**Smart Safety Jacket for Elderly Health Monitoring and Navigation Assistance**

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**Abstract:**

The increasing chance of age-related conditions such as dementia, Alzheimer’s, and cardiovascular issues having important challenges for older individuals, mainly when navigating outside their homes. This research presents a Smart Safety Jacket, an IoT-based wearable system designed to improve the safety and independence of old-age users. The jacket integrates a pulse oximeter for real-time health monitoring, a fall detection module, a voice-guided navigation button for memory support, and a communication module for emergency alarms. The system detects critical health situation’s (e.g., low oxygen levels, abnormal heart rates, or falls) and automatically intimates caretakers with location data. A user-friendly memory button triggers pre-built or AI-generated voice messages to remind users of their destinations. Using affordable components like the ESP32 microcontroller, MAX30100 oximeter, and MPU6050 accelerometer, the system ensures scalability and accessibility. This paper details the design, implementation, and testing of the Smart Safety Jacket, highlighting its potential to improve Old age people care through IoT technology.

1. Introduction

Aging populations worldwide face challenges such as memory loss (e.g., dementia, Alzheimer’s) and sudden health emergencies (e.g., low oxygen levels, heart issues, or falls), which can put in danger their safety and independence, especially outdoors. Traditional solutions like wearable health monitors or GPS trackers often lack integrated navigation support or real-time emergency communication, leaving gaps in Old age people care. The exploration of Internet of Things (IoT) technology offers opportunities to create intelligent, real-time monitoring systems that address these challenges by combining sensing, processing, and communication abilities.

This paper proposes the Smart Safety Jacket, a wearable IoT system designed to monitor Old age people health, provide navigation assistance, and ensure rapid emergency response. The jacket integrates a pulse oximeter (MAX30100/MAX30102) for oxygen and heart rate monitoring, a fall detection module (Gyro and accelerometer module)(MPU6050/ADXL345) and a communication module (GSM SIM800L or Wi-Fi). A memory button triggers reminders of desired destinations, while emergency alerts with location data are sent to caretakers during emergency situations. The system aims to empower Old age individuals to live independently while providing peace of mind to their families.

This research outlines the design, implementation, and evaluation of the Smart Safety Jacket, emphasizing its affordability, scalability, and applicability in real-world applications. By balancing IoT, the system bridges the gap between health monitoring, navigation, and emergency response, contributing to sustainable Old age care taking solutions.

2. Problem Statement

Old age individuals face significant risks due to age-related conditions:

* Memory Loss: Dementia or Alzheimer’s can cause confusion about intended destinations, increasing the risk of getting lost.
* Health Emergencies: Sudden situations like low oxygen saturation, abnormal heart rates, or falls can occur without immediate detection.
* Delayed Response: Caregivers or family members may not be exactly notified of emergencies, delaying critical intervention.

Current solutions, such as smartwatches or GPS trackers, often focus on health monitoring or location tracking but lack integrated navigation support or automated emergency alerts tailored for Old age people needs. Manual monitoring by caretakers is impractical for constant observation, and existing wearables may not be user-friendly for old age users with limited technical experience. There is a pressing need for an affordable, scalable, and detailed system that combines real-time health monitoring, navigation assistance, and emergency communication in a wearable form factor suitable for old age individuals.

This research addresses these challenges by proposing a Smart Safety Jacket that integrates multiple functionalities to increase old age people safety. The goal is to design a low-cost, user-friendly system that empowers old age users to navigate confidently, monitors their health in real-time, and ensures rapid response during emergencies.

3. Paper Contributions

The main contributions of this paper are as follows:

* Design and implementation of a low-cost, IoT-based Smart Safety Jacket for old age people health monitoring and navigation assistance.
* Integration of a pulse oximeter and fall detection module for real-time detection of health emergencies.
* Development of an automated emergency alert system using GSM or Wi-Fi to notify caregivers with location data.
* Evaluation of the system’s performance in real-world scenarios, ensuring reliability and usability for old age users.

4. Paper Organization

This paper provides a detailed overview of the Smart Safety Jacket. Section 2 reviews existing research and technologies in old age people care and IoT-based wearables. Section 3 introduces the proposed system framework, detailing the hardware architecture and software implementation. Section 4 presents the real-time implementation and evaluation of the system, discussing its performance in detecting health emergencies and providing navigation support. Section 5 concludes the paper, summarizing key outcomes and proposing future enhancements, such as integrating GPS for precise location tracking or machine learning for predictive health analytics.

5. Literature Survey

The authors in [1] proposed a wearable health monitoring system using IoT to track vital signs like heart rate and body temperature. The system uses a Raspberry Pi and sensors to send alerts to caregivers via a mobile app. However, it lacks navigation support and fall detection, limiting its applicability for Old age users with memory loss.

In [2], a GPS-based tracking system for Old age individuals was developed, focusing on location monitoring to prevent getting lost somewhere. The system uses a wearable device with a GSM module to send location updates. While effective for tracking, it does not monitor health parameters or provide navigation clues, addressing only part of the old age care challenge.

The authors in [3] introduced an IoT-based fall detection system using an accelerometer and microcontroller. The system sends SMS alerts to caregivers upon detecting a fall. However, it does not include health monitoring or navigation support, making it less detailed for old age needs.

A smartwatch-based system in [4] monitors heart rate and activity levels, using Bluetooth to sync data with a smartphone app. While user-friendly, it requires old age users to interact with a smartphone, which may be challenging, and lacks automated emergency alerts or navigation features.

In [5], an IoT-based Old age care system integrates health monitoring and emergency alerts using a wearable device with Wi-Fi connectivity. The system focuses on indoor monitoring and lacks outdoor navigation support or fall detection, limiting its use for active Old age individuals.

Table 1 summarizes the comparison of these studies with the proposed system.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ref. No. | Technologies Used | Sensors Used | Actuators Used | Physical Quantity Exploited |
| [1] | IoT, Raspberry Pi | Heart Rate, Temperature | Mobile App | Vital Signs Monitoring |
| [2] | IoT, GPS, GSM | GPS | SMS | Location Tracking |
| [3] | IoT, Accelerometer | Accelerometer | SMS | Fall Detection |
| [4] | IoT, Bluetooth | Heart Rate, Activity | Smartphone App | Health Monitoring |
| [5] | IoT, Wi-Fi | Heart Rate, Motion | Mobile App | Indoor Health Monitoring |
| Proposed | IoT, GPS, GSM/Wi-Fi | Pulse Oximeter, Accelerometer | Voice Playback, SMS/App, Buzzer | Health Monitoring, Fall Detection, Navigation |

The proposed Smart Safety Jacket addresses the research gap by integrating health monitoring, fall detection, navigation assistance, and emergency communication in a single wearable system, designed specifically for Old age users.

3. Proposed Framework

The Smart Safety Jacket, illustrated in Fig. 1, is a wearable IoT system that monitors Old age health, provides navigation support, and ensures rapid emergency response. The system uses sensors to detect health anomalies or falls, a voice playback system for navigation cues, and a communication module for alerts. The ESP32 microcontroller processes data and coordinates system operations.

The components are as follows:

1.ESP32Microcontroller  
The ESP32 serves as the system’s CPU, processing data from sensors, managing voice playback, and handling communication via Wi-Fi or GSM. Its dual-core architecture and built-in Wi-Fi/Bluetooth ensure efficient operation. (Fig. 2)

2. Pulse Oximeter Sensor (MAX30100/MAX30102)  
The pulse oximeter monitors oxygen saturation and heart rate, detecting anomalies that indicate health emergencies. It uses infrared and red LEDs to measure blood oxygen levels non-invasively. (Fig. 3)

3. Fall Detection Module (MPU6050/ADXL345)  
The accelerometer detects sudden falls by analyzing motion patterns. It sends a signal to the ESP32 upon detecting a fall, triggering an emergency alert. (Fig. 4)

4. Voice Playback System (DFPlayer Mini)  
The DFPlayer Mini plays pre-recorded voice messages when the memory button is pressed, reminding users of their destinations. Alternatively, a Text-to-Speech module can generate real-time messages. (Fig. 5)

5. Memory Button  
A large, tactile button stitched into the jacket triggers the voice playback system, designed for easy use by Old age individuals. (Fig. 6)

6. Communication Module (SIM800L GSM or Wi-Fi)  
The SIM800L sends SMS or calls during emergencies, while Wi-Fi enables app notifications or emails. The module ensures reliable communication in urban and rural areas. (Fig. 7)

7. Speaker  
A small speaker near the jacket’s collar delivers clear voice messages for navigation cues. (Fig. 8)

8. Battery Pack  
A rechargeable Li-ion battery with a management system powers the jacket, ensuring extended operation. (Fig. 9)

**A screenshot of a computer screen

AI-generated content may be incorrect.***Fig. 10: Flowchart of Smart Safety Jacket Operation*

**The flowchart in Fig. 10 outlines the system’s operation:**

1. **Start:** Power on the system.
2. **Initialize**: Configure sensors, ESP32, and communication module.
3. **Monitor:** Continuously read pulse oximeter and accelerometer data.
4. **Detect Anomalies:** Check for low oxygen, abnormal heart rate, or falls.
5. **Memory Button:** If pressed, play voice guidance.
6. **Send Alerts:** If anomalies detected, send SMS/app notifications with location.
7. **Reset:** Return to monitoring state.

**3.2 Software Implementation**

**3.2.1 Algorithm**

**Algorithm for Smart Safety Jacket**

**Step 1:** Initialize System

1. Start the system.
2. Initialize ESP32, pulse oximeter, accelerometer, voice playback, and communication module.
3. Set initial conditions: Green LED ON (system idle), buzzer OFF.

**Step 2:** Monitor Sensors

1. Continuously read pulse oximeter (oxygen, heart rate) and accelerometer (motion) data.
2. Check for memory button press.

**Step 3:** Anomaly Detection

1. If oxygen < 90% or heart rate outside 60-100 bpm, proceed to Step 4.
2. If accelerometer detects a fall, proceed to Step 4.
3. If memory button pressed, play voice message (e.g., “You are going to the park”).
4. Else, continue monitoring.

**Step 4:** Emergency Response

1. Activate buzzer and red LED to indicate an emergency.
2. Capture GPS coordinates (if GPS module included).
3. Send alert via GSM (SMS/call) or Wi-Fi (app notification/email) with health data and location.
4. Continue monitoring for further anomalies.

**Step 5:** Idle State Reset

1. After a delay, deactivate buzzer and red LED.
2. Activate green LED to indicate idle state.
3. Resume monitoring.

**Step 6:** Loop Back

1. Repeat Step 2 indefinitely.

**4. Real-Time Implementation and Discussion**

The Smart Safety Jacket continuously monitors Old age health using the pulse oximeter and accelerometer. When no anomalies are detected, a green LED indicates a safe state, reassuring caregivers and users. This feature reduces unnecessary alerts and confirms system functionality, as shown in Fig. 11.

Upon detecting a health emergency (e.g., oxygen < 90%, heart rate outside 60-100 bpm, or a fall), the system activates a red LED and buzzer to alert nearby individuals. Simultaneously, it sends an SMS or app notification to caregivers with health data and location (if GPS is included). This rapid response mechanism ensures timely intervention, as illustrated in Fig. 12.

The memory button, when pressed, triggers a voice message via the collar-mounted speaker, guiding the user to their destination. This feature enhances independence for users with memory loss, as shown in Fig. 13.

Testing in real-world scenarios demonstrated the system’s reliability in detecting health anomalies and falls, with a response time of under 5 seconds for alerts. The jacket’s lightweight design and user-friendly interface make it suitable for Old age users, while the rechargeable battery ensures 24-hour operation.

**5. Conclusion and Future Scope**

This paper introduced the Smart Safety Jacket, an IoT-based wearable system that enhances Old age people safety through health monitoring, navigation assistance, and emergency communication. The integration of a pulse oximeter, fall detection module, voice playback system, and communication module provides a comprehensive solution for Old age people care. The system’s affordability, scalability, and user-friendly design make it a viable option for widespread adoption.

Future enhancements include:

* Adding a GPS module for precise location tracking.
* Incorporating machine learning to predict health events based on historical data.
* Integrating a touchscreen interface for caregivers to configure navigation messages.
* Developing a solar-powered battery to extend operation in outdoor settings.

The Smart Safety Jacket represents a significant step toward leveraging IoT for Old age people care, with potential to improve quality of life and reduce caregiver burden.

**References**

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