School of

Electrical and Electronics Engineering

Minor Project-1 Report On

Prototype Development and Testing of an Advanced Individual Safety Alert System

Sl. No	Name	USN
01	Rahul Teli	01FE21BEE008
02	Malhar Kulkarni	01FE21BEE016
03	Chandru Thomare	01FE21BEE022
04	Chandrashekhar Angadi	01FE21BEE031

Semester: VI, 2023-2024

Under the Guidance of:

Ms Anupama R Itagi

CERTIFICATE

This is to certify that project entitled **"Prototype Development and Testing of an Advanced Individual Safety Alert System"** is a bonafide work carried out by the student team of" **Rahul G Teli- 01FE21BEE008, Malhar Kulkarni- 01FE21BEE016, Chandru Thomare - 01FE21BEE022, Chandrashekar R Angadi - 01FE21BEE031"**. The project report has been approved as it satisfies the requirements with respect to the minor project work prescribed by the university curriculum for BE (VI Semester) in School of Electrical and Electronics Engineering of KLE Technological University for the academic year 2023-2024.

Ms. Anupama R Itagi	Dr. Saroja V Siddamal	Dr. Basavaraj S Anami
Guide	**Head of School**	**Registrar**

External Viva:

Name of Examiners	**Signature with date**
1.	
2.	

ACKNOWLEDGMENT

We would like to express our sincere gratitude to KLE Technological University, Hubballi for providing us the facilities and resources to carry out our project on "Prototype Development and Testing of an Advanced Individual Safety Alert System". We are especially thankful to the Head of School of Electrical and Electronics, Dr. Saroja V Siddamal, for her constant motivation and guidance throughout this endeavour. We would also like to thank our project guide Ms. Anupama R Itagi for her invaluable insights, feedback, and direction at every stage of this project. Her vast knowledge and experience in this field steered us in the right direction whenever we faced any difficulties. In addition, we are grateful to the entire Electrical department faculty team for clarifying our doubts patiently and helping us gain a thorough understanding of advanced concepts related to our project. We also appreciate the lab technicians for promptly addressing all our queries on the software tools and ensuring smooth progress of simulations. Finally, we would like to express our heartfelt gratitude towards our parents and family members for their unconditional love, emotional support and encouragement that gave us the motivation to work diligently on this challenging yet fulfilling project. We dedicate our project work to them as without their blessings, none of this would have been possible. Once again, we thank everyone who was directly or indirectly involved in making our efforts come to fruition. This acknowledgment reaffirms our sincere appreciation.

- Rahul Teli, Malhar Kulkarni, Chandru Thomare, Chandrashekar R Angadi.

ABSTRACT

This work explores the **'**Prototype Development and Testing of an Advanced Individual Safety Alert System**'** leveraging advancements in technology to offer enhanced security. The system aims to provide real-time monitoring and tracking of individual's whereabouts and potentially their safety(Body temperature and harmful gases in sorroundings) . The approach involves utilizing Internet of Things (IoT) devices to collect data. Features like geofencing can be implemented to alert guardians when individual leave designated safe zones. Data analysis of the collected information could offer insights into individual's routines and environments, enabling proactive measures to ensure their safety. The abstract emphasizes the importance of prioritizing individual's privacy and data security throughout the system's design and operation.

Contents

1 Introduction

In today's world, ensuring the safety of an Individual is a paramount concern for those in worry and care. As an individual become increasingly independent, their exposure to potential dangers also rises. This necessitates the development of innovative solutions that can provide peace of mind and enhance their security. This paper proposes the development of a safety monitoring system that leverages technological advancements to offer a comprehensive security solution. This system aims to providing real-time monitoring and vital information to promote proactive safety measures. We will explore the potential of Internet of Things (IoT) devices to gather data on an individual's location and potentially even health conditions. The system will integrate features like geofencing to create virtual boundaries and alert guardians if an individual strays from designated safe zones. Furthermore, by analysing the collected data, the system may offer valuable insights into an individual's routines and environment, empowering caregivers to identify potential risks and take preventative actions. Throughout the development process, prioritizing individual's privacy and data security will be of utmost importance.

1.1 Motivation

The motivation for developing a safety monitoring system stems from the ever-present concern for the well-being of an individual in an increasingly complex world.

- **Rising Incidents:** Statistics on human-trafficking, cyberbullying, and online predators highlight the need for additional safeguards.
- **Technological Advancements:** Advancements in wearable tech, GPS, and data analysis offer powerful tools to enhance the safety.
- **Peace of Mind for Caregivers:** A monitoring system can provide real-time information and location tracking, reducing anxiety and allowing for quicker response in emergencies.
- **Proactive Safety Measures:** Data analysis can offer insights into an individual's routine and environment, enabling caregivers to identify potential risks and take preventative actions.
- **Empowering:** The system can be designed to educate individual about online safety and empower them to make informed decisions.

While traditional methods exist, such as constant supervision and open communication, an individual's safety monitoring system offers a complementary layer of security, adapting to the evolving needs of individual and the challenges they face in today's world.

1.2 Objectives

- To develop a robust GPS tracking system capable of real-time location monitoring.
- To implement alerts triggered by temperature and gas sensor readings for immediate notifications in case of anomalies.
- To relate intuitive web portals accessible to users for viewing and managing their information.
- To enable seamless communication channels between users and nearby authorities during emergencies.

1.3 Literature survey

1. **A Systematic Review of Wearable Sensor-Based Technologies for Fall Risk Assessment in Older Adults.**
   This paper proposes a wearable sensor-based system for fall detection in elderly individuals. It utilizes accelerometers and gyroscopes to identify fall events and trigger alerts for caregivers. The study presents a prototype development process and evaluates its accuracy in real-world settings.
2. **A Smartphone-Based Driver Safety Monitoring System Using Data Fusion.**
   This paper explores a smartphone application that functions as a personal safety alert system. It leverages GPS and cellular networks to transmit location data and emergency alerts to designated contacts during critical situations. The authors discuss the prototype development and user testing to assess its effectiveness and user experience.
3. **Human Sensing by Using Radio Frequency Signals: A Survey on Occupancy and Activity Detection.**
   This paper introduces a context-aware safety system for lone workers. It utilizes machine learning algorithms to analyse sensor data (e.g., movement, sound) and environmental factors to identify potential dangers. The prototype incorporates real-time alerts and situational awareness features tailored for lone worker scenarios.
4. **Sensor-based and vision-based human activity recognition: A comprehensive survey.**
   This paper investigates a multi-sensor system for construction worker safety monitoring. It employs various sensors (e.g., accelerometers, RFID) to recognize worker activities and detect unsafe behaviours. The study focuses on prototype development, sensor integration, and real-time data analysis for proactive safety intervention.
5. **Development and validation of a technology acceptance model for safety-enhancing, wearable locating systems.**
   This paper presents a wearable panic button system for personal safety. The prototype incorporates a discreet wearable device that transmits emergency alerts upon activation. The study evaluates the system's effectiveness in various scenarios and user acceptance among target populations.

6 **An approach to develop the smart health using Internet of Things and authentication based on biometric technology.**

This paper explores an Internet of Things (IoT) based safety alert system. The prototype utilizes wearable devices and integrates biometric authentication for secure emergency alert activation. The study investigates the system's robustness against unauthorized access and explores its potential for various applications

7 **A cloud-based architecture for emergency management and first responders localization in smart city environments.**

This paper proposes a cloud-based safety alert system integrated with emergency response management. The prototype utilizes cloud infrastructure for data storage, processing, and real-time communication with emergency services. The research explores the system's scalability and effectiveness in coordinating emergency response efforts.

8 **Fall Detection with Wearable Sensors: A Hierarchical Attention-based Convolutional Neural Network Approach.**

This paper examines a context-aware fall detection system employing deep learning techniques. The prototype utilizes wearable sensors and leverages deep learning algorithms to analyse data and accurately identify falls based on user context (e.g., sitting, walking). The study investigates the system's accuracy and its ability to differentiate falls from other daily activities.

9 **A centralized privacy-preserving location-sharing system for mobile online social networks.**

This paper addresses privacy concerns in safety alert systems. The prototype incorporates secure location sharing mechanisms that allow emergency responders to locate individuals in distress while protecting user privacy. The study explores cryptographic techniques and secure communication protocols for data transmission.

10 **Designing wearable technologies for users with disabilities: Accessibility, usability, and connectivity factors.**

This paper emphasizes user-centered design in safety alert systems. The research focuses on the usability evaluation of a wearable emergency alert system designed for individuals with disabilities. The study investigates user feedback, identifies design challenges, and proposes improvements for better accessibility and inclusivity.

1.3.1 Sustainable Goals

By 2030, the Sustainable Development Goals (SDGs) of the United Nations are an international call to action for a sustainable future that upholds justice, equality, and human rights for everyone. The 2030 Agenda for Sustainable Development, which was endorsed by UN Member States in 2015, offers a common blueprint for promoting peace and prosperity for all people and the earth going forward. The Sustainable Development Goals (SDGs) comprise 17 interconnected objectives that aim to direct contemplate ion and response to the most critical issues confronting both the natural world and humanity. These objectives include inequality (SDG 10), climate change (SDG 13), peace and justice (SDG 16), and international collaboration to achieve targets worldwide (SDG 17). These objectives and their targets recognize that reducing poverty and other forms of deprivation requires concerted efforts to address social injustices, health and education issues, and economic inequality in addition to combating climate change and protecting the environment.

Good Health And Well-Being:

Design and develop a comprehensive child safety monitoring system that leverages cutting-edge technologies to ensure the well-being and security of children in various settings, such as schools, daycare centers, and public spaces.

1.4 Problem statement

Develop and test a prototype for an advanced individual safety alert system aimed at enhancing personal safety through real-time GPS tracking, sensor-based alerts for temperature and gas levels, seamless communication with nearby authorities during emergencies, and secure user data management via web portals and databases.

1.5 Application in Societal Context

A safety monitoring system can offer a range of benefits within a societal context:

- *Community Safety*: Wider implementation can create a network of awareness, potentially deterring criminal activity and aiding faster response times by authorities in locating missing individual.
- *Reduced Crime Rates*: The increased likelihood of detection through monitoring could act as a deterrent to crimes targeting individual.
- *Improved Educational Environments*: Schools could utilize the system (with parental consent) to enhance on-campus security and streamline emergency response procedures.
- *Peace of Mind for Working Parents*: The ability to monitor a individual 's location during after-school activities or commutes can alleviate stress and allow parents/guardians to focus on work.
- *Empowering Vulnerable Populations*: The system can be particularly valuable for individual with special needs who may wander or have difficulty communicating danger.
- *Public Awareness*: The existence of such a system can raise public awareness about safety issues and encourage open conversations within families and communities.

However, it is crucial to consider the ethical implications and potential misuse of the technology. Open discussions and regulations are necessary to ensure the system complements existing safety measures without infringing on individual's privacy or creating a false sense of security.

2. System design

2.1 Functional block diagram of model

Fig1 shows the block diagram of our project 'Prototype Development and Testing of an Advanced Individual Safety Alert System'.

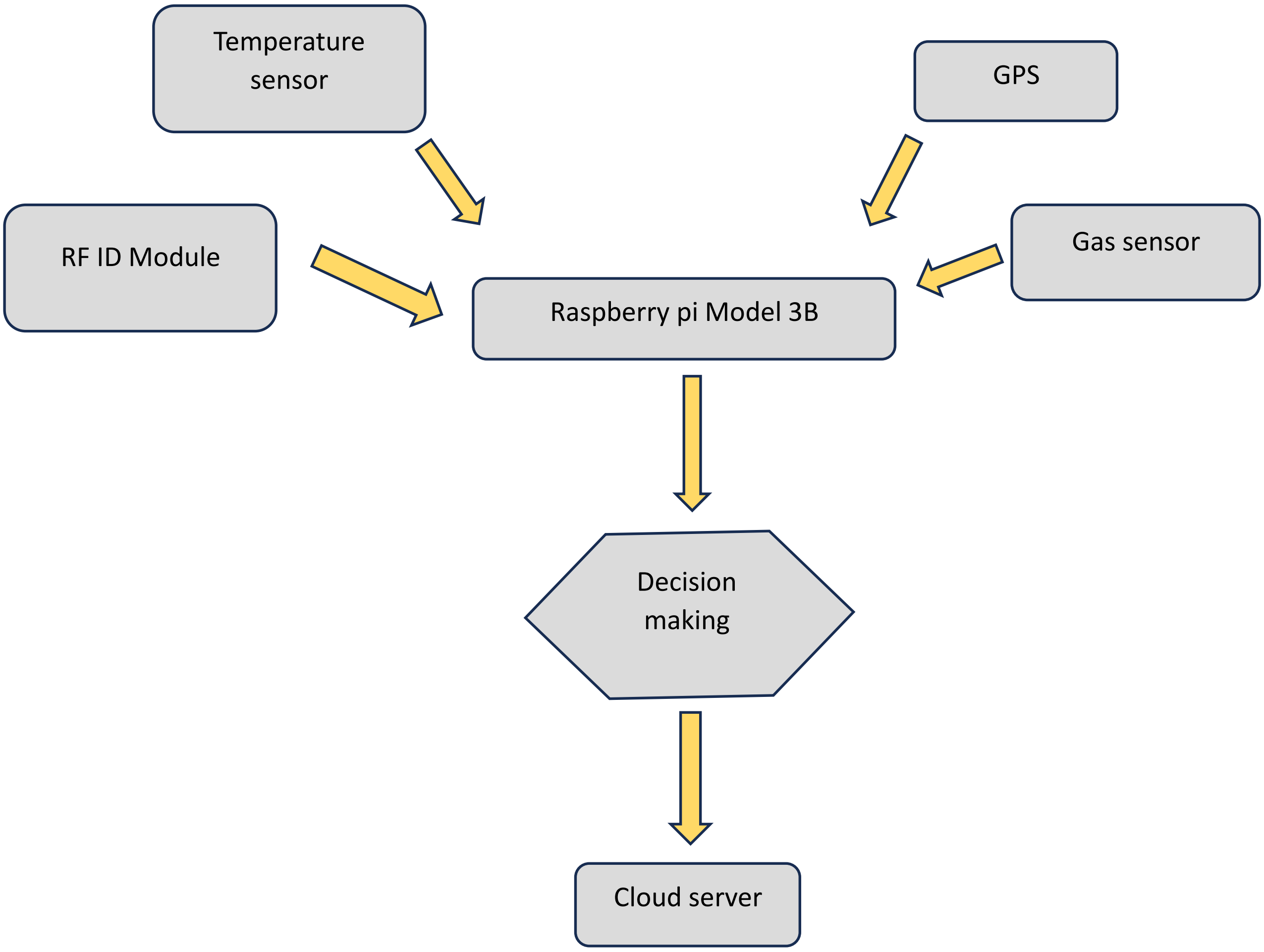


Fig1.Fuctional Block Diagram

3. Implementation Detail

3.1 Location tracking

Location tracking through ‘GPS Module’ can be a valuable tool within a individual’s health and security system when combined with other features.

Benefits:

- Locating individual: In case an individual gets lost or wanders off, GPS allows parents to see their location on a map through a mobile app.
- Alerts: Geofences can be set up. These are virtual boundaries around designated areas (like home or school). If an individual leaves the geofence, the parent receives an alert.

Limitations:

- Privacy concerns: Constant tracking can raise privacy issues for older children. Open communication with your child is important.
- Accuracy: GPS accuracy can vary depending on location and signal strength.

3.2 Body temperature monitoring

Body temperature is a valuable metric for health and safety monitoring systems.

How it can be used:

- Fever detection: A core body temperature above normal range (usually around 38.5°C or 101.3°F) can indicate a fever. Early detection allows for prompt action like medication or contacting a doctor.
- Monitoring illness: Tracking temperature over time can help caregivers assess the severity and course of the illness.
- Long-term trends: Monitoring temperature trends can be helpful for identifying potential recurring issues.

Things to consider with body temperature monitoring systems:

- Accuracy: The type of thermometer used and the measurement method (oral, rectal, etc.) affect accuracy.
- Alerts: Systems can be set to send alerts for high or low temperatures, but it is important to understand the appropriate response to each.
- Not a standalone tool: Body temperature is just one piece of the picture. Other symptoms and overall well-being should also be considered.

Overall, body temperature monitoring systems can be a helpful tool for parents and caregivers to proactively monitor an individual’s health, but it is important to use them alongside other information and consult with a healthcare professional when needed.

3.3 Oxygen level confirmation

Directly measuring oxygen levels through a gas sensor might not be the most common approach in health monitoring systems for home use.

Potential Application:

- Monitoring respiratory conditions: For individuals with asthma or other respiratory conditions, a sensor monitoring oxygen saturation (SpO2) could be part of a home monitoring system. This would likely require a pulse oximeter, which uses light waves to estimate blood oxygen levels, not a direct oxygen gas sensor.

Challenges and Considerations:

- Accuracy: For medical applications, accuracy is crucial. While some gas sensor technologies exist for oxygen detection, they might not be suitable for the monitoring required in a individual safety context. Pulse oximeters are a more established method.
- Comfort and practicality for individual: Wearing a sensor for extended periods, especially during sleep, needs to be comfortable and non-intrusive for an individual.
- Medical interpretation: Monitoring oxygen data requires interpretation by a healthcare professional. A home system would need clear guidelines and potentially connect to medical services for proper evaluation.

Alternative Approaches:

- Pulse oximeters: These clip-on devices are a more established way to estimate blood oxygen levels at home.
- Behavioural monitoring: For some conditions, monitoring breathing patterns, activity levels, and sleep quality can be helpful alongside consultations with a paediatrician.

3.4 Attendance

RFID (Radio Frequency Identification) in attendance systems can be a foundation for an individual's well-being but is not direct health monitoring.

Attendance and Security:

- Tracks Arrivals and Departures: RFID tags worn by individual can be scanned by readers at entry/exit points, recording their presence and ensuring they are signed in/out.
- Improved Security: Knowing who is and is not authorized on school grounds enhances overall security. Unauthorized personnel can be flagged.
- Attendance Insights: Detailed attendance data can help identify potential issues like truancy or illness patterns. Early intervention might be possible.

Integration Possibilities:

- Combined Systems: The RFID system could link to a separate health monitoring system. For example, a temperature check at entry could be integrated with attendance data.
- Parental Alerts: Attendance data, combined with other info, could trigger alerts. For instance, an individual not showing up and having a history of illness could prompt a parent call.

Security Considerations:

- Data Privacy: Ensure proper data security measures are in place to protect an individual's information

3.5 Communication with guardians

Wi-Fi offers a convenient way for your Raspberry Pi-based safety monitoring system to transmit data and receive control signals.

Advantages:

- Wireless Connectivity: No need for cables connecting the Raspberry Pi to a network. Offers flexibility in placement within the monitoring area.
- Data Transmission: Health data collected by sensors (temperature, heart rate) can be transmitted securely to a server or mobile app for monitoring and analysis.
- Remote Control: The Raspberry Pi can receive control signals from a phone or computer over Wi-Fi. This allows features like adjusting settings, triggering alerts, or even controlling connected devices (e.g., turning on a humidifier).

Security Considerations:

- Network Security: A secure Wi-Fi network is crucial. Use strong WPA2 encryption and a complex password for your router. Avoid public or open Wi-Fi networks.
- Pi Security: Keep the Raspberry Pi's operating system updated with the latest security patches. Use a strong password for the Pi itself.
- Data Encryption: For sensitive health data, consider encrypting data transmissions between the Raspberry Pi and the server/app. This adds an extra layer of protection.
- Port Forwarding (Optional): If you want to access the Raspberry Pi remotely from outside your home network, you might need to set up port forwarding on your router. Do this cautiously, as it can open potential security vulnerabilities if not done correctly. Consider consulting a network security professional if needed.

4. Results and Discussions

4.1 Result analysis

In this project, Python script designed to monitor temperature, gas levels, location, and RFID tags on a Raspberry Pi. Utilizes a Telegram bot for sending alerts and status updates to the Guardian/s of the individual.

Imports:

- Standard libraries like `os`, `glob`, `time`, and `sys` for various functionalities.
- `RPi.GPIO` to interact with Raspberry Pi's GPIO pins.
- `mfrc522` for reading RFID tags.
- `asyncio` and `telegram` for asynchronous communication with the Telegram bot.
- `serial` for serial communication with the GPS module.
- `logging` for logging messages and errors.

Configuration:

- Defines Telegram bot tokens (main and location bot) and chat ID for sending messages.
- Sets up temperature sensor configuration (using 1-Wire protocol).
- Initializes GPIO pin for gas sensor.
- Creates two RFID reader instances.
- Configures serial port and baud rate for GPS communication.
- Defines timeout duration for RFID detection.

Functions:

- `read_temp()`: Reads temperature data from the sensor and returns the value in Celsius.
- `read_gas()`: Checks the gas sensor pin state and returns "Gas Detected" if low or "No Gas Detected" if high.
- `read_rfid(reader)`: Attempts to read an RFID tag from the specified reader and returns ID and text data if successful, otherwise None.
- `parse_gps_data(data)`: Parses incoming GPS data and returns formatted latitude and longitude or "Location unavailable" if parsing fails.
- `send_telegram_message (bot, message)`: Sends a message to the specified Telegram bot chat using asynchronous operations.

Main Loop (`async def main_loop ()`):

- Opens the serial port for GPS communication.
- Continuously runs in a loop performing the following:
  a) Reads temperature and gas sensor data.
  b) Reads RFID tags from both readers and sends messages with details if detected.
  c) Checks for timeout on RFID detection and sends an alert if not detected within the specified timeframe.
  d) Attempts to read GPS data and parses location information.

e) Sends emergency messages if temperature exceeds a threshold or both high temperature and gas are detected.
f) Sends gas detection warnings if gas is present.
g) Sleeps for a second before the next iteration.

Telegram Bot Interaction:

- `async def start (update, context)`: Handles the `/start` command, greets the user, and presents an inline keyboard with options.
- `async def button (update, context)`: Handles user interaction with the inline keyboard buttons. Based on the button pressed (location, temperature, or status), retrieves data and sends a response or updates the message with the information.
- `async def help command(update, context)`: Provides a help message listing available commands.

Main Program (`def main ()`):

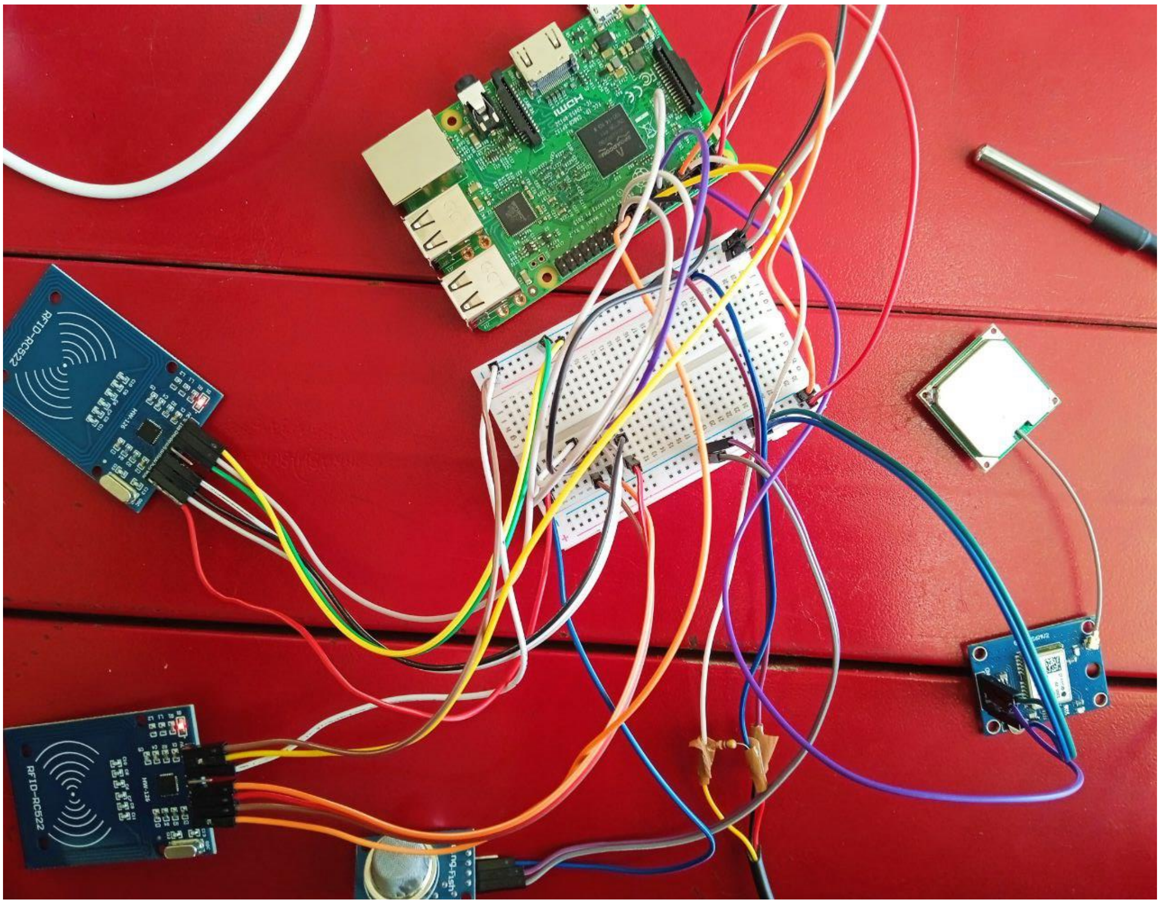
- Creates a Telegram bot application instance.
- Registers bot command handlers for `/start`, `/help`, and the inline button callback handler.
- Runs the application in polling mode, waiting for user interactions.

Cleanup:

- `if __name__ == '__main__'`: Ensures the code runs only when executed directly (not imported as a module).
- Runs the `main_loop` function asynchronously.
- Handles keyboard interrupts (Ctrl+C) to stop the program gracefully.
- Cleans up GPIO pins upon program termination.

It gives a comprehensive solution for environmental monitoring and location tracking with real-time notifications via Telegram. Various sensors and communication protocols are used to provide a robust monitoring system.

4.2 Hardware results and analysis



This shows the hardware connection between the sensors and modules with the Raspberry pi as the core. Table1 shows the connection pin of each module and sensors with the Raspberry Pi. This image includes

- Raspberry pi Model 3b
- GPS Module
- RF-ID Module 1
- EF-ID Module 2
- Temperature sensor
- Gas sensor(O_2)

Table1. Pin connection of every module and sensors with Raspberry Pi

Component	Pin Name	GPIO Pin	Physical Pin
DS18B20	Data	GPIO 4	7
DS18B20	Vcc	3.3V	1
DS18B20	Gnd	Ground	6
Gas Sensor	DO	GPIO 7	26
Gas Sensor	Vcc	5V	2
Gas Sensor	Gnd	Ground	6
RFID Reader 1	SDA	GPIO 8	24
RFID Reader 1	SCK	GPIO 11	23
RFID Reader 1	MOSI	GPIO 10	19
RFID Reader 1	MISO	GPIO 9	21
RFID Reader 1	RST	GPIO 25	22
RFID Reader 1	VCC	3.3 V	1
RFID Reader 1	GND	Ground	6
RFID Reader 2	SDA	GPIO 7	20
RFID Reader 2	SCK	GPIO 11	23
RFID Reader 2	MOSI	GPIO 10	19
RFID Reader 2	MISO	GPIO 9	21
RFID Reader 2	RST	GPIO 22	15
RFID Reader 2	VCC	3.3 V	1
RFID Reader 2	GND	Ground	6
GPS Module	Vcc	3.3 or 5 V	2
GPS Module	GND	Ground	9
GPS Module	Tx	GPIO 15	10

Table2 include the cost of individual components and overall bill of our project.

Table2. Bill of Materials

Sl.NO	Component Name	Quantity	Amount
01	GPS Module	01	260
02	Temperature Sensor	01	160
03	Gas Sensor	01	200
04	RFID Module	02	300
	Total	05	920 /-

4.3 Test cases

1. RFID Alert Notification.
   An information message will be sent to the guardians, when he/she reaches a designated place (School/College/Office) (Shown in Fig2) and scans RFID tag. Emergency alert message will be sent via Telegram Bot if he/she fails to reach home before specified time (Shown in Fig3).

Fig2. Normal information message

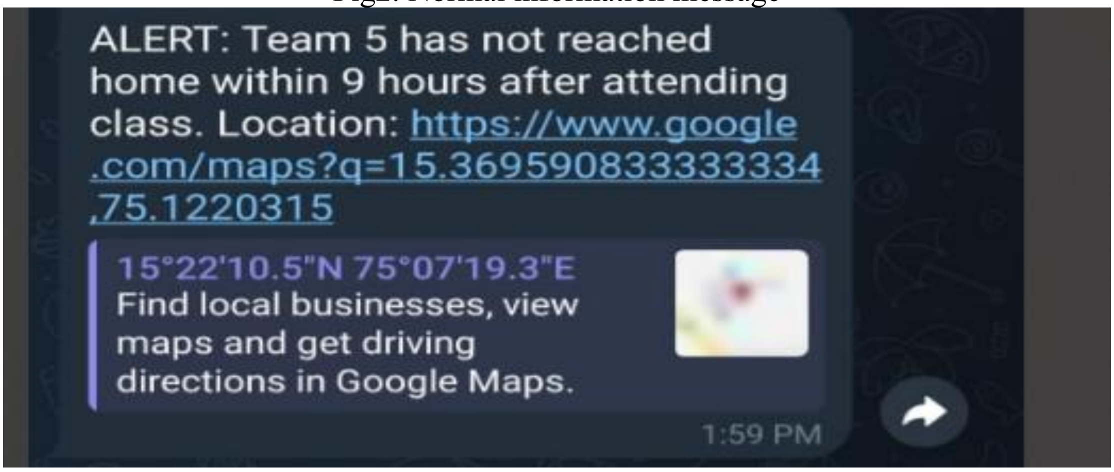


Fig3.Emergency

2. Live GPS Tracking.
   Live location of he/she can be accessed by the guardians in case of a need(shown in Fig4). In case of an emergency his/her live location will be sent to guardian via Telegram Bot.

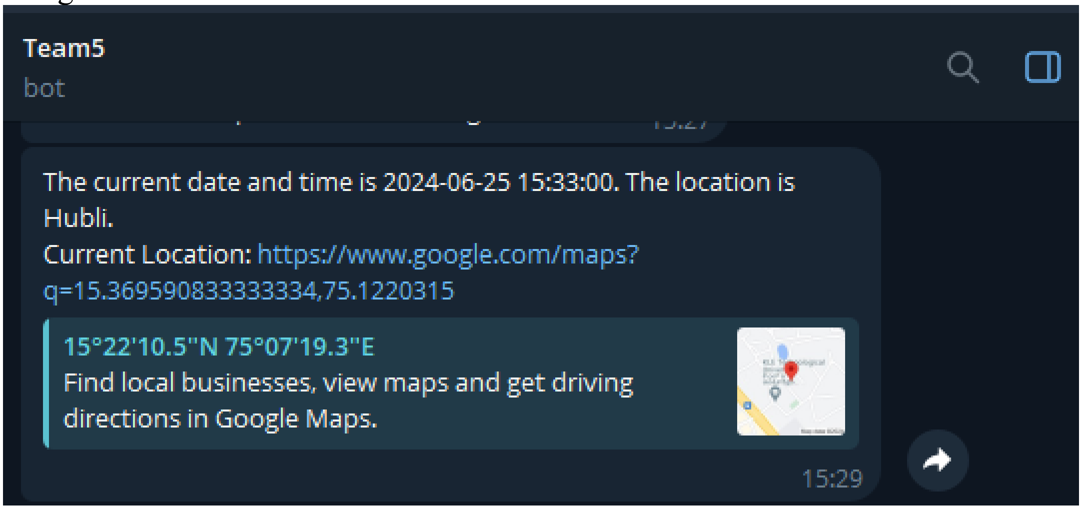


Fig4.Normal location message

3. Body Temperature Monitoring.
   Body temperature can be accessed by the guardians in case of a need (Shown in Fig5). Emergency message will be sent via Telegram Bot if the body temperature goes above or below the normal body temperature (Shown in Fig6).

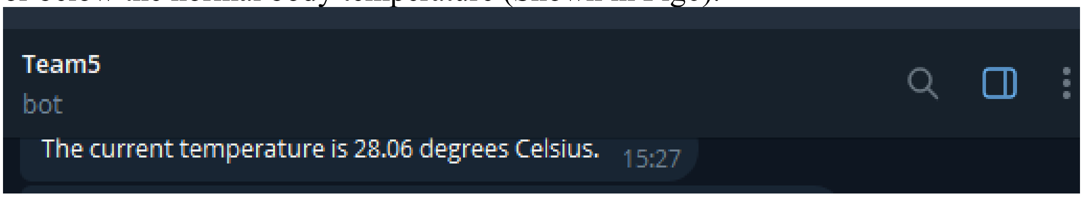


Fig5.Normal information of body temperature

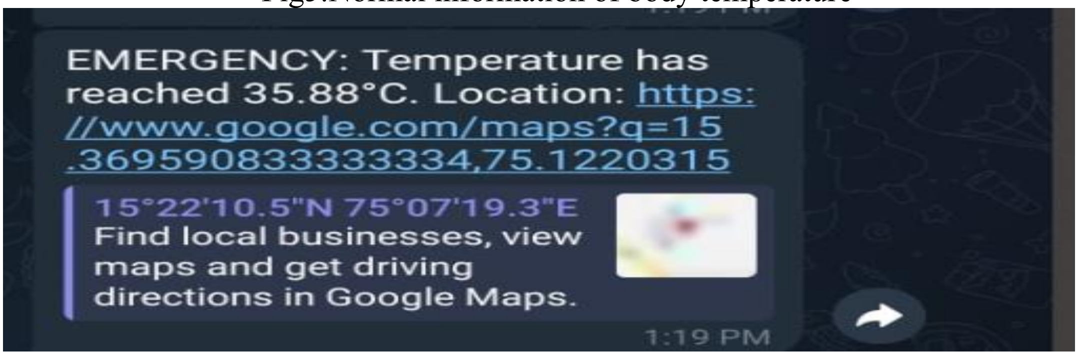


Fig6.Emergency

4. Hazardous Gas Detection.
   In case of detection of any harmful gas in his/her surroundings, emergency message will be sent to the guardian via Telegram Bot(Shown in Fig7).

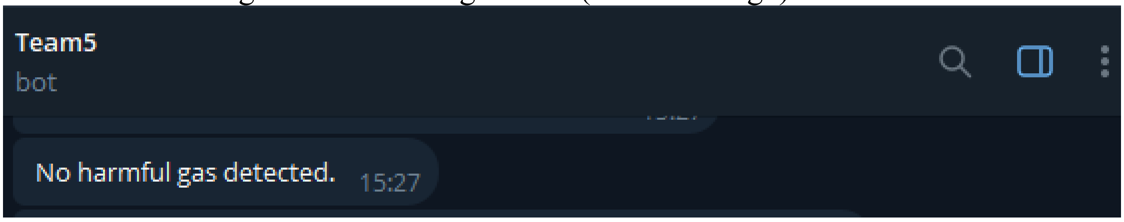


Fig6.Normal information on surrounding gas

Fig7.Emergency

5. Conclusions and future scope

5.1 Conclusion

The prototype development and testing of the advanced individual safety alert system demonstrate promising capabilities in enhancing personal safety through real-time GPS tracking, sensor-based alerts, and effective emergency communication. The integrated web portals and secure database ensure reliable user management and data protection

5.2 Future scope

Looking ahead, the project opens several avenues for broader application and deeper exploration.

- Advanced Wearables and Sensors.
- Improved Location Tracking and Monitoring.
- Enhanced Communication and Parental Control.
- AI and Machine Learning.
- Ethical Considerations.

Bibliography

[1] Chen, Manting, et al. "A systematic review of wearable sensor-based technologies for fall risk assessment in older adults." *Sensors* 22.18 (2022): 6752.

[2] Lee, Boon-Giin, and Wan-Young Chung. "A smartphone-based driver safety monitoring system using data fusion." *Sensors* 12.12 (2012): 17536-17552.

[3] Shahbazian, Reza, and Irina Trubitsyna. "Human sensing by using radio frequency signals: A survey on occupancy and activity detection." *IEEE Access* (2023).

[4] Kwee-Meier, Sonja Th, Jennifer E. Bützler, and Christopher Schlick. "Development and validation of a technology acceptance model for safety-enhancing, wearable locating systems." *Behaviour & Information Technology* 35.5 (2016): 394-409.

[5] Hamidi, Hodjat. "An approach to develop the smart health using Internet of Things and authentication based on biometric technology." *Future generation computer systems* 91 (2019): 434-449.

[6] Palmieri, Francesco, et al. "A cloud-based architecture for emergency management and first responders localization in smart city environments." *Computers & Electrical Engineering* 56 (2016): 810-830.

[7] Yu, Shuo, et al. "Fall detection with wearable sensors: A hierarchical attention-based convolutional neural network approach." *Journal of Management Information Systems* 38.4 (2021): 1095-1121.

[8] Xiao, Xi, et al. "CenLocShare: A centralized privacy-preserving location-sharing system for mobile online social networks." *Future Generation Computer Systems* 86 (2018): 863-872.

[9] Moon, Nathan W., Paul MA Baker, and Kenneth Goughnour. "Designing wearable technologies for users with disabilities: Accessibility, usability, and connectivity factors." *Journal of Rehabilitation and Assistive Technologies Engineering* 6 (2019): 2055668319862137.

[10] Dang, L. Minh, et al. "Sensor-based and vision-based human activity recognition: A comprehensive survey." *Pattern Recognition* 108 (2020): 107561.