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Automatic Threat Detection and Alerting System for Women

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ABSTRACT: Women's safety is a critical concern in today's world, necessitating innovative and real-time solutions to address potential threats effectively. This project proposes an Automatic Threat Detection and Alerting System for Women, leveraging IoT technologies and wearable sensors to provide immediate assistance during emergencies. The system integrates multiple sensors, including a heart rate sensor, SpO₂ sensor, temperature sensor, and tilt sensor, to monitor vital signs and detect unusual physical conditions such as sudden falls or health anomalies. An ESP32 camera captures images when a potential threat or fall is detected, while a NodeMCU ensures seamless data transmission. For real-time monitoring and visualization, the system connects to the Ubidots IoT platform, enabling continuous tracking. Additional safety features include a GPS module for location sharing and a buzzer to alert nearby individuals in case of emergencies. A compact LCD display provides real-time feedback to the user. Furthermore, captured images are transmitted via Telegram, facilitating quick and informed responses. Designed to be efficient, scalable, and cost-effective, this system offers a reliable framework for women's security in both personal and public environments, ensuring rapid detection and response without requiring manual intervention.

KEYWORDS: Alerting System, Wearable sensors, Internet of Things (IoT), Vital signs monitoring, Tilt sensor, Temperature sensor, SpO₂ sensor, Heart rate sensor, ESP32 camera, NodeMCU, Data transmission, GPS module, Real-time monitoring, Ubidots IoT platform, LCD panel, Telegram alerts, Emergency response etc.

I. INTRODUCTION

Women's safety is a paramount concern in modern society, requiring innovative and immediate solutions. Traditional safety measures often rely on reactive responses, proving insufficient in preventing or mitigating incidents in real-time. The rapid advancement of Internet of Things (IoT) technologies, coupled with sophisticated sensor systems, offers a promising avenue for developing proactive and automated safety solutions [15, 18]. Existing safety systems have evolved from basic personal alarms to more complex systems integrating GPS tracking and manual emergency calls [14, 17]. However, these systems often rely on user activation and lack the ability to automatically detect and respond to threats or emergencies. The need for systems that seamlessly integrate health monitoring, environmental sensing, and real-time communication has become increasingly evident. Recent research has explored the use of wearable sensors for vital sign monitoring and fall detection, as well as the integration of camera systems for visual threat assessment [4, 6, 20]. The development of IoT platforms like Ubidots and communication tools like Telegram further enables real-time data visualization and rapid response coordination.

Despite advancements, several challenges persist in the development of effective women's safety systems. A significant limitation is the reliance on manual activation, which can be impractical during emergencies [2, 11]. Existing systems often struggle with accurately distinguishing between genuine threats and false alarms, leading to desensitization and reduced user trust [3, 9]. Integrating diverse sensor data, such as heart rate, SpO₂, temperature, and accelerometer readings, requires robust data fusion and processing mechanisms [6, 18]. Furthermore, ensuring continuous connectivity and reliable data transmission in diverse environments remains a challenge [12, 13]. Privacy concerns related to data collection and location tracking also necessitate the implementation of secure and transparent data management practices [18]. Additionally, many systems lack the ability to provide comprehensive situational awareness, combining health data, visual information, and location tracking for effective emergency response.

This project is motivated by the need to develop a comprehensive and automated safety system that addresses the limitations of existing solutions. The increasing availability of affordable IoT devices and powerful communication platforms enables the creation of a system that combines vital sign monitoring, fall detection, visual threat assessment, and real-time location tracking. The motivation is to provide a proactive and reliable safety net for women, enhancing their security in both personal and public environments by ensuring rapid detection and response without requiring manual intervention. We aim to create a system that is efficient, scalable, and cost-effective, making it accessible to a wide range of users.

The primary objectives of this project are:

- To develop an integrated IoT-based system that combines wearable sensors (heart rate, SpO₂, temperature, tilt) with a camera system for comprehensive threat detection.
- To implement real-time data transmission and visualization using NodeMCU and Ubidots IoT platform.
- To enable automatic fall detection and health anomaly monitoring through sensor data analysis.
- To integrate a GPS module for precise location tracking and emergency location sharing.
- To provide immediate local alerts through a buzzer and LCD display.
- To facilitate rapid remote intervention by transmitting captured images via Telegram.
- To design a system that is efficient, scalable, and cost-effective, ensuring accessibility and reliability.

This project contributes to the field of women's safety by:

- Developing a multi-sensor system that integrates health monitoring, fall detection, and visual threat assessment for enhanced situational awareness.
- Implementing a real-time data transmission and visualization framework using IoT platforms and communication tools.
- Providing an automated threat detection and alerting system that minimizes reliance on manual activation.
- Enhancing emergency response capabilities through precise location tracking and rapid remote intervention.
- Offering a cost-effective and scalable solution that can be deployed in diverse environments

The paper is organized as follows: Section II presents the literature survey of related works. Section III about existing method, Section IV details the proposed methodology, including system design and implementation. In Section V shows the discussion of results. Section V concludes the paper, providing insights into the future directions of research.

II. RELATED WORKS

Vasamsetti et al. [1] propose a hybrid detection and alert mechanism using AI-based smart surveillance systems. This approach emphasizes the integration of multiple AI techniques to enhance detection accuracy in diverse environments.

Miriyala et al. [10] also focus on the integration of AI-based advanced surveillance approaches for women's safety. Yogi et al. [3] introduce "VigilNet," an IoT and ML-based system for real-time threat detection and alerts, demonstrating the synergy between these technologies.

Pagadala et al. [6] focus on wearable IoT devices for automatic threat sensing and monitoring.

Priya et al. [7], Akram et al. [12], Sathyasri et al. [13], Khan et al. [15], Patel et al. [17], and Rao et al. [18] all describe various systems using IoT devices and sensors for real time alerts, location tracking and health monitoring.

Computer Vision and AI for Threat Detection:

Hansda et al. [4] explore a computer vision-based approach for protecting women from safety threats using AI and IoT, demonstrating the potential of visual analysis in identifying dangerous situations.

Singh et al. [5] presents a platform that utilizes AI, ML, and IoT for real-time threat detection, incorporating GPS tracking for comprehensive safety analytics.

Machine Learning and Audio Sensing:

Madhavi et al. [8] investigate a women safety app that uses machine learning and audio sensing for danger detection

and incident prevention, showing the importance of auditory cues in threat assessment.

Chakraborty et al. [19] describe a machine learning-based threat prediction system, which anticipates and prevents threats by analyzing data patterns.

GPS and GSM Technologies for Location Tracking and Emergency Alerts:

Prabha et al. [14] discuss a real-time safety system for women incorporating GPS and GSM technologies, emphasizing the importance of reliable communication for emergency response.

Patel et al. [17] also integrate GPS tracking into their alerting system.

Wearable Technology and Real-Time Emergency Response:

Nair et al. [20] discusses a wearable device that integrates IoT and AI technologies for real-time emergency response.

Akram et al. [12] and Sathyasri et al. [13] also use wearable devices in their systems.

AI Integration for Enhanced Security Alerts:

Kumar et al. [9] explores AI-assisted threat detection systems, integrating IoT and AI for real-time security alerts, highlighting the role of intelligent algorithms in improving alert accuracy.

Reddy et al. [11] discusses IoT based smart security and safety systems.

III. EXISTING METHOD

The majority of women's safety systems in use today rely on wearable technology or smartphone apps that incorporate GPS and GSM for emergency alerting and real-time location tracking. These gadgets are made to send SMS or phone calls to designated contacts or authorities in the event of an emergency. A panic button serves as the main activation mechanism for many of these devices, necessitating user participation. Furthermore, some systems use buzzer mechanisms or flashlights to draw attention in public areas, while others use mobile applications to dynamically communicate the user's location.

Despite their effectiveness in basic location monitoring and emergency communication, these systems frequently lack automation when it comes to identifying possible dangers or irregularities in health. Advanced features like multi-sensor integration to track vital signs, identify odd movements, or detect falls are either non-existent or not fully developed. This restricts their ability to act proactively when the user is unable to manually activate the gadget or is incapacitated.

IV. PROPOSED METHOD

The proposed system consists of various interconnected hardware components for efficient threat detection and alerting:

1. **GPS Module:** This module continuously tracks the user's real-time location. When a threat is detected, the GPS coordinates are sent to predefined emergency contacts and law enforcement agencies via IoT communication.
2. **Heart Beat Sensor:** The heartbeat sensor monitors the user's heart rate and detects abnormalities such as sudden increases or decreases in pulse rate, which could indicate distress or a medical emergency.
3. **SpO2 Sensor:** This sensor measures the oxygen saturation levels in the user's blood. A sudden drop in SpO2 levels can indicate health distress, prompting the system to trigger an alert.
4. **Temperature Sensor:** Monitors body temperature variations to identify conditions like fever or shock, which could suggest medical distress or physical assault.
5. **Tilt Sensor:** This sensor detects unusual body postures and falls. If a sudden tilt or collapse is identified, it assumes an emergency situation and sends an alert.
6. **ESP32 Camera:** When a threat is detected, this camera captures images of the surroundings and sends them to emergency contacts and law enforcement via Telegram.
7. **Power Supply:** Ensures stable power distribution to all components, including microcontrollers, sensors, and communication modules.
8. **Arduino:** The primary microcontroller that processes data from various sensors and manages the overall

- system operation. It also communicates with the NodeMCU for cloud-based monitoring.
9. LCD Display: Displays real-time data, including heartbeat rate, temperature, SpO2 levels, and system status.
 10. NodeMCU ESP8266: This module enables Wi-Fi connectivity, allowing the system to send alerts to cloud platforms such as Ubidots for real-time monitoring and data visualization.
 11. Buzzer: An audible alert system that activates in an emergency to attract nearby help and alert bystanders.
 12. IoT (Ubidots Platform): A cloud-based IoT platform where real-time sensor data is stored, analyzed, and visualized for monitoring. Authorities and family members can access this data remotely.
 13. **Telegram:** Used for instant messaging, the system sends images and location updates through Telegram to predefined contacts, ensuring quick responses in emergencies.

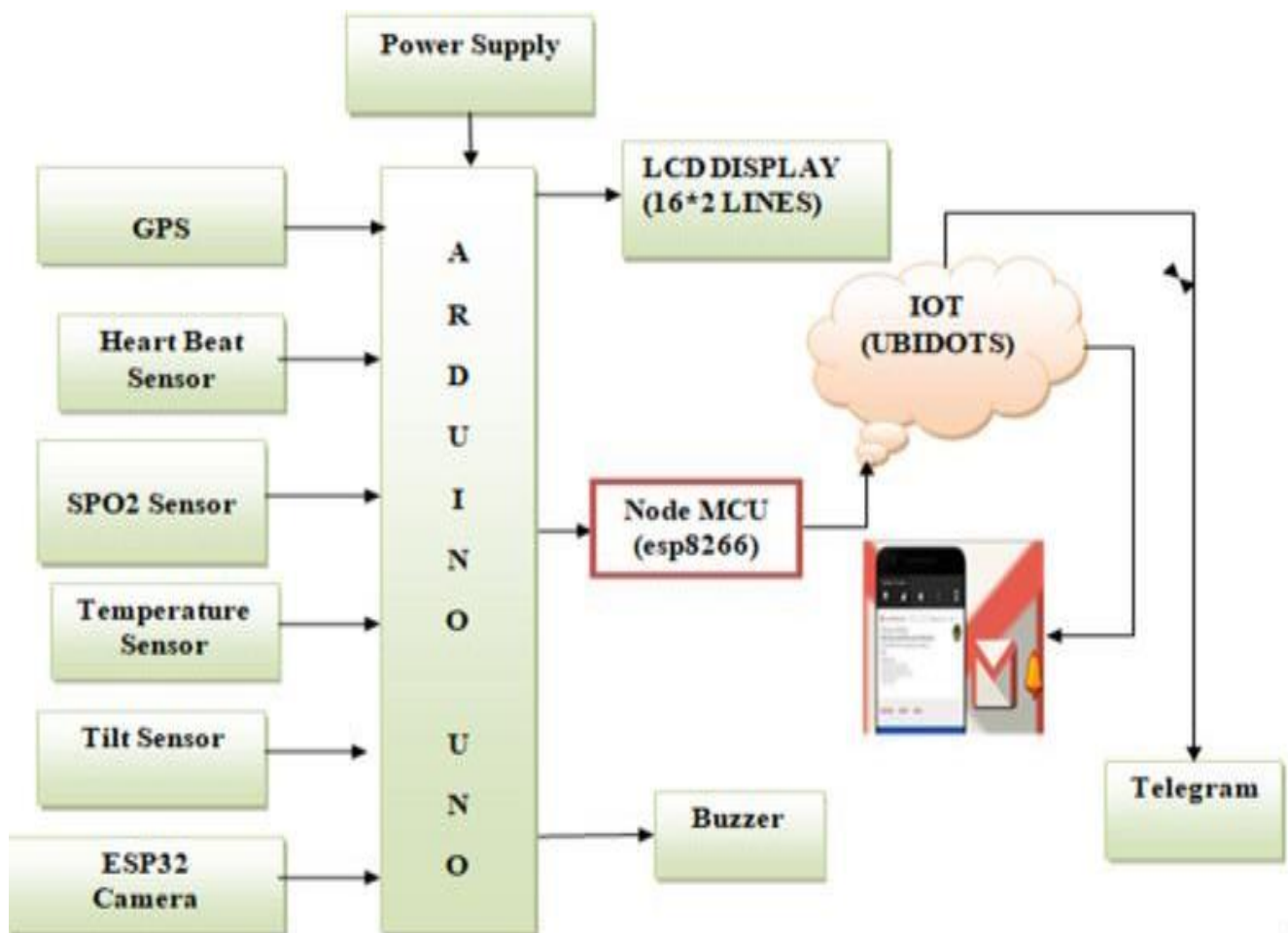


Fig. 1. Proposed Block Diagram

Overall, the block diagram illustrates a well-integrated system where all components work synchronously to detect and respond to potential threats in real time. The sensors continuously monitor the user's physiological and environmental parameters, while the Arduino processes the data and triggers alerts through NodeMCU. The ESP32 camera captures evidence, and GPS tracks the user's precise location. The system ensures rapid communication via IoT cloud platforms and Telegram, making it highly reliable for real-world deployment. The incorporation of a buzzer for immediate attention and an LCD for real-time feedback further enhances the system's effectiveness, providing a comprehensive safety solution for women.

Methodology:

The methodology for the proposed Automatic Threat Detection and Alerting System for Women involves the following key phases:

Hardware Integration:

A wearable device is designed, integrating multiple sensors including a GPS module, heart rate sensor, SpO2 sensor, temperature sensor, and tilt sensor. An ESP32 camera is incorporated to capture images when a threat is detected. The system is powered using a stable power supply unit, ensuring efficient operation of all components. Arduino and NodeMCU ESP8266 microcontrollers are used to manage data collection and processing. An LCD display is included to provide real-time feedback to the user.

Sensor Data Acquisition and Processing:

The sensors continuously monitor the user's physiological parameters and environmental conditions. Collected sensor data is processed in real-time using Arduino, which analyzes anomalies and distress conditions. The tilt sensor detects sudden movements or falls, which are considered as emergency triggers. The ESP32 camera captures images when a distress signal is detected.

Threat Detection and Decision-Making:

A predefined threshold algorithm is implemented to classify normal and emergency conditions based on sensor readings. If a sudden fall, abnormal heart rate, drop in SpO2 levels, or high temperature is detected, the system triggers emergency response. AI-based models may be integrated for anomaly detection to improve accuracy.

Communication and Alerting Mechanism:

In case of an emergency, the system sends an SOS alert via NodeMCU ESP8266. The GPS module transmits real-time location data to the cloud-based IoT platform (Ubidots). telegram messaging service is used to send captured images and GPS coordinates to predefined emergency contacts and law enforcement agencies. A buzzer is activated to draw immediate attention from nearby individuals.

IoT Cloud-Based Monitoring:

All sensor data and alerts are logged into the Ubidots IoT platform for remote monitoring. Emergency responders and family members can access the real-time data through a web interface or mobile application.

Power Optimization and System Efficiency:

Low-power modes are implemented in sensors and microcontrollers to enhance battery life. The system is designed to balance power efficiency with real-time processing.

Testing and Validation:

The prototype is tested in controlled environments to evaluate response time, accuracy, and system reliability. Field testing is conducted to analyze real-world applicability and user feedback is incorporated for improvements.

V. IMPLEMENTATION

The flow chart explanation is given as follows:

Start → The system is powered on, and all sensors and modules are initialized.

Initialize Sensors and Components → The GPS, heart rate sensor, SpO2 sensor, temperature sensor, tilt sensor, ESP32 camera, and other components start collecting real-time data.

Monitor Physiological and Environmental Data → The system continuously monitors heart rate, SpO2 levels, body temperature, and motion using the tilt sensor.

Detect Abnormal Conditions

If the system detects abnormal physiological data (e.g., high heart rate, low SpO2, extreme temperature) or unusual body movement (fall detected by tilt sensor), it triggers an emergency response.

If no abnormal condition is detected, it continues monitoring.

Capture Image using ESP32 Camera → The system captures an image of the surroundings to provide visual context for emergency responders.

Send Emergency Alert → An alert message containing GPS location, sensor data, and the captured image is sent via the NodeMCU ESP8266.

Transmit Data to Ubidots IoT Platform → The collected data is sent to a cloud-based platform for real-time monitoring and logging.

Send Alert via Telegram → Emergency alerts, including location and images, are sent to predefined contacts (family, law enforcement, or emergency services) via Telegram.

Activate Buzzer for Immediate Attention → A loud buzzer is activated to draw attention and help in the vicinity.

End → The process loops back for continuous monitoring and response.

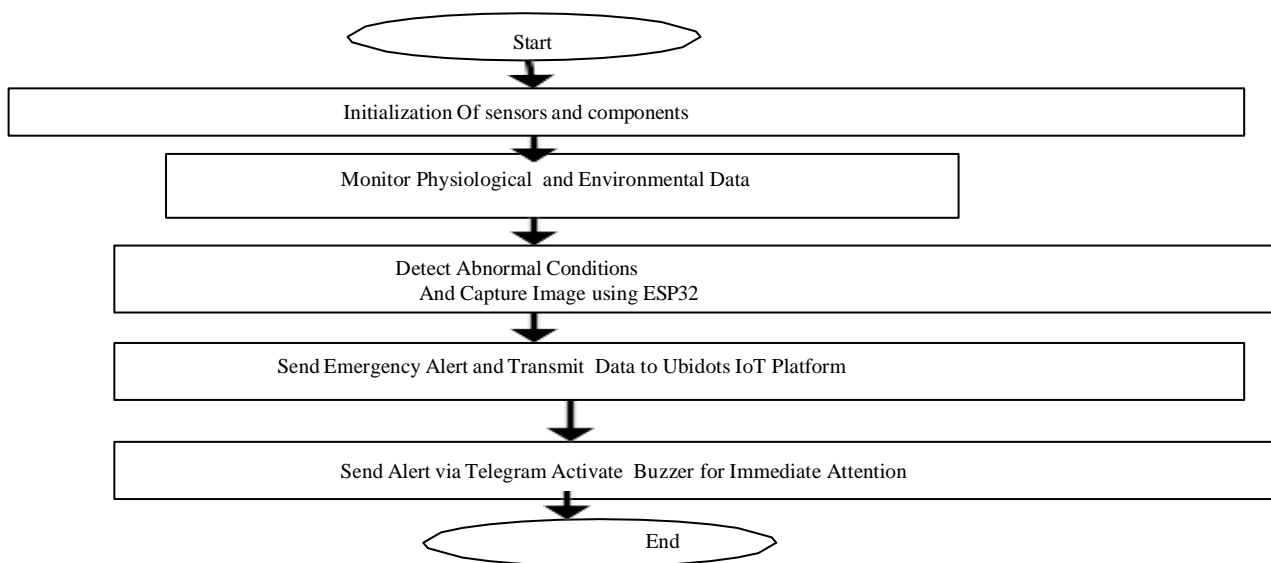


Fig. 2. Implementation Flow chart of Proposed method

VI. SIMULATION RESULTS

The components are arranged in a prototype. Arduino tool is used as software. It is used for writing the code and compile code in the project. The below figure 3 shows the hardware setup. The below figure 4 shows the ESP camera capturing and sending the emergency alerts message. The figure 5 gives the information regarding the temperature and spo2 levels of a person. The below figures 6 and 7 indicates heartbeat bpm and fall status and corresponding latitude and longitude values.



Fig. 3. Hardware set Up diagram

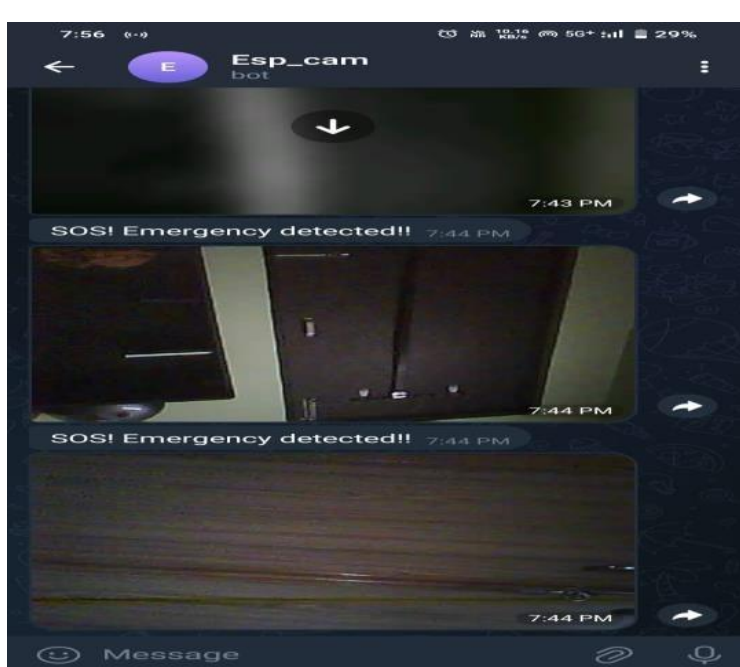


Fig. 4. ESP32 Capturing and sending alerts

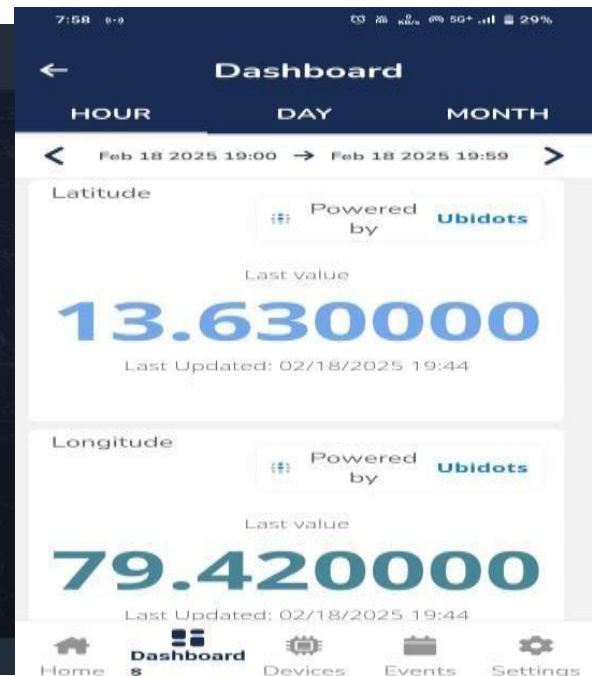


Fig. 5. Indication of Latitude and Longitude values



Fig. 6. Indication of temperature and spo2 values



Fig. 7. Heartbeat BPM and fall status

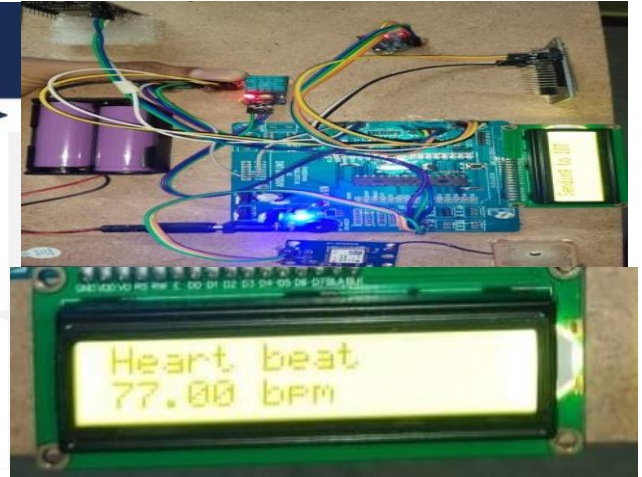


Fig.8. Indication Heartbeat

VII. CONCLUSION AND FUTURE SCOPE

With real-time monitoring, automatic threat detection, and quick alerting, the Automatic Threat Detection and Alerting System for Women is a complete Internet of Things-based system designed to improve personal safety. The system guarantees dependable and continuous tracking of the user's position and health by combining a number of sensors, including tilt, temperature, heart rate, SpO2, GPS, and a camera module. While automated notifications by email and Telegram provide prompt connection with designated contacts during emergencies, the integration of the Ubidots IoT platform allows for smooth real-time data viewing and alert production. The system addresses significant shortcomings of current safety solutions and is made to be scalable, economical, and effective. This paper offers a strong framework for improving women's safety by utilizing cutting-edge IoT technology, providing prompt support and proactive danger identification in a variety of settings.

Future work can explore deep reinforcement learning for adaptive threat detection and improved predictive analytics.

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