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An IoT-Based Smart Device for Real-Time Women Safety and Emergency Response

Sumanta Chatterjee[1], Bishtu Bhowmick[2], Joydeep Kundu[3], Parthib Sarkar[4], Ahana[5], Joy Mondal[6], Kushagradhi Bhowmick[7]

[1] *Asst. Professor, Department of CSE, JIS College of Engineering, Kalyani, India.*
[2,3,4,5,6,7] *UG Students, Department of CSE, JIS College of Engineering, Kalyani, India.*

Abstract - With the increase in sexual violence and harassment complaints, personal safety, especially for women, has become a big issue in today's society. This Research Work outlines an IoT (Internet of Things) based Smart Device for Women Safety system that proactively prevents such cases and responds when they happen. The proposed system continuously monitors the user's safety by using several components such as NodeMCU ESP32, fingerprint sensor, GSM module (SIM 800L/A7670C) and GPS module (Neo-6M) which help send alerts in case there is any danger. When in danger the user(Women) gets to activate the machinery that needs her to prove she is the right owner once in every five minutes through a fingerprint detector. If the verification is not done by the user during that set period of time, then GPS module will automatically track her current location and through GSM already registered contacts along with the emergency services number provided by the government for immediate rescue by coops will receive an emergency message containing where she is located. Our Research Work's main aim is to create a portable, adaptable and low cost make-do gadget which would improve individual security as well as provide prompt help in critical situations. This is an approach to ensure we have the exact location of that person activated the device at all times so that, in case of emergencies no matter what happens she shouldn't get lost. The design of the gadget is such that it would be possible to place it inside your purse or even carry it around in your hand thereby promoting mobility among women. Thus generally speaking this work seeks forward towards designing a system for real-time monitoring of users based on their geographical position enabling them to avoid dangers preemptively and also seek assistance faster during emergencies anywhere anytime.

Key Words: Women Safety, NodeMCU ESP32, Fingerprint Authentication, GSM Module (SIM 800L/A7670C), GPS Module (Neo-6M).

1. INTRODUCTION

Safety of women has emerged as a global issue in the recent past due to rising incidences of harassment, violence and unsafe environments. As a result, there is growing need for innovative ways that can enhance individual security and provide immediate help during emergencies.

The proposed Research Work focuses on the design and development IOT-based Smart Device for Women Safety which is intended to be a reliable, convenient and easy to operate device by which women can save themselves from dangerous circumstances. Designed for real-time communication as well as tracking, a number of components are integrated into the Smart Device which includes NodeMCU ESP32 (microcontroller), GSM module (SIM 800L/A7670C), fingerprint sensor and GPS module (Neo-6M). When the user believes that she is in danger, she can turn on the device causing it to remain continuously on guard for her safety. The user is then supposed to authenticate herself from time to time using a fingerprint sensor (after every five minutes) so that she does not lose grip of things. If the fingerprint is not authenticated within the set time, it automatically triggers emergency response by tracking the user's current location through GPS and sending distress message to pre-registered contacts and local emergency services via GSM module. Furthermore, this device can utilize IoT for constant transmission of location information to a web-based system, which will enable authorized persons make it suitable for everyday use, hence allowing women to hide it well in their devices without causing any disturbances thus adding an extra channel of protection. This Research Work is meant for cater to the high demand for accessible and efficient personal safety devices, using IoT technology as well as real-time communication combined with bio-metric security. With these technologies integrated in one small cheap package, the Smart Device gives women a way of taking control over their safety making sure by just pressing her finger, she will get assistance., such as family members or police officers to follow the movements of the user in real time. Its small size and portability. This Research Work is meant for cater to the high demand for accessible and efficient personal safety devices, using IoT technology as well as real-time communication combined with bio-metric security. With these technologies integrated in one small cheap package, the Smart Device gives women a way of taking control over their safety making sure by just pressing her finger, she will get assistance.

2. LITERATURE REVIEW

The use of smart devices based on the Internet of Things has led to the development of new solutions for safety, especially for women. Several research with works other have emerging been technologies conducted in to order demonstrate to how develop IoT safety can mechanisms. be This integrated review focuses on major themes of the literature, the power management, wearable designs, artificial intelligence, and health monitoring.

Power Management :

The management of power is a major concern in the development of IoT devices. The application of low energy components and renewable energy sources such as solar charging systems have been recognized as key factors to increase the lifespan of the device. Solar powered wearables have been found to be effective in minimizing the charging frequency thus offering case efficient of service an in case of emergency.

Wearable and Discreet Safety Designs :

Safety has become a main focus in wearable technology, and thus the design of the safety devices has also received much attention in terms of both functionality and design. Research has been conducted on the integration of safety features in everyday wear such as bracelets, watches and key chains to ensure that the aspect of convenience is met. These designs not only enhance the portability of the device but also enhance the usability of the device by making it easily incorporated in the day to day activities of the user.

Artificial Intelligence in Safety Systems :

AI has played a great role in the advancement of safety precautions by developing adaptive safety measures. The current machine learning algorithms are able to identify any change in the user's behavior like sudden halt, erratic movement or no movement at all for long periods. Real-time emergency response systems are enhanced by AI systems as they are able to identify potential threats and raise alarm subjecting the victims to danger for longer periods.

Here's a structured **Methodology** section for the paper, which outlines the approach, tools, and processes involved in developing the Smart Device for Women Safety is divided among five sections for better understanding of our device, and these sections are introduction part followed by research methodology, result analysis, conclusion, future scope and the references used.

3. METHODOLOGY

To guarantee a dependable, effective and easy to use device, the progression of the IoT based Smart Device for Women Safety utilizes an organized research and development approach. The different stages of the project such as system design, component selection, hardware and software integration, as well as testing are discussed in this section.

3.1 System Design and Conceptualization

The very first step taken for the project was creating an idea for the general layout of a Smart Device and analyzing its functions. More precisely, this aspect aimed at producing a handy, secretive but effective system capable of real time safety observation as well as emergency response.

The steps involved are : The process began by recognizing the actual security challenges that women face in society. Next, available safety tools were examined to identify their weaknesses. This led to the establishment of key features for the Smart Device, such as biometric security, GPS tracking, and GSM communication. To integrate the various software and hardware components, the system architecture was outlined in a block diagram.

3.2 Component Selection

This was an essential stage in the procedure used to develop the Smart Device, considering that it has an effect on performance, affordability as well as size of the device. The selection made on some of the vital components was informed by their ability to offer reliability, consume less power and be readily available.

Fig.1: NODEMCU ESP32

NodeMCU ESP32 (Microcontroller) (Fig-1): It has been selected due to its low rate of power consumption and supports wireless communications including Wi-Fi and Bluetooth; this makes it easy to program through Arduino IDE.

Fig.2: : GSM Module (A7670C)

GSM Module (SIM 800L/A7670C) (Fig-2): For SMS alerts and emergency contact communication, this module is integrated with the system.

Fig.3: Fingerprint sensor

Fingerprint Sensor(Fig-3): This function helps to protect the system bio metrically, allowing periodic authentication by the user.

Fig.4: GPS Module (Neo-6M)

GPS Module (Neo-6M)(Fig-4): Allows real time location tracking of the user accurately.

3.3 Workflow Diagram:

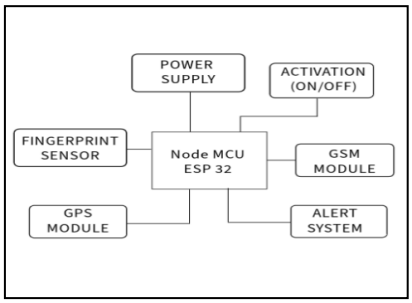

Fig.5: Workflow Diagram.

3.4 Circuit Diagram:

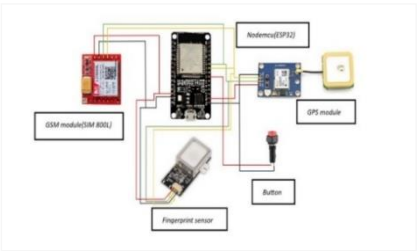

Fig.6: Circuit Diagram.

Working Principle of this research:

The IoT-based Smart Device for Women Safety works by combining a number of hardware components that are interconnected through a circuit to allow communication and operation. The central controller is the NodeMCU ESP32, which manages the data coming in and going out of the other modules. A fingerprint sensor is interfaced with the ESP32 and the user in a threatening situation activates the device and must scan her fingerprint after a period of time. In the case of missed fingerprint scanning in the pre-defined period of 5 minutes which is the limit, the ESP32 commands to active the GPS module (Neo-6M) in order to catch the current location of the user. At the same time, the ESP32 activates the module GSM (SIM800) that will make a voice call or send a message with the geographic coordinates to emergency services and already registered individuals. Owing to the IoT capability of the ESP32, it is able to send information about a person's location via Wi-Fi, allowing the continuous tracking of the person on a web page that can be accessed by authorized users. The whole system relies on a portable battery connected to the ESP32 and other components, making sure the circuit is lightweight and compact to fit in a bag. The dual mode of ESP32 means it can communicate via GSM and Wi-Fi networks, which makes sure the system works even in poorly connected internet regions using GSM to send emergency alerts. The presented circuit design allows for automatic monitoring, biometric and emergency response solutions which altogether forms an effective solution to the problem of women's safety.

Table 1: Pin connection of the NodeMCU ESP32 to the GSM module , GPS module , Fingerprint sensor, and a Button

Component	ESP32 Pin	Module Pin	Description
GSM Module (SIM800)	GPIO16 (TX)	RX (Pin 9)	ESP32 Transmit to GSM Receive (Serial Communication)
	GPIO17 (RX)	TX (Pin 10)	ESP32 Receive from GSM Transmit (Serial Communication)
	3.3V	VCC	Power the GSM Module
	GND	GND	Common Ground
GPS Module (Neo-6M)	GPIO18 (TX)	RX (Pin 3)	ESP32 Transmit to GPS Receive (Serial Communication)
	GPIO19 (RX)	TX (Pin 4)	ESP32 Receive from GPS Transmit (Serial Communication)
	3.3V	VCC	Power the GPS Module
	GND	GND	Common Ground
Fingerprint Sensor	GPIO5 (TX)	RX (Pin 5)	ESP32 Transmit to Fingerprint Sensor Receive
	GPIO6 (RX)	TX (Pin 6)	ESP32 Receive from Fingerprint Sensor Transmit

	3.3V	VCC	Power the Fingerprint Sensor
	GND	GND	Common Ground
Button	GPIO4 (Digital Pin)	One side of the button	Used to turn the system ON/OFF or trigger actions
	GND	Other side of the button	Ground side of the Button

4. RESULT & ANALYSIS

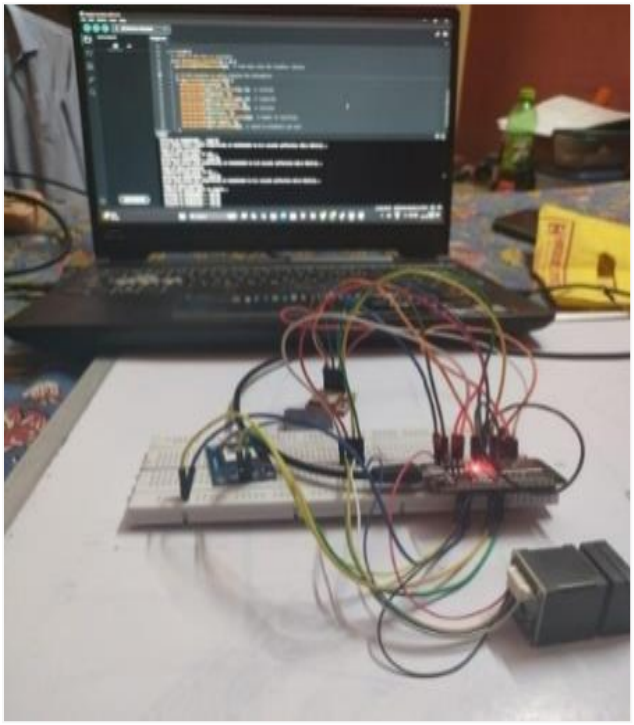

Fig.7: Working circuit diagram.

Experimental data analysis of fingerprint sensor:

This data will show that after giving the fingerprint the message will be transferred through the GSM Module as Safe:

CASE NO.	Sample	Fingerprint Timing (min)	Message Transfer
1	1	1 min	Yes
	2	1 min	Yes
	3	1 min	Yes
	4	1 min	Yes
	5	1 min	Yes
	6	1 min	Yes
	7	1 min	Yes
	8	1 min	No
	9	1 min	Yes
	10	1 min	Yes
2	1	2 min	Yes
	2	2 min	Yes
	3	2 min	Yes
	4	2 min	Yes
	5	2 min	Yes
	6	2 min	No
	7	2 min	Yes
	8	2 min	Yes
	9	2 min	Yes
	10	2 min	Yes
3	1	3 min	Yes
	2	3 min	Yes
	3	3 min	Yes
	4	3 min	Yes
	5	3 min	Yes
	6	3 min	Yes
	7	3 min	Yes
	8	3 min	Yes
	9	3 min	Yes
	10	3 min	Yes

Table 2: Experimental result analysis for safe detection.

We have shown above the three (3) case no. having 10 samples each for being in Safe condition of the device user that after giving the fingerprint the message will be transferred through GSM Module as Safe and for better accuracy we have taken 500 samples further, which has been displayed in the following link : https://docs.google.com/spreadsheets/d/1cU6XmSH3lMakfWxDpv8qEHajU3CSZBaD/edit?usp=sharing&ouid=108884057295876080521&rtpof=true&sd=true

Table 3: Experimental result analysis for unsafe detection.

CASE NO.	Sample	Fingerprint Timing (min)	Message Transfer
1	1	1 min	No
	2	1 min	No
	3	1 min	No
	4	1 min	No
	5	1 min	No
	6	1 min	No
	7	1 min	No
	8	1 min	No
	9	1 min	No
	10	1 min	No
2	1	2 min	No
	2	2 min	No
	3	2 min	No
	4	2 min	No
	5	2 min	No
	6	2 min	No
	7	2 min	No
	8	2 min	No
	9	2 min	No
	10	2 min	No
3	1	3 min	No
	2	3 min	No
	3	3 min	No
	4	3 min	No
	5	3 min	Yes
	6	3 min	No
	7	3 min	No
	8	3 min	Yes
	9	3 min	No
	10	3 min	No

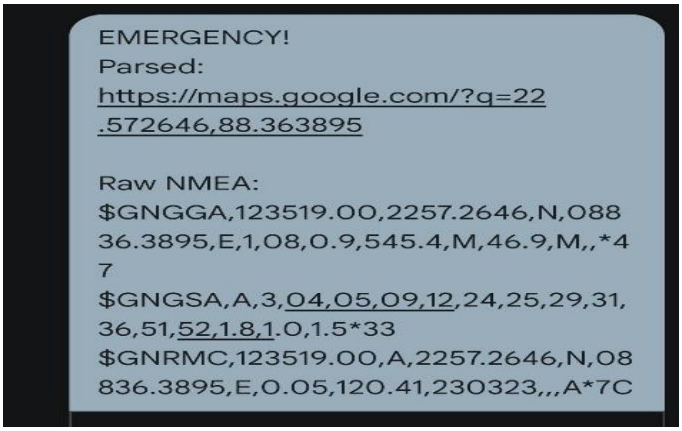

Fig. 8: Output view

We have shown above the three (3) case no. having 10 samples each for being in Unsafe condition of the device user that after giving the fingerprint the message will be transferred through GSM Module as Unsafe and for better accuracy we have taken 500 samples further, which has been displayed in the following link : https://docs.google.com/spreadsheets/d/1gzGchYWBLqsjU3gwR4kHFoO0z7QmkpME/edit?usp=sharing&ouid=108884057295876080521&rtpof=true&sd=true

In this table we have conducted the experiment 500 times. It has been observed that the device is working smoothly with overall accuracy of 98%.

5. CONCLUSIONS

By using IoT technology, the smart device for women's safety was created. This is one of the most brilliant and practical ways to handle female personal protection issues today. An authentic system that tracks user locations, verifies her identity and sends out alarms when there is a risk to life has been thus set up using a NodeMCU ESP32, fingerprint sensor, GSM module (SIM800L) as well as GPS module (Neo-6M). Because it can be easily carried about anywhere, its portability and simplicity in use are amazing while its internet property enables constant tracking of locations. The purpose of this mechanism is to warn the personal safety problems more especially for women while they are passing through dangerous conditions via fingerprints recognition technology with real-time text messages. It is also implemented taking into account scalability; thus it will be adaptable even at global level.The Smart Device has potential to evolve into complete safety mechanism with improvements in connectivity, power consumption and user interface in the future so as to provide peace of mind for females globally. This Research Work has established grounds for improved and long-lasting personal security engineering beyond short term concerns on security issues needing immediate attention..

6. FUTURE SCOPE :

Prospects for what lies ahead: The Smart Device for Women Safety based on IoT includes several ways to develop a more advanced personal safety mechanism. Such Technologies can enhance and grow in many anticipated improvements that can boost the functionality as well as the effectiveness. One area of improvement is the power management. Using components that consume less energy can extend the life of batteries in such smart devices. Additionally, a solar energy charging system can help the smart device work without so many recharges, which also makes it better for users. Another area that seems promising would be the inclusion in wearables. The smart safety system can now evolve into smaller, less visible objects like watches, bracelets or key chains, increasing convenience and making the safety devices less visible. In this way, people would carry personal safety mechanisms in different forms that fit perfectly into their day-to-day lives. Personal safety can also greatly rely on advances in Artificial Intelligence (AI). By using the AI algorithms, abnormal activity of the user could be detected and alarm messages issued when anything is wrong with that situation. As such, real-time response to emergency will also be improved by this. Furthering the health monitoring features adds value to this smart device. Vital sign sensors include monitoring heart rate, blood pressure, and body temperature. The system may automatically notify emergency services to further safeguard users in cases where the user may faint or get stressed or suffer any type of injury.

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