authorized stakeholders when the user's GPS coordinates are within 4 km of any red zone (as determined by the Haversine distance formula), as shown in Figure 4. Even without internet access, users can send emergency messages right away with the SIM900A GSM module thanks to the card's physical SOS button. The alert message contains the threat type that was detected as well as the user's current location. Furthermore, the HC-05 Bluetooth module enables local connectivity with a mobile device, enabling the continuous display of status updates and gas readings, as shown in Figure 5. Only authorized users can access sensitive data thanks to a user authentication mechanism built into the system's mobile and web-based applications. To view their dashboards, which show current gas measurements, red zone alerts, movement history, and emergency reports, users must log in with legitimate credentials, as shown in Figure 6. The interface, which was created with Gradio and Folium, offers a simple platform for map-based red zone display and real-time tracking, as shown in Figure 7. The login system allows institutional surveillance, safeguards user identification, and guarantees data privacy. The cost-effectiveness of this technology is among its most important benefits. The gadget is inexpensive for schools, colleges, workplaces, and even individual users because its hardware components—which include an Arduino Uno (ATmega328P), an MQ2 gas sensor, a GPS module, a SIM900A GSM module, a Bluetooth HC-05, and a 9V battery—are widely accessible and reasonably priced. Software development expenses are further decreased by using open-source Python modules for web deployment and machine learning. By eliminating costly proprietary platforms and concentrating on off-the-shelf, modular components, the system ensures low production costs while maintaining high functionality. The Women Safety ID Card is a potent and reasonably priced personal safety tool that combines machine learning, gas detection, GPS-based red zone alerts, and secure digital communication into a single, portable package. It is a scalable system appropriate for institutional deployment because of its high classification accuracy, real-time responsiveness, user privacy features, and economical architecture. Most significantly, it gives women the confidence and security they need to traverse public, professional, and educational settings, making a

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significant contribution to a society that is safer and more inclusive.

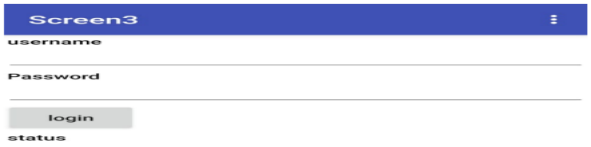

Fig. 6. Login Screen of The User Interface

6. Conclusion

In summary, the suggested Women Safety ID Card offers a creative, multipur pose, and affordable way to address women's increasing safety concerns in public

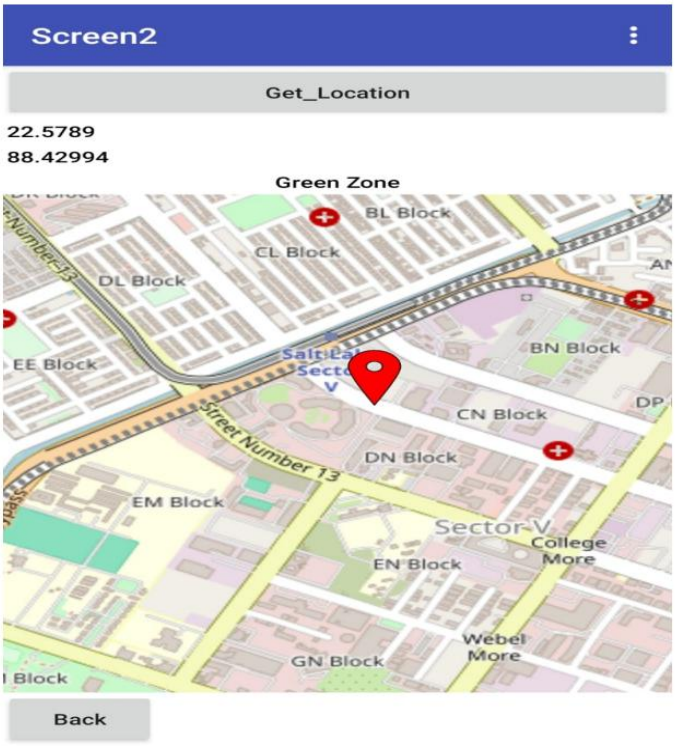

Fig.7. Location Tracking and Zone Detection in the User Interface

areas, workplaces, and educational institutions c. The system guarantees both proactive and reactive responses to any dangers by integrating real-time gas detection, GPS-based red zone alerts, machine learning classification, GSMenabled emergency communication, and secure app-based monitoring[19]. The system's dependability in accurately identifying dangerous gases, including LPG, alcohol, and anaesthetic chemicals, is further supported by the incorporation of a Random Forest classifier, which produced a high accuracy of 98.75%. Additionally, defining red zones based on past crime data improves situational awareness and

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assists users in avoiding high-risk areas. Help may be accessed quickly, even in low-network conditions, thanks to the SIM900A GSM module, which enables the device to deliver instant alarms via both automated detection methods and manual button triggers. The user-authenticated web and mobile application offers a safe platform for location tracking, alarm management, and realtime data visualisation. This guarantees that only people who can be trust including family members or institutional authority, can access sensitive information. This system is not only useful but also extremely scalable across multiple industries because of the use of widely available and reasonably priced hardware components like the Arduino Uno, MQ2 sensor, GPS, and Bluetooth modules. The Women Safety ID Card is a step toward empowering women by providing them with a sense of protection and independence; it is more than just a piece of technology. It is a great option for widespread deployment due to its understated appearance, clever functionality, and reasonable price, particularly in places where people's safety is a constant worry. The approach promotes a safer and more inclusive environment by facilitating prompt awareness and reaction, ultimately supporting the larger objectives of gender equality and societal growth.

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References

[1] King, J.A., Greer, D.A., Danvers, R.S.M., Keating, B.W. (2025). The personal safety burden for women taking public transport in Australia and implications for the provision of equitable public transport. *Journal of Public Transportation*, 27, 100118. https://doi.org/10.1016/j.jpubtr.2025.100118

[2] Dubey, S., Bailey, A., Lee, J. (2025). Women's perceived safety in pub lic places and public transport: A narrative review of contributing factors and measurement methods. In: *Cities*, vol. 156, Article 105534. Elsevier. https://doi.org/10.1016/j.cities.2024.105534

[3] Sangeetha, K., Devi, R.L., Ananya, A., Suvetha, M.M. and RV, V.P., 2022, May. Women's Safety System using IoT. In 2022 International Conference on Applied Artificial Intelligence and Computing (ICAAIC) (pp. 1477-1480). IEEE.

[4] Saranya, N., Aakash, R., Aakash, K. and Marimuthu, K., 2021, December. A Smart, Friendly IoT Device for Women's Safety with GSM and GPS Location Tracking. In 2021 5th International Conference on Electronics, Communication and Aerospace Technology (ICECA) (pp. 409-414). IEEE.

[5] Liu, J., Zhang, X., Li, Y., Wang, J. and Kim, H.J., 2019. Deep Learning-Based Reasoning with Multi-ontology for IoT Applications. IEEE Access, 7, pp.124688 124701.

[6] Hariharan, S., Monica, R., Deepasri, K., Gayathri, T.: A Novel and Reliable SOS Alert Band System for Women's Safety. Irish Interdisciplinary Journal of Science & Research, 9(1), 61–72 (2025). https://doi.org/10.46759/IIJSR.2025.9107

[7] Harsha, B.K., Shruthi, M.L.J., Naveen Kumar, G.N., Chaitra, K.U. and Priyanka, N.M., 2023, October. Empowering Women's Safety: A Comprehensive GPS and GSM-Enabled Automated Anesthesia and Pepper Spray Defense System. In 2023 7th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC) (pp. 1077-1081). IEEE. Title Suppressed Due to Excessive Length 17

[8] Venkatesh, K., Parthiban, S., Kumar, P.S. and Kumar, C.V., 2021, February. IoT Based Unified Approach for Women Safety Alert Using GSM. In 2021 Third In ternational Conference on Intelligent Communication Technologies and Virtual Mobile Networks (ICICV) (pp. 388-392). IEEE

[9] Daniel, P., Backer, A., Shini, K. N., Nazar, S., Joseph, S.: Smart Band for Women Safety. International Journal of Computer Science Trends and Technology (IJCST), 7(2), pp. 25–30, 2019. Available at: https://d1wqtxts1xzle7.cloudfront.net/58666422/IJCST-V7I2P5-libre.pdf

[10] A. K., B. Rajalakshmi, K. S. Chaitanya Reddy, G. P. Guggulla, and S. K. B. V., "A review on women safety in India using machine learning on different social media platforms," in *Proc. 2nd Int. Conf.

Received: 2025-08-02
Accepted: 2025-08-29
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Adv. Technol. Intell. Control, Envi ron., Comput. Commun. Eng. (ICATIECE)*, Bangalore, India, 2022, pp. 1–5, doi: 10.1109/ICATIECE56365.2022.10047377.

[11] Ebenezer, V., Falicica, J.U., Thanka, M.R., Baskaran, R., Celesty, A. and Eden, S.R., 2023. IoT-Based Wrist Band for Women's Safety. Journal of Artificial Intel ligence and Technology, 3(2), pp.69-74.

[12] Gowrishankar, V., Prabhakaran, G., Tamilselvan, K.S., Judgi, T., Devi, M.P. and Murugesan, A., 2023, May. IoT-Based Smart ID Card for Working Women's Safety. In 2023 7th International Conference on Intelligent Computing and Control Sys tems (ICICCS) (pp. 1598-1604). IEEE.

[13] Guchait, D., Kundu, A., Jana, S. (2025). A Novel Framework for Women's Safety Using Computer Vision and Machine Learning. In: Chaki, N., Roy, N.D., Chakraborty, S., Debnath, P., Yang, XS. (eds) Proceedings of International Con ference on Data Analytics and Insights. ICDAI 2024. Lecture Notes in Networks and Systems, vol 1233. Springer, Singapore. https://doi.org/10.1007/978-981-963287-9_13

[14] Ashikuzzaman, M., Aziz, A., Fime, A.A. (2025). DangerDet: A Mobile Application Based Danger Detection Platform for Women and Children Using Deep Learning. In: Lecture Notes in Computer Science (to match format). SoftwareX, vol 29. Elsevier. https://doi.org/10.1016/j.softx.2024.101983

[15] Farooq, M.S., Masooma, A., Omer, U., Tehseen, R., Gilani, S.A.M., Atal, Z. (2023). The role of IoT in women's safety: A systematic literature review. In: *IEEE Ac cess*, vol. 11, pp. 69807–69825. https://doi.org/10.1109/ACCESS.2023.3252903

[16] Dhawale, K.R., Jha, S.S., Gube, M.S., Guduri, S.M. (2023). Empowering Women's Safety. In: *Advances in Computational Intelligence and Robotics*, pp.139–159. IGI Global. https://doi.org/10.4018/979-8-3693-2679-4.ch009

[17] Sadeghi, A.R., Baghi, E.S.M.S., Shams, F. et al. Women in a safe and healthy urban environment: environmental top priorities for the women's presence in urban public spaces. BMC Women's Health 23, 163 (2023). https://doi.org/10.1186/s12905-023 02281-8

[18] Gomathy, C.K., Venkatesh, K.: Women Safety Device Using IoT. International Journal of Innovative Research in Computer and Communication Engineering, 9(12), 123–128 (2022). Available at: https://www.researchgate.net/publication/357748826

[19] G. Uganya, N. Kirubakaran, B. T. and M. Boobalan, "Smart Women Safety De vice Using IoT and GPS Tracker," 2023 Intelligent Computing and Control for Engineering and Business Systems (ICCEBS), Chennai, India, 2023, pp. 1-6, doi: 10.1109/ICCEBS58601.2023.10449302.

[20] Osipova, M., Hornecker, E., van Koningsbruggen, R.: Exploring the Potential for Smart City Technology for Women's Safety. In: Proceedings of the 26th Interna 18 P.Chatterjee et al. tional Academic Mindtrek Conference (Mindtrek '23), pp. 245–256. ACM, New York (2023). https://doi.org/10.1145/3616961.3616988

[21] Brigstocke, S., Yu, V., Nee, J.: Review of the safety profiles of laxatives in pregnant women. Journal of Clinical Gastroenterology, 56(3), 197–203 (2022). https://doi.org/10.1097/MCG.0000000000001660

[22] A. J. Bonny, M. Jahan, Z. F. Tuna, A. Al Marouf and S. M. T. Siddiqee, "Sentiment Analysis of User-Generated Reviews of Women Safety Mobile Applications," 2022 First International Conference on Electrical, Electronics, Information and Commu nication Technologies (ICEEICT), Trichy, India, 2022, pp. 1-6, doi: 10.1109/ICE ICT53079.2022.9768554