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The Role of IoT in Woman's Safety: A Systematic Literature Review

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Abstract: *Women's safety has been highlighted as one of the major concerns of any society where several women are dealing with various safety issues like harassment, rape, molestation, and domestic violence due to different social or cultural reasons. Internet of Things (IoT) is becoming a promising technology to support day-to-day concerns and provide support in handling various affairs. Many IoT-based devices have been introduced by the community to help women deal with their potential safety threats. This study presents a systematic literature review of research studies exhibiting the IoT devices for women's safety, the main features these devices offer as well as the wearable, sensors used, and the machine learning algorithms used.The Internet of Things (IoT) is highly significant to the protection of women as it encompasses constant surveillance, activation of alerts and links to emergency response systems during crisis events. Distress signals or irregular behaviors can be automatically reported through devices enabled with the IoT, such as a wearable safety device, a smart home system, or a mobile application, to either the police or other registered contacts. Such technologies help minimize response time, enhance safety, and maximize convenience in public as well as private areas. With IoT, it becomes easier to incorporate various security features in routine practice by automatically locking doors, tracking movement by GPS, and identifying users by their physical attributes and this is a more preventive approach to women's safety.*

Keywords: Women's safety

I. INTRODUCTION

Women's safety means the rights of women and their protection against harmful acts such as physical, emotional, sexual and psychological abuse. It covers quite a range of concerns, for instance, initiatives aimed at preventing violence and harassment in public and workplaces as well as providing a safe and secure environment at home. Women's safety and security has become important especially in public places and home alike considering the patterns of history where gender related violence has always been inflicted to women in the first place[1].

With respect to women's safety, efforts include legal reforms, campaigning and education programmers and the use of technologies targeting women's empowerment, prevention of violence and provision of support and resources as and when necessary. In the most recent years for instance, incorporation of other forms of technology such as IoT devices, mobile apps and smart security systems have been critical in improving women safety as they are able to send alerts and prevent issues before they deteriorate. Safety of women is not a personal issue only but rather a societal as well as a systemic issue that needs partnership among the communities, the governments and the organizations to end violence against all women around the world.

Women that nine out of ten women have dealt with some sort of violence [2]. The findings of WHO (World Health Organization) also showed that every one in three women are subject to violence globally [3]. The Global Gender Gap Report showed that every fifth woman is suffering sexual violence globally [4]. These figures show that the women are becoming unsafe day-by-day [5], [6]. Women face safety issues at public places, which include workplaces and markets, as well as in their houses. Women are harassed not only during night-time or evening but also during daylight even in public places. Almost 80% of women have fear of being not safe at all [7] find how it can support to prevent

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occurrence of women's violence cases and help women deal with potential situation of security threat and danger.

Internet of Things (IoT) has emerged as a promising field of study that provides support through technological assisted solutions of connected devices. Several IoT-based devices have been introduced by the community for the safety and protection of women. Some of these devices automatically capture and identify the safety concerns through their voice recognition systems [8] while some are operated by sending explicit alerts through mobile phones [9]. These devices offer different types of features to help support the cause that is mainly related to sending alert to the guardian of the women under threat. Reference [10] proposed a device with fingerprint sensor and shock generator along with facility of voice

recording. Then the global positing system (GPS) and global system for mobile communication (GSM) are used to trace the location and send message of danger to the guardian of the woman.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 tattoo.The IoT-based devices for women's safety also use several sensors to sense the state and movement of women in order to detect any safety threats. Such sensors gather data from different parts of the body. This includes the acceleration sensor [11], pulse-rate sensor [12], heartbeat sensor [13] and temperature sensor [14]. Some of the sensors are body-area specific such as heartbeat and pulse-rate sensors while some could work by taking input from any part of the body such as temperature and tilt sensors. Although some sensors can relate to specific body areas whilst there are sensors which could generally be related to movement of any body part such as tilt sensor [15], and flex sensors [16].

Applying the machine learning algorithms on the input data captured through these sensors would result in making decisions reflecting whether the particular state of women could be considered as unsafe or not. Hence, various machine learning algorithms are applied in IoT devices for women's safety to decide the state of the women [17], [18].

II. RELATED WORK

1. Wearable IOT Devices for Women's Safety

Zhao et al. (2018) developed wearable devices equipped with IoT technologies that can sense the occurrence of falls, unusual movements or distress signals by the wearer, thus transmitting an instant alert to the emergency contact or authority. According to them, "wearable technology will reduce the critical response time".

Block Diagram Description

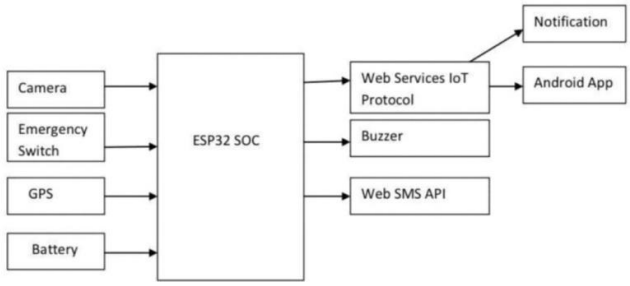

Fig 1: Smart wearable device for women safety

As shown in the diagram above the system consists of development of IOT based smart wearable device for Women safety. The system consists of an EPS32 SOC which is interfaced to the different sensors and the GPS modem. The sensors such as push button will activate the device when the girl is in danger and start sending the GPS coordinates to the android application forlive tracking as well assendb the notification to the family members. The ESP32SOC will take the data from the sensors as well as Communicate with the cloud backend hostedremotely using web services API and IOT protocols. The GPS modem will fetch the live location and send it to the tracking application. The camera module will capture the live images and send it to the android application.

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2. Mobile Applications For Women Safety

Some of the popular mobile applications are available for women safety. Most of these applications are reactive, i.e. can raise an alert when the user is in danger. These applications provide a means to contact the police, selected contact persons, or guardians when triggered. If the user goes to a distant location away from the contacts, only the police force will be available for help, and sending alerts to contacts at a distant place may be of limited use. Most of the applications do not offer assistance in warning women about a danger prone area. My SafetiPin app classifies a public area as 'unsafe' or 'safe' at night, based on parameters such as lighting conditions, openness, visibility, number of people in the vicinity, number of police stations, walking path, etc .

However, the reliability of the warnings generated by this application is mostly limited by the perceived data as entered by other users and not based on criminal history records from reliable sources. Also, higher number of people of the opposite sex in an area or poor visibility or lighting conditions may not necessarily indicate that the area is unsafe for women. It has to be noted that the safety of women is compromised even within house premises. These factors thus cause limited use of the available applications in ensuring women's safety.

Nithya et al. (2017) also designed a mobile application that uses IOT for sending GPS coordinates and real-time alerts when a woman perceives she is under threat. It connects several sensors, including accelerometers and gyroscopes that detect the symptoms of distress, such as rapid movement or abnormal interaction in the physical world, followed by alerting the predefined contacts or law enforcement.

3. Smart Home Systems

In Kumar and Ranjan (2020), a smart home system is designed to increase the security of women at home. The system integrates IOT devices like smart cameras, motion detectors, and smart locks to monitor the surroundings and immediately send notifications if suspicious activity is detected. The system also allows remote control and monitoring, ensuring safety even when the woman is not at home.

4. Internet of Things and Public Safety Network

Patel et al. (2021) described the idea of public safety network using IoT sensors for smart cities. These are systems that collect and analyze data coming from different IoT-enabled public infrastructures like streetlights, surveillance cameras, and emergency call boxes. This further helps increase women's safety by detecting risky areas and efficiently deploying necessary resources or alarms during emergencies.

5. Real-time Incident Reporting Systems

Singh et al. (2019) has designed and developed a real-time incident reporting system, which utilizes IoT sensors like GPS and accelerometers to alert police and rescue teams in real-time whenever a woman is in danger. The proposed system will utilize cloud computing to store and process data. This will enable expedited location of the victims along with faster response times by rescue teams.

6. Integrated IoT Safety Devices for Women

Rathi and Kumar (2019) developed an intelligent, portable gadget that women can carry with them in their handbags. With the aid of IoT, this device rapidly sends alert signals, records audio or video, and tracks location. It transmits real-time information to the user's contacts or emergency services immediately after the device are activated, thus increasing personal safety during threatening situations.

III. LITERATURE SURVEY

IoT, in its present form, appears to be a promising technology that can help enhance the safety and security of women in different settings. The inclusion of smart devices, sensors, and real-time communication can bring innovative solutions to counter safety issues such as harassment, violence, and delay in emergency response time. To improve the accuracy.

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1. Personal Safety via Internet of Things-Based Wearable Devices

IoT-based wearable's with SOS Features: There are many other studies that depict the development of wearable devices such as smart watches, rings, and pendants that are embedded with GPS trackers, panic buttons, and emergency alerts. These devices enable females to send distress signals at the touch of a finger or a voice command. Safer Smart Pendant and Leaf Wearable's are examples where users could immediately alert their emergency contact with their location information.

Real-Time Monitoring: IoT-based wearables are tailored to monitor women's movement and health parameters, including heart rate and body temperature to detect stressful or dangerous situations. This information is then relayed to a cloud or local server for analysis over time to detect anomalies. This enables not only alerts in emergency situations but also prediction of behavioral patterns.

2. Smart City Infrastructure for Women's Safety

Connected Public Spaces:Smart streetlights, CCTV cameras, and panic buttons are being installed in the city to enhance infrastructure. Such systems can identify suspicious activity in real time, set off alarms, and alert law enforcement in real-time. As an example, smart bus stops with SOS buttons and cameras are being installed to ensure that security of women is enhanced due to IoT. Surveillance and Security:

Many studies discuss the role of IoT in creating safer public areas. For example, smart lighting systems with motion sensors can detect abnormal movement patterns and alert security teams instantly. Cities like New York and London are testing such solutions to create safer spaces for women.

3. IoT-Enabled Mobile Apps

Several mobile applications integrate IoT devices, such as wearable trackers, with smartphones for real-time location sharing. Apps like Safe and My Safetipin provide users with features like live GPS tracking, emergency contact alerts, and real-time monitoring of surroundings. These apps use Bluetooth, GSM, and Wi-Fi to stay connected, ensuring continuous safety coverage.

Many IoT safety solutions use GPS and geofencing technologies to track a user's location. If the user deviates from predefined safe zones, the system sends an alert to authorities or family members. Research shows that geofencing can also be used to prevent domestic violence by monitoring the movements of victims and aggressors

4. Challenges axons

Privacy Concerns: One challenge well-discussed in the literature refers to the privacy and data security of women using IoT devices. Many of the solutions involve location tracking and personal health data thus requiring confidentiality and secure transmission.

Power Consumption and Battery - IoT-based wearable's need to be low power to remain operational for extended periods. Several studies outline the difficulty of ensuring sufficient battery life, because the continuous tracking of locations with simultaneous sensor monitoring may drain battery resources quickly.

User Acceptance and Usability: At the devices are intuitive and comfortable is another key issue. According to various studies, it has been indicated that the acceptance of wearable safety devices by women significantly depends on their ease of use, design, and fit within the context of daily life.

5. Future Trends and Directions

AI a Learning Integration: IoT devices are integrated with AI to predict and prevent dangerous situations. AI can analyze user behavior patterns, identify anomalies, and raise alerts or warnings before an emergency actually occurs.

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Voice and Gesture Recognition:Latest IoT innovations voice assistants or gesture recognition systems that enable women to initiate calls to emergency services without having to physically interact with their devices. It is particularly beneficial in scenarios where manual input is not practicable.

Involving the Police:Future research suggests labourations between IoT solutions and law enforcement agencies to improve emergency response times. Some systems are already being designed to directly connect to police or emergency dispatch centers for intervention.This literature review outlines the breadth of work and recent developments concerning Internet-of-Things-based solutions for women's safety, how technology can be used both in anticipatory and responsive ways to enhance security.

IV. CONCLUSION

This study reports a systematic literature review of IoT-based devices designed for women's safety to protect them from threats like molestation, harassment, rape, and abuse. It was conducted by reviewing 34 research articles gathered through eminent publication sources. The papers for reviewing the IoT-based devices forwomen's safety are gathered by considering a number of keywords and their alternate words. Though a number of the keywords are used to search relevant literature, there exists the possibility that some studies used other words and their synonyms in their work that could

Affect the final results. This risk was mitigated by carefully considering various keywords and classifies these keywords as primary, secondary, and tertiary to form the search string and apply different Boolean operators to combine the specified classification of keywords. In addition, the classification of the studies has been made by authors, which is reviewed by Two independent reviewers. In case any disagreement was observed, a comprehensive discussion among the authors was made till reaching to consensus. The interrater reliability was 0.92 that depicted a high agreement.

After detailed analysis of the shortlisted studies, it was identified that IoT-based women's safety devices use different technologies as well as exhibits a number of prominent features, sensors and machine learning algorithms. Various categories of these aspects are classified to present taxonomy of IoT-based women's safety devices. Although each system provides different features which define the main working of those devices yet there are some shortcomings due to which these systems still not able to give effective support to deal with the potential safety threats for women.

Moreover, this study presented the gaps and challenges of using the previous devices due to which some devices could notwork effectively to serve the purpose. Furthermore, this review proposed an architectural model for IoT-based devices for women safety as future recommendation. This work will be helpful for the researchers to gain the state-of-the-art insight into the IoT-based women's safety devices as well as the practitioners to build useful and more effective IoT-based women safety devices.

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