Automated smart handbag with enhanced women's safety using cutting edge technology

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ABSTRACT

Women's safety has been an area of concern, especially in public places where timely assistance cannot be provided. To mitigate this problem, this paper proposes an intelligent handbag-based women's safety system that utilizes the concept of biometric identification, location tracking, and edge computing-based artificial intelligence (AI) threat verification. The proposed system, unlike other traditional women's safety devices that rely on GPS-GSM for emergency alerts and are more likely to send false alarms, utilizes fingerprint identification for secure and authorized use, along with YOLO v3 vision model on an ESP32-CAM for threat verification. Upon failure in the authentication process or threat detection, the system sends an SOS message with the current location via GSM with the help of GPS coordinates. The system achieves an emergency response time of 33 seconds, primarily limited by GPS acquisition delay. The results confirm the effectiveness and applicability of the proposed system in providing an intelligent emergency response system for women's safety.

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1. INTRODUCTION

Women's safety is one of the major global issues, and many women are exposed to unsafe conditions in their day-to-day activities. According to the World Health Organization survey, as part of the UN interagency assessment of 161 countries, approximately 736 million women, or one in every three, have faced physical harassment and different forms of violence and maltreatment in their lives [1]. Statistics indicate that the risk of violence and maltreatment occurs at different stages of life, with the highest risk during the teenage and young adult years [2]. Thus, the safety of women must be ensured universally, irrespective of age. The safety of women's lives is the core of sustainable development, and it relates to the UN 2030 Agenda, as well as the UN's Sustainable Development Goals 5 and 16, which are related to 'Gender Equality' and 'Peace, Justice, and Strong Institutions,' respectively.

This limits the extent of freedom of movement of women and girls in the community, as well as their involvement in the broader community, the workforce, and educational institutions, and it affects their health and well-being, thereby preventing access to health and other essential services, as well as social, cultural, and sporting activities. In addition, violence against women also contributes to health complications, including depression, anxiety, and other related conditions [3].

Table 1 indicates that current women's safety systems for ensuring safety for women depend largely on manual intervention, sensors for detection, and passive surveillance. Although wearable devices and IoT have the advantage of portability and fast alerting, they fail to authenticate the user and do not use artificial intelligence for making decisions on threats in real-time, which may cause false positives. These limitations highlight the need for an integrated system combining authentication, real-time artificial intelligence (AI) based threat verification, and reliable communication.

Table 1. Literature review

References	Category of Proposed Solution	Key Characteristics	Limitations/Research Gap
[4]	Survey and review studies	Review of IoT-based women's safety systems: wearables, apps, and sensors	Lacks practical architectures and experimental validation
[5], [6], [7], [8], [9]	Wearable and accessory-based safety devices	Smart handbags, shoes, and wearable gadgets integrating GPS–GSM for location tracking and emergency alerts	Predominantly manual activation; absence of secure authentication; prone to false alarms
[10], [11], [12]	Manual trigger–based IoT safety systems	Emergency activation via buttons, taps, or pull mechanisms with GSM-based alerts	Highly user-dependent; unreliable during panic or restraint
[13], [14], [15], [16], [17]	Sensor-based IoT safety systems	Use of physiological, motion, and multimodal sensors for automated distress detection	Threshold-based logic lacks contextual awareness, resulting in false positives
[18]	Biometric authentication	Incorporation of fingerprint sensors to restrict activation to authorized users and reduce misuse	Authentication not combined with intelligent threat verification
[7], [11], [12]	Camera-enabled safety devices	Camera modules used for image capture and evidence recording during emergency situations	Mainly passive recording; lacks AI-based real-time threat classification
[19]	Short-range wireless tracking systems	Bluetooth low energy (BLE), iBeacons, and received signal strength indicator (RSSI)-based localization for short-range tracking	Limited range; unsuitable for outdoor or long-distance emergencies
[20], [21]	Blockchain and data-driven safety frameworks	Blockchain and machine learning used for secure data storage, integrity, and predictive analytics	Focused on analytics or infrastructure; not designed for real-time personal safety
[22]–[26]	AI/ML and real-time IoT frameworks	AI-based anomaly detection with real-time, low-latency IoT communication	Not directly integrated into personal women's safety devices

2. DESIGN OF AUTOMATED SMART HANDBAG

The proposed system enhances women's safety by means of a smart handbag incorporating tracking, threats detection, and an emergency alert system. Arduino Uno will be used as a microcontroller for connecting the following elements of the device: fingerprint sensor, GPS, trigger, camera and GSM modules as shown in Figure 1. When the system is activated, fingerprinting takes place using the registered information, while GPS and GSM modules perform tracking and SMS messaging correspondingly. The ESP32-CAM captures images and performs threat classification using YOLO v3.

The system uses a layered architecture with two controllers: Arduino Uno and ESP32-CAM. Arduino Uno is used as the main controller fingerprint authentication, overall system control, and communication via GPS and GSM modules. The ESP32-CAM module handles the image capturing and AI-based threat validation process. In case of authentication failure or time-out, the GPS coordinates are fetched, images are taken, and the GSM alert is sent out.

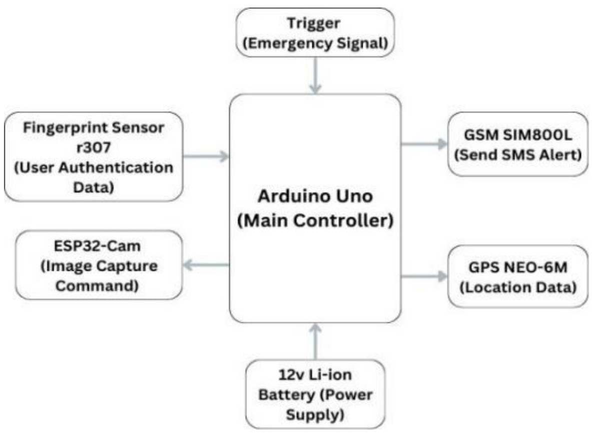


Figure 1. System architecture

This hardware prototype integrates the selected components, as presented in Table 2, based on performance, reliability, and real-time safety requirements. The Arduino Uno R3 board integrates as the core of the system because of its low cost and extensive library support. For fast and effective user authentication, the R307 fingerprint sensor module meets the requirements and can support up to 1000 fingerprints. For real-time positioning, the GPS module of choice, the GPS NEO 6M, excels based on its sensitivity and satellite lock time. For effective transmission of the location, the low-power consumption and support for the quad-band SIM800L GSM module are suitable. For the power source, the 12V Li-ion rechargeable battery, with its light weight and high energy density, meets the requirements. The ESP32 camera module is used for image capture to support AI-based threat analysis, with acceptable performance under normal lighting conditions. In order to provide a fast response, the trigger mechanism provides instant switching of the alert system without significant delay. Figure 2 illustrates the circuit connections of the system. The Arduino integrates the fingerprint sensor, GPS, GSM, and camera modules to enable authentication, monitoring, and real-time emergency alert transmission.

Table 2. Specification of components in experimented automate smart handbag

Component	Specification
Arduino Uno R3	7V-12V
Fingerprint Sensor r307	4.2V-6V
GPS NEO 6M	2.7V-6V
GSM SIM800L	3.4V-4.4V
Li-ion Battery	12V
ESP32 Camera	3.3V
Trigger	-

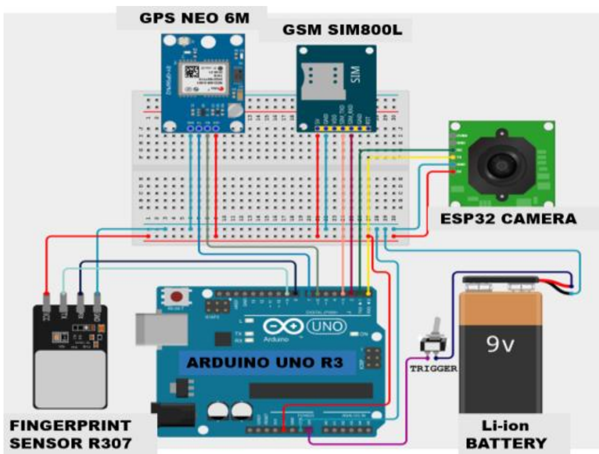


Figure 2. Circuit diagram of prototype

3. RESULTS AND DISCUSSION

Figure 3 depicts the working of the smart handbag system. Upon activation, the system performs fingerprint authentication. If authentication fails, GPS location is acquired, an image is captured, and an SOS alert is transmitted via GSM.

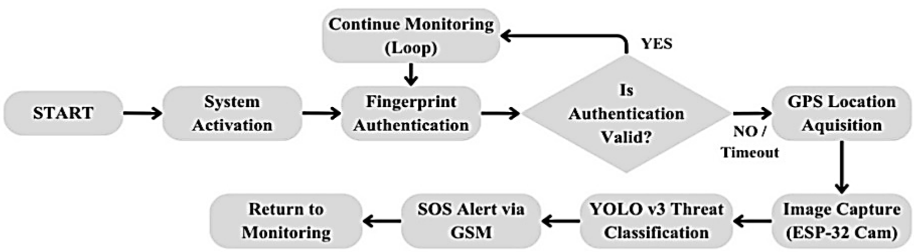
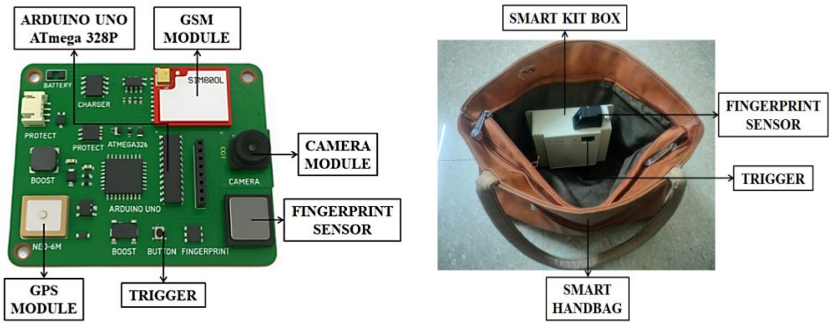


Figure 3. Flow diagram of model

Figure 4 represents the hardware of the proposed smart handbag system. Figure 4(a) represents the PCB layout of the hardware prototype, while Figure 4(b) represents the real time deployment of the system running in real-time emergency scenarios. The hardware prototype utilizes a 12 V, 2500 mAh Li-ion battery. The battery life was calculated on the basis of the average current drawn from the battery in different modes, which ranges from 20–55 hours depending on operating modes shown in Table 3, with GPS and GSM modules being the primary power consumers in the device's active and emergency states. The battery's standby time is sufficient for regular usage, the effect of always-on GPS on battery life is considerable. This implies that there is potential for future battery life improvements by using duty-cycled GPS or assisted GPS. The integrated hardware system enables coordinated operation of authentication, tracking, and communication modules for real-time safety monitoring.

Table 3. Power analysis in different modes of operation

Operating Mode	Active Modules	Estimated Current	Duration
Standby	MCU only	Low (200mA)	50–55 h
Active	MCU + GPS	Medium (350mA)	32–36 h
Peak Load	GPS + GSM + Camera	High (600mA)	20–23 h



(a) (b)

Figure 4. Model of smart handbag (a) PCB design and (b) real time deployment

3.1. AI-based threat classification using YOLO v3

The camera module also introduces an extra security feature that captures images of the environment and uses the YOLO v3 object detection algorithm to aid the verification of the threat. The AI module will filter the captured images into three categories: humans, animals, and vehicles. This will ensure that the emergency situations are validated correctly before the SOS message is sent.

Figure 5 shows a schematic representation of the YOLO v3-based threat classification. When a trigger occurs or authentication times out, the ESP32-CAM module captures an image, which is then resized to 416×416 pixels during pre-processing. Then, the resized image is processed by the YOLO v3 model, which uses pre-trained darknet weights for object detection. After object detection, non-maximum suppression is performed during post-processing to categorize the scene as a human, animal, or vehicle.

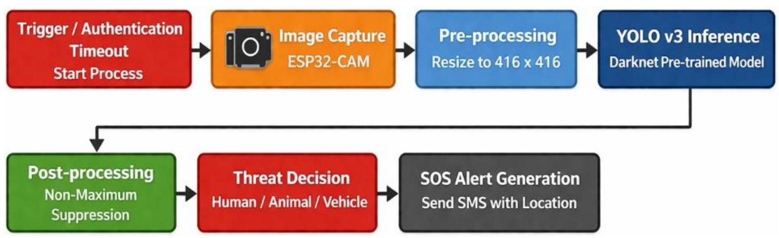


Figure 5. Threat classification process using YOLOv3

This model was trained and evaluated using a combination of publicly available images and a custom dataset consisting of approximately 1,800 images, with an 80:20 train–test split. Images were processed offline on a desktop system using a learning rate of 0.001, a batch size of 16, and 50 epochs. Overfitting was controlled through dataset splitting and validation monitoring. The prototype evaluation of ESP-32 camera, employing a YOLO v3-based threat classification module, is presented in Figure 6. Once a threat object is identified, it is enclosed in a bounding box and classified into one of three categories: human, animal, or vehicle. This verifies the emergency situation before sending out the SOS signal.

The confusion matrix in Figure 7 shows clear separation among classes, resulting in an accuracy of 92.5%. The values in Table 4 reflect the fact that our model has achieved 0.92, 0.91, and 0.91 of average precision, recall and F1-scores respectively. Although models such as SSD, RetinaNet, and EfficientDet offer high accuracy, their deployment on low-power edge devices like ESP32 is constrained. YOLO v3 provides an effective balance between detection accuracy and computational efficiency, making it suitable for real-time safety applications as shown in Table 5.

In other words, while YOLO v3 is a good trade-off between its accuracy in detecting objects and its practicality for deployment, especially for safety validation purposes, the fact that it only needs to focus on safety-relevant objects like people, animals, and vehicles means that it can provide reliable performance while being computationally and power-efficient.

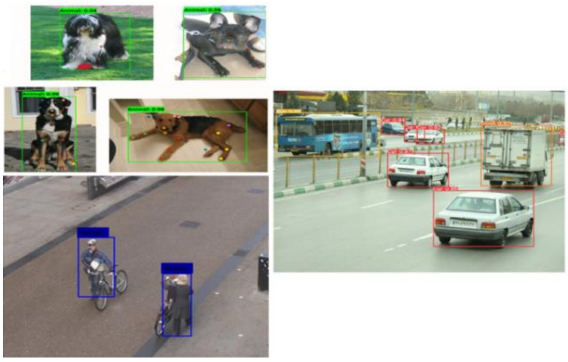


Figure 6. Image classification using YOLO v3

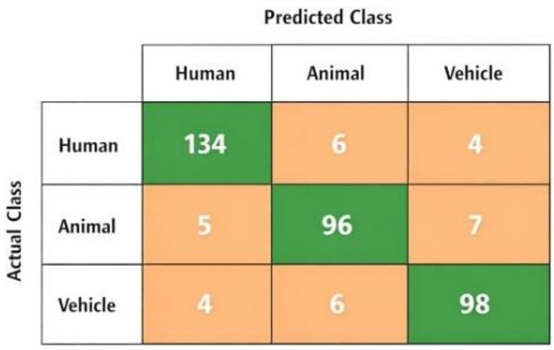


Figure 7. Confusion matrix for YOLO v3

Table 4. Class-wise performance metrics

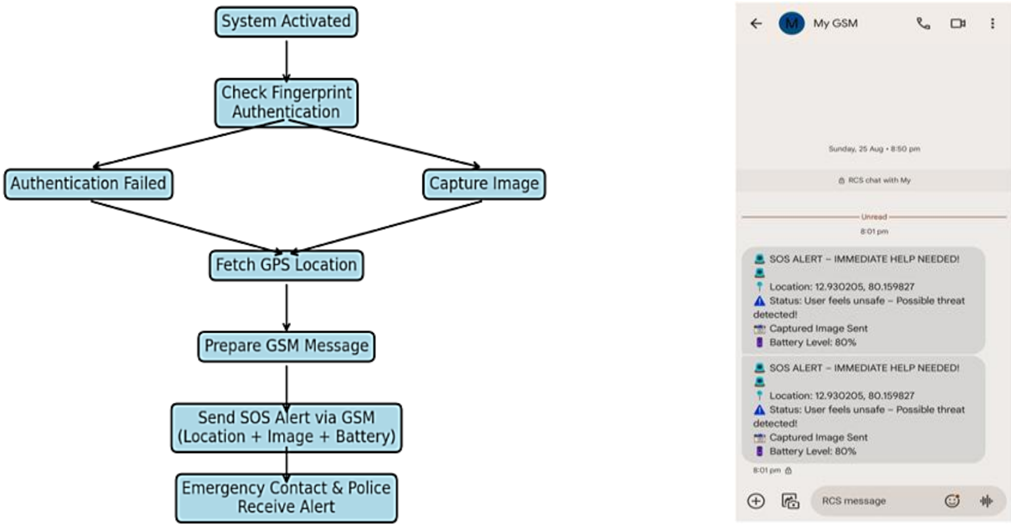
Class	Precision	Recall	F1-Score
Human	0.94	0.93	0.93
Animal	0.90	0.89	0.89
Vehicle	0.92	0.91	0.91
Average	0.92	0.91	0.91

Table 5. Comparison of object detection models for low-power edge AI systems

Parameter	Single Shot Detector (SSD)	RetinaNet	EfficientDet	YOLO v3 (Proposed)
Design objective	Fast detection with lightweight architecture	High accuracy using focal loss	Balanced accuracy–efficiency scaling	Real-time detection under edge constraints
Detection accuracy	Moderate	High	High	High (92.5%) on task-specific dataset
Model complexity	Low	High	Medium–High	Moderate, edge-optimized
Edge deploys ability	Feasible but limited	Not feasible	Challenging	Feasible
Suitability for Safety-critical use	Limited	Impractical	Resource-heavy	Best trade-off

3.2. Performance evaluation and comparative analysis of prototype

In case of an emergency, the handbag sends a message or alert to the pre-configured contacts, notifying them of the woman's location. All these components combine to create a smart handbag prototype that improves the safety of women through secure access control and the ability to track location and communicate in case of an emergency. Here, the device has to be activated by the woman in case she perceives danger, and the system has to request the fingerprint authentication periodically as a safety check. If the woman fails to do so, then the location has to be tracked using GPS and send an emergency message to the registered mobile number and the nearest police station using the GSM module. Figure 8 describes the automated SOS alert system. Figure 8(a) describes the flow of the automated SOS alert message, which is sent using the GSM module from the smart safety device. This sends the geographical location of the user in real-time, indicating a possible threat, and the battery level of the device, so that the concerned authority can respond accordingly in a timely manner, as described in Figure 8(b). The smart safety device was used in a real-life situation to test the efficiency of the system in case of emergencies. It was observed that the device had taken only 33 seconds to authenticate and send the alert. Thus, the performance of the smart devices has been studied and found satisfactory.



(a) (b)

Figure 8. Alert from smart device (a) system flow (b) GSM module

From the performance results presented in Table 6, it can be seen that the overall emergency response time taken is about 33 s, with the main component being GPS acquisition time of (25-30 s). The location accuracy obtained is ±5-10 meters, while the GSM communication and fingerprint verification take very little time to complete. The YOLO-based threat classification achieves an accuracy of approximately 92.5%, demonstrating reliable system performance. Table 7 compares the proposed system with existing safety solutions. Most conventional systems rely on manual activation and lack authentication, resulting in longer response times. The proposed system achieves a faster response time of approximately 33 s due to the integration of biometric authentication and AI-based threat verification.

Table 6. Evaluation parameters of automated handbag

Parameter	Measured value
GPS TTFF (Cold Start)	~25–30 s
GPS Accuracy	±5–10 m
GSM SMS Latency	~3–5 s
Fingerprint Authentication Time	~1 s
Fingerprint FAR/FRR	Low (observed)
YOLO v3 Accuracy	~92.5%
Total SOS Time	33 s

Table 7. State-of-the-art comparison

Work	Authentication	AI	Response Time	Platform
[10]	No	No	>1 min	GSM
[7]	No	Camera only	~45 s	Arduino
This work	Fingerprint	YOLO	~33 s	Arduino + ESP32

The combination of the Arduino and ESP32 allows for efficient control of the system and real-time decision-making, which provides an improvement over traditional system. Although the system exhibits a reliable and automatic emergency response, there is still room for improvement by decreasing the GPS data retrieval time, improving low-light image quality, and enhancing edge inference capability.

4. CONCLUSION

This work presents a smart handbag system integrating biometric authentication and AI-based threat detection to provide increased protection for women. The designed security system attains an average response time of 33 seconds, wherein the process of acquiring GPS coordinates is the main source of time loss, and has an AI model detection precision rate of around 92.5%. Further research would involve reducing the latency of GPS, improving the quality of images captured in poor lighting conditions, and enhancing AI algorithms to enable their efficient implementation on edge devices. Further enhancement of this solution can be achieved through sensor fusion by leveraging the accelerometer sensor for automatically detecting emergencies, combined with remote surveillance via the cloud, audio detection, and machine learning.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
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Va : **Va**lidation
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R : **R**esources
D : **D**ata Curation
O : Writing -**O**riginal Draft
E : Writing - Review &**E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

REFERENCES

[1] WHO, "Devastatingly pervasive : 1 in 3 women globally experience violence," *World Health Organisation (WHO)*, Mar. 2021. https://www.who.int/news/item/09-03-2021-devastatingly-pervasive-1-in-3-women-globally-experience-violence (accessed Mar. 01, 2025).

[2] H. Kearl, "The facts behind the #MeToo movement: A national study on sexual harassment and assault," *Stop Street Harassment Stop*, 2018. https://stopstreetharassment.org/our-work/nationalstudy/2018-national-sexual-abuse-report/ (accessed Mar. 01, 2025).

[3] WHO, "Violence against women," *World Health Organization (WHO)*, 2024. https://www.who.int/news-room/fact-sheets/detail/violence-against-women (accessed Mar. 01, 2025).

[4] M. S. Farooq, A. Masooma, U. Omer, R. Tehseen, S. A. M. Gilani, and Z. Atal, "The role of IoT in woman's safety: A systematic literature review," *IEEE Access*, vol. 11, pp. 69807–69825, 2023, doi: 10.1109/ACCESS.2023.3252903.

[5] M. T. Ali, N. S. Islam, M. W. Rakib, R. Al Ahmed, and M. H. Kaicher, "Designing of a handbag for women safetyt," in *International Conference on Robotics, Electrical and Signal Processing Techniques*, 2021, pp. 274–277. doi: 10.1109/ICREST51555.2021.9331002.

[6] S. Karmakar and T. K. Rana, "Smart bag for women safety," in *2020 4th International Conference on Electronics, Materials Engineering and Nano-Technology, IEMENTech 2020*, 2020, pp. 1–4. doi: 10.1109/IEMENTech51367.2020.9270046.

[7] K. Sagadevan, D. S. Kumar, S. Poonguzhali, A. Sivasangari, G. Ilakiya, and S. Ragavi, "A design of digital tote bag for women's safety," in *IEMECON 2021 - 10th International Conference on Internet of Everything, Microwave Engineering, Communication and Networks*, 2021, pp. 1–4. doi: 10.1109/IEMECON53809.2021.9689128.

[8] M. Hareni, S. Abishaya, P. Kavya, and K. Rajasekar, "Design of smart shoe for women safety with emergency alert system," in *Proceedings - 2023 3rd International Conference on Pervasive Computing and Social Networking, ICPCSN 2023*, 2023, pp. 424–430. doi: 10.1109/ICPCSN58827.2023.00075.

[9] R. Ramesh, "Design and development of an IoT enabled multi features smart bag and women's security monitoring system," in *Proceedings - 3rd International Conference on Smart Technologies, Communication and Robotics 2023, STCR 2023*, 2023, pp. 1–6. doi: 10.1109/STCR59085.2023.10396941.

[10] P. Gupta, Y. Goyal, Di. Gulati, P. Rastogi, and S. Saboo, "Women's safety device based on Internet of Things," in *2021 IEEE International Conference on Mobile Networks and Wireless Communications, ICMNWC 2021*, 2021, pp. 1–6. doi: 10.1109/ICMNWC52512.2021.9688529.

[11] G. Uganya, N. Kirubakaran, T. Bernatin, and M. Boobalan, "Smart women safety device using IoT and GPS tracker," in *2023 Intelligent Computing and Control for Engineering and Business Systems, ICCEBS 2023*, 2023, pp. 1–6. doi: 10.1109/ICCEBS58601.2023.10449302.

[12] S. A. Sawant, S. Gurakhe, T. S. Shaikh, S. Bagmare, C. Rathad, and S. Sobale, "Safety with technology: A smart SOS device," in *2023 7th International Conference On Computing, Communication, Control And Automation, ICCUBEA 2023*, 2023, pp. 1–6. doi: 10.1109/ICCUBEA58933.2023.10392200.

[13] S. Rohini, A. Deepa, A. Kalaimani, N. Rajiv Gandhi, L. Sudha, and V. S. Pandi, "Empirical evaluation of Internet of Things oriented enriched women protection system with smart sensors association," in *2023 Annual International Conference on Emerging Research Areas: International Conference on Intelligent Systems, AICERA/ICIS 2023*, 2023, pp. 1–6. doi: 10.1109/AICERA/ICIS59538.2023.10420095.

[14] M. V. Bhuvaneswari, A. S. Gowthami, B. Revathi, D. V. Gopal, and B. J. Kumar, "Smart Hi-Tech Emergency Rescuer Using IoT," in *Proceedings of the 9th International Conference on Inventive Systems and Control, ICISC 2025*, 2025, pp. 1194–1198. doi: 10.1109/ICISC65841.2025.11187989.

[15] D. Paul, A. T. Z. Prince, M. A. Nabil, M. I. Jim, S. M. Z. A. Ratul, and A. Tasnim, "IoT-enhanced multimodal wearable system for women's safety," in *2025 IEEE International Conference on Quantum Photonics, Artificial Intelligence, and Networking, QPAIN 2025*, 2025, pp. 1–6. doi: 10.1109/QPAIN66474.2025.11172126.

[16] P. Sumalatha, R. Radhakrishnan, D. Beula, and M. Palati, "IoT based smart safety system for women's protection," in *Proceedings - International Conference on Next Generation Communication and Information Processing, INCIP 2025*, 2025, pp. 441–444. doi: 10.1109/INCIP64058.2025.11020103.

[17] K. Elavarasi, B. Kalaiselvi, P. Rajasekar, M. G. Kumari, and K. Sabareeshwaran, "Smart guardian: An IoT-based safety solution for women," in *2025 International Conference on Emerging Technologies in Engineering Applications, ICETEA 2025 - Proceedings*, 2025, pp. 1–6. doi: 10.1109/ICETEA64585.2025.11099709.

[18] R. Khan, N. Mahfuz, and N. Nowshin, "A novel approach of women safety assistant device with biometric verification in real scenario," in *Proceedings of 2020 IEEE International Women in Engineering (WIE) Conference on Electrical and Computer Engineering, WIECON-ECE 2020*, 2020, pp. 426–431. doi: 10.1109/WIECON-ECE52138.2020.9397938.

[19] S. Vivek Sharma, C. S. Ranganathan, G. Elavel Visuvanathan, S. Srinivasan, and N. Latha, "Real-time monitoring of women's safety through Bluetooth Low Energy and iBeacons," in *2023 2nd International Conference on Smart Technologies for Smart Nation, SmartTechCon 2023*, 2023, pp. 1282–1287. doi: 10.1109/SmartTechCon57526.2023.10391725.

[20] P. Pattnayak, A. Mohanty, T. Das, and S. Patnaik, "A machine learning-based blockchain model for the storage of maternal health records and safety prediction," in *Proceedings - 4th IEEE 2023 International Conference on Computing, Communication, and Intelligent Systems, ICCCIS 2023*, 2023, pp. 752–756. doi: 10.1109/ICCCIS60361.2023.10424994.

[21] P. Badoni, S. I. Yaqoob, K. Mahender, S. Kumar, V. M. Shrimal, and M. Wadhwa, "The IoT transformation: Improving safety and efficiency in smart city transportation," in *2025 World Skills Conference on Universal Data Analytics and Sciences, WorldSUAS 2025*, 2025, pp. 1–5. doi: 10.1109/WorldSUAS66815.2025.11199148.

[22] H. Nizam, S. Zafar, Z. Lv, F. Wang, and X. Hu, "Real-time deep anomaly detection framework for multivariate time-series data in industrial IoT," *IEEE Sensors Journal*, vol. 22, no. 23, pp. 22836–22849, Dec. 2022, doi: 10.1109/JSEN.2022.3211874.

[23] S. Abolhassani Khajeh, M. Saberikamarposhti, and A. M. Rahmani, "Real-time scheduling in IoT applications: A systematic review," *Sensors*, vol. 23, no. 1, p. 232, 2023, doi: 10.3390/s23010232.

[24] I. Behnke and H. Austad, "Real-time performance of industrial IoT communication technologies: A review," *IEEE Internet of Things Journal*, vol. 11, no. 5, pp. 7399–7410, Mar. 2024, doi: 10.1109/JIOT.2023.3332507.

[25] A. Shafique, M. S. Saeed, D. Javeed, and K. N. Qureshi, "AI models and ethical considerations in research," in *Next Generation AI Language Models in Research: Promising Perspectives and Valid Concerns*, CRC Press, 2024, pp. 170–190. doi: 10.1201/9781032667911-7.

[26] A. Shafique, A. A. R. Farea, and K. N. Qureshi, "AI as a new paradigm for distributed healthcare networks," in *Artificial Intelligence-Based Smart Healthcare Systems: New Standards, Technologies, and Communication Systems*, Academic Press, 2025, pp. 97–118. doi: 10.1016/B978-0-443-26476-4.00012-5.

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