

IoT Based Automatic Women's Safety Device for Enhanced Personal Security

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Abstract: Women's security is a worldwide important concern in today's scenario which needs urgent attention of all the concerns of the society to provide enhanced safety to women. This paper presents development and deployment of automatically operated women safety device based on IoT technology with improved features meant for giving added layer of security and safety to women. In this paper IoT based device is developed with Raspberry pi technology. The automatic triggering of electric shock mechanism is provided using machine learning algorithm for detecting emergency condition based on of user's body parameters. It sends message and current location to the registered contact number.

1 INTRODUCTION

Even in today's scenario, women's security is the serious global concern which needs urgent attention. The women are integral part of the society and for the progress of the society active participation of the women is necessary. Today women lead every sector of the world including social, political, economic and cultural. Although constitution provides equal rights to women in society but there is still discrepancy exist in the society. The violence against women is increasing both in urban and rural areas in every country across the globe. As per the report of WHO (World Health Organization) 30% women worldwide have faced the violence (UN News, 2020). According to NFHS (National Family Health Survey) 32% of married women in India have faced the violence (IIPS, 2021). National Crime Records Bureau of India, showed an increase in crime against women by 15.3% in 2021 in comparison with the year 2020 (NCRB, 2021). These figures indicate the seriousness of the situation. The significant rise in the crimes against women necessitates the development of effective solution to provide the complete safety to the women. This work aims at developing the women safety device which requires study of existing women safety devices for identifying gaps to develop the hardware.

The advanced technology can be utilized to develop the women safety device. Internet of Things (IoT) is a new technology which has brought a paradigm shift in the modern world. IOT provides the physical network of connected devices and the exchange of data between these devices and cloud.

2 RELATED WORK

Several research papers are published on women safety devices to address the women safety issue. The safety devices are based on Internet of Things (IoT) technology. Most of the devices are wearable devices where different sensors are used to measure the biometric parameters to detect the emergency situation. Some devices require human intervention to operate the device. Most of the devices use GPS/GSM technology to send the alert messages to saved contacts. IoT based women safety device developed in (Sathyashri B., 2019) device with attack mechanism. This device has electric shock generator circuit which can generate the voltage around 1200mV and current of 3 microampere. A smart device with android app developed in one research work (Penchalaiah N., 2021) in which device provides the user the location nearest safe zone. This device is activated by emergency

button and upon activation of the device it sends the users location to local police station and volunteer. A machine learning based device developed in other research work (Muskan, 2018) using IOT technology wherein temperature and heartbeat signals are used as measuring parameter for operating the device. Then this device is customized by applying machine learning algorithm to learn the specific pattern of temperature and pulse rate in normal and panic situation. A smart device with online and offline working flexibility is developed in one research work (Anusha,D.C. 2022) which sends the location of device to saved contact in online and offline mode. A self defense device is developed in (Srishkumar Mani J., 2023) where pepper spray is used for attacking purpose. After pressing spray button the mobile app gets activated which shares the location of user. A smart device with automatic activation is developed in (D. K. M. Anand Kumar , 2020). This device doesn't require human intervention for triggering of the device. The device has pressure sensors which send the data to machine learning algorithm for detecting the emergency condition. A smart band designed in (Bhate A., 2019) with accelerometer and temperature sensor with machine learning technique to detect the alarming condition. It is based on Arduino controller with GPS/GSM system for communication. A device embedded in necklace is developed in (Chowdhuri A. N. ,2023) with attack mechanism and recording system. In this system the device is embedded in necklace with emergency button. The device has camera module which captures the picture when the press button is pressed. A smart device with attack mechanism is developed in (K.S. Sagar Reddy, 2023) which requires manual activation of electric shock circuit for attack. A device with monitoring and messaging system is developed in (Uganya G., 2023). It is based on microcontroller, GSM modem and a GPS receiver. Another device for women safety developed in (Tayal S. , 2021) using NodeMCU, GSM, and GPS modules with manual control. A tracking device developed in (C.Priya, 2022) for women security with manual activation mechanism. The device traces the movements using GPS and posts messages to saved contact umbers using GSM.

The currently available women safety devices don't have all features of safety. Some devices require human intervention for their activation which is not helpful in the situation when women are not able to manually activate the device. Some devices are automatic which detects the physical parameters of women's body to trigger the device automatically but they don't have attack mechanism. The aim of

this work is to develop an automatic women safety device with attack, defense and message delivery mechanism.

3 PROPOSED WORK

The major features of proposed device are shown in Fig. 1. The proposed system can be a carry in the bag device or a wearable device with following major features:

- IoT based system with sensors: IoT device will be integrated with smart sensors such as pulse rate sensor, accelerometer and sound detector to sense abrupt change in the pulse rate or sound or movement. These sensors provide the identification of emergency situation condition.
- Self Defense and Attack Mode: It will prevent the incidence by giving attack and defense power to the user. It includes the electric shock, hitting rod or pepper spray which will impede the attacker and give time to the user to escape.
- Alert for Assistance : It will generate high decibel alarm or blinding flash light which can alert and attract the attention of nearby people for immediate help.
- Communication Mechanism: It will send emergency message and location to the saved contact numbers and authorities.



Figure 1: Major features of proposed women safety device.

The developed system will be in the form of standalone device which will automatically

activate the device and send the message without need of internet

3.1 Architecture of Women Safety Device

Fig.2 shows architecture of proposed system. It consists of sensing system, communication system, alert system and defense and attack system. An array of sensors is used to detect the parameters such as pulse rate, temperature and light. The temperature sensor DS18B20 is used to measure temperature. The DS18B20 is a digital thermometer which gives 9-bit to 12-bit Celsius temperature measurements with user-programmable alarm feature at high and low temperature set points. The DS18B20 needs one data line for communication over 33 a 1-Wire bus with a central microprocessor. Additionally it don't require external power supply as it takes the power from data line (parasite power). The heart-rate monitoring sensor used to measure heart rate based on spectrophotometry principle. It has red light and infrared light emitting LEDs and photo detector. This sensor is placed on the finger and the amount of light absorbed by the blood is measured. The BH1715 ambient light sensor is used to detect the light of surrounding environment. The sensor data will be transferred to controller for further processing. Raspberry pi controller is be used to coordinate and control the various devices connected to women safety system. Controller is programmed such that it can read the sensor data and detect the true safe and unsafe condition based on the values of sensor data. Machine learning algorithm is implemented to detect the true condition for triggering of device in order to avoid false triggering of the device.

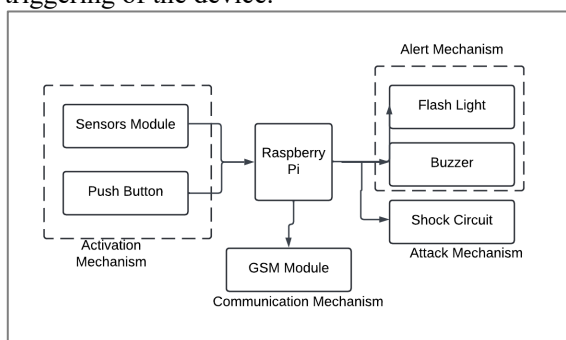


Figure 2 .Architecture of women safety device.

The device has the feature of automatic triggering activation such that initially manual button is used when the women travels alone or at night or when

she enters in unknown area. After activation of manual button, the device will monitor the sensor signal, device will also consider the environment factors including time, location etc. If the machine learning algorithm detects the abnormal situation, the device activates its automated response system which includes activation of shock circuit, sending messages to predefined contacts and authorities and triggering an alarm.

3.2 User Interface of Women Safety Device

Fig. 3 demonstrates the user interface of a women's safety device. It is equipped with pulse rate and temperature sensors, an alarm, flash light, shock circuit, web data monitoring, and SMS functionality to notify emergency contacts involves creating an intuitive and user-friendly experience for the wearer. The functionality of women safety device from user point of view is explained in this pictorial diagram. An alarm and shock circuit will get activated if the emergency situation is detected by the device. It will also send message and location details to registered contacts along with measured body parameters.

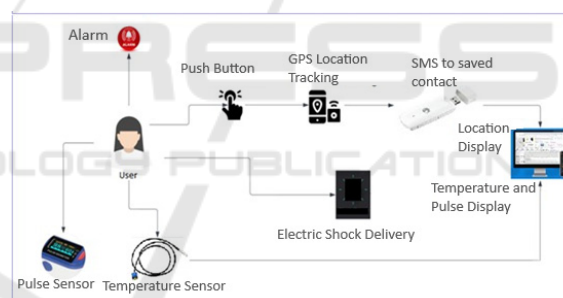


Figure 3. User interface of women safety device.

3.3 Working of Women Safety Device

The working process of women safety device is illustrated by the flow chart as shown in Fig. 3.6. Initially push button and shock circuit are switched off. The device continuously monitors the pulse rate and temperature of the user in real time. This physiological data serves as critical indicators of the wearer's well-being and can potentially reveal signs of distress or emergency situations.

The dataset is generated by data collection method and this data is provided to machine learning algorithm. The machine learning algorithm is embedded in Raspberry pi. The dataset is used to train the algorithm which has certain relationship

among the given parameters of data set. The algorithm takes care of all inputs and compares the incoming data with the already stored dataset. Upon detecting a potential emergency situation, the algorithm triggers the activation of the electric shock circuit.

The electric shock circuit is designed to deliver a non-lethal electric shock to potential assailants or attackers, providing the wearer with a means of self-defense and a deterrent against further harm. This feature aims to empower individuals in distressing situations and create a window of opportunity to escape or seek help. Additionally, the device sends the message to alert the emergency contacts or authorities. It also transmits the wearer's location information and physiological parameters to emergency contacts. It generates audible alarms and flashlight to attract attention and aid in rescue efforts.

The electric shock circuit give a high voltage and low amperage charge to the body. The voltage level is in the range of 200-230V DC voltage and current is 5mA which causes no harm to the attacker. This current level is safe and do not pose a significant health risk to attacker and provides a wearer with a means of self-defense and a deterrent against further harm. This feature aims to empower individuals in distressing situations and create a window of opportunity to escape or seek help. Additionally, the device sends the message to alert the emergency contacts or authorities. It also transmits the wearer's location information and physiological parameters to emergency contacts. It generates audible alarms and flashlight to attract attention and aid in rescue efforts.

The women safety device will work in two modes in normal condition and in emergency condition

Normal condition. In normal condition the pulse rate, temperature is continuously monitored by machine learning algorithm.

Abnormal Condition. In abnormal condition the shock delivery mechanism and an alarm will be activated and alert message along with location details sent to registered contact no. Following steps will be followed:

- Shock circuit activation
- Alarm activation
- Alert messages to registered contact nos

3.4 Design of Women Safety Device

The implementation of a women's safety device integrating temperature, pulse rate, GPS, and a shock circuit interfacing with a Raspberry Pi involves a systematic arrangement of hardware and software components. At the core of the system lies the Raspberry Pi, serving as the central processing unit. Connected to it are the various sensors and modules crucial for monitoring and responding to potential threats. The diagram portrays the interconnectedness of these components. Raspberry Pi OS is operating system for the Raspberry Pi which is pre-installed with various programming tools and environment. Python is one of the most popular programming languages for Raspberry Pi development. Since Python is open source and cross platform language, it is used for programming in this paper. System is designed by connecting the components to Raspberry Pi. Fig.4 explains the connections between Raspberry Pi and their components of the system like pulse sensor, temperature sensor, GPS module, electric shock circuit. The connections are explained as follows:

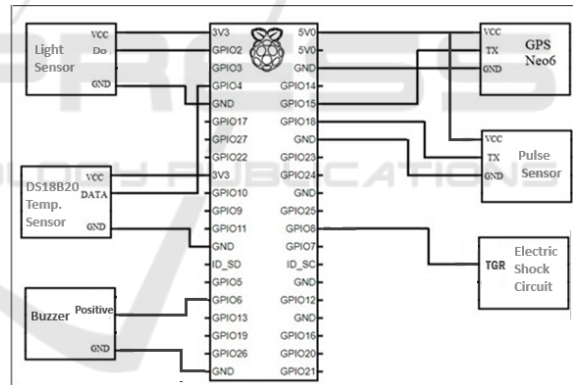


Figure 4. Circuit diagram of women safety device.

3.5 Machine Learning Algorithm

The machine-learning algorithm acquires perception the sensor parameters and identifies the safe and unsafe condition of the women. The body parameters and environment parameters are used to classify the women condition whether safe or unsafe. We have selected logistic regression machine learning algorithm for this work. Logistic regression provides prediction of safe or unsafe condition of the women by considering the real time variables such as pulse rate, temperature, age, and environmental conditions. It is statistical technique used to evaluate the probability of a women being in safe or unsafe condition

based on these parameters. The real time physiological parameters such as pulse rate and temperature gives the indication of stress which can be correlated with the condition of body in unsafe condition. Age is also a significant factor, as younger or older individuals might perceive and respond to safety concerns differently. Further, environmental conditions includes the parameters like time of day and lighting in surrounding environment, all of these factors can cause a significant impact on safety perceptions. In the logistic regression algorithm, we use these input variables to estimate the probability of a woman being in a safe situation. By training the model on data that includes incidents of safety concerns alongside corresponding measurements of pulse rate, temperature, age, and environmental conditions, we can establish patterns and relationships that help predict safety outcomes.

Model is trained on the training data, after which it is deployed to evaluate the real time data to identify the safety condition. By monitoring and analysing these predictions, it prevents the false triggering of the device. If a woman is found in unsafe condition then it takes the action as per the functionality of the device.

3.6 Implementation of Women Safety Device

To assess feasibility of the proposed system, we have implemented the system on an IoT based testbed i.e. a Raspberry Pi series platform. Fig. 5 shows the implementation diagram of women safety system. The electric shock circuit is connected raspberry pi through relays. GPS, pulse and temperature sensors are energized by raspberry pi whereas the electric shock circuit requires the battery to store the energy for instantaneous discharge.

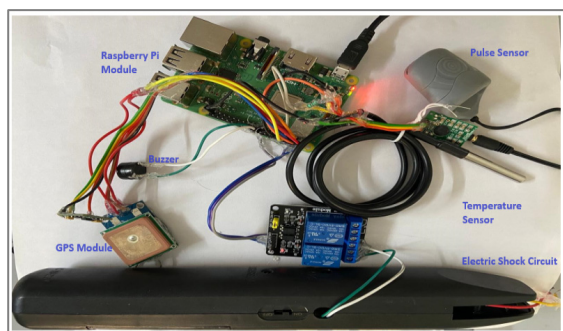


Figure 5. Prototype of women safety device.

4 RESULTS

The device generates the electric shock and buzzer in emergency situation and sends the SMS to registered contact numbers. The non-lethal shock is generated which can stop the attacker and help the women by giving opportunity to escape. The sound of buzzer is kept high so as to attract the attention and alert the nearby people.

Fig. 6 shows the screen shot of the message delivered to the registered contacts when the women has faced the emergency condition. The current location of the women is transmitted along with message. The location is displayed on the map for easy identification of the area.



Figure 6. Emergency SMS snapshot.

5 CONCLUSION

This study focuses on development of women security system that provides safety to women so that women can use these devices as and when required while facing social challenges.

It was observed that IoT based devices offer innovative features, sensors for making them smart devices. Still there are few gaps which affect the widespread use of these devices. To address those gaps, the solution is provided in this paper to make the device more effective. Furthermore, developed paper provide the self-defense tool to the women to move confidently in

the society. This device is developed by taking into account all possible ways of attack and possible ways for easy defense. The device is automatically operated by continuously monitoring pulse, temperature, lighting condition of the surrounding which can give the indication of emergency condition. The device has shock delivery mechanism which will be activated once emergency condition is detected. Also an alarm sound is also generated to attract the attention of nearby people. The text messages and location details will be sent to registered mobile no upon activation of the device using GPS and GSM techniques. Thus this device will provide the enhanced protection to the women.

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