SMART WEARABLE DEVICE FOR ALZHEIMER'S PATIENTS

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Abstract

Alzheimer's disease is a progressive neurodegenerative disorder characterized by memory impairment, cognitive decline, and behavioral disorientation, often leading to wandering incidents and unattended medical emergencies. This paper presents the design and implementation of a low-power, IoT-enabled smart wearable system aimed at enhancing patient safety while providing continuous caregiver support. The proposed architecture integrates a microcontroller-based embedded platform with multi-parameter sensing modules, including photoplethysmography (PPG)-based heart rate monitoring, inertial motion sensing, and Global Positioning System (GPS) tracking. The system employs real-time data acquisition and adaptive threshold-based event detection to identify abnormal motion patterns and potential wandering behavior. Upon detection of critical events, an automated alert mechanism is triggered via GSM communication, transmitting geolocation coordinates and physiological status to registered caregivers. Cloud-based IoT integration enables secure remote monitoring, historical data logging, and activity trend analysis for proactive healthcare management. Power optimization techniques, including duty-cycled sensing and efficient firmware scheduling, are implemented to ensure extended operational life suitable for wearable applications. The proposed device emphasizes reliability, scalability, and user-centric ergonomic design, minimizing patient interaction requirements while maximizing autonomous safety monitoring. Experimental validation demonstrates the system's capability to provide continuous tracking, timely emergency alerts, and stable wireless communication under real-world conditions. The developed solution offers a cost-effective and scalable assistive healthcare framework that bridges embedded system intelligence with IoT-driven remote supervision, contributing toward improved quality of life for Alzheimer's patients and reduced caregiver burden.

Keywords: *Alzheimer's disease, Embedded Systems, IoT, Wearable Healthcare, GPS Tracking, GSM Communication, Remote Monitoring.*

1. INTRODUCTION

Alzheimer's disease is one of the leading causes of cognitive decline among elderly individuals. Patients often experience memory loss, confusion, and impaired decision-making, making them vulnerable to wandering and accidental harm. Traditional monitoring approaches rely heavily on constant human supervision, which increases caregiver stress and limits patient independence.

Advancements in embedded systems and IoT technologies provide opportunities to develop intelligent wearable healthcare devices capable of continuous monitoring and real-time communication. This paper presents a smart wearable solution designed to ensure patient safety while enabling caregivers to monitor health and location remotely.

Alzheimer's disease (AD) is a neurological condition that primarily affects elderly individuals. It causes a gradual decline in cognitive abilities, making even the most basic daily tasks increasingly challenging. Gradually, cognitive declines such as memory loss and cognitive impairment are observed.

Generalized cognitive decline, memory impairment, and an additional cognitive impairment that significantly hinders activities of daily living are the hallmarks of a clinical syndrome called dementia [1].

DAT, or Alzheimer's disease-related dementia, is a fatal neurological condition that gradually impairs memory and other cognitive abilities. leads to severe dementia and impairs judgment, comprehension, language, and attention [2]. The prognosis for Alzheimer's disease (AD), a multifactorial neurodegenerative illness, is not good. It is the main cause of dementia worldwide [3].
It is among the primary causes of cognitive impairment in the elderly [4].

2. PROBLEM STATEMENT

Alzheimer's patients face:

- Risk of wandering and getting lost
- Inability to respond effectively during medical emergencies
- Lack of continuous physiological monitoring
- High dependency on caregivers

There is a need for a compact, energy-efficient wearable system capable of providing real-time tracking, health monitoring, and emergency alert function
Significant cognitive decline, memory loss, and spatial disorientation are symptoms of Alzheimer's disease (AD), a progressive neurodegenerative illness. Patients run three main risks as the illness worsens:

1. **Wandering & Disorientation:** More than 60% of dementia patients will go missing at least once, and up to half of these individuals will be seriously injured or killed if they are not located within 24 hours.
2. **Physical Safety:** Falls are common due to impaired motor skills and balance, and they frequently go unnoticed if the patient is by themselves.
3. **Caregiver Burnout:** Family members experience extreme physical and emotional exhaustion as a result of constant vigilance (24/7 monitoring), which frequently results in "caregiver syndrome"

3. PROPOSED SYSTEM ARCHITECTURE

The proposed system consists of:

3.1 Hardware Components

- Microcontroller (ESP32-based architecture)
- Heart rate sensor (PPG-based)
- Accelerometer (motion detection)
- GPS module (location tracking)
- GSM module (alert communication)
- Rechargeable power supply unit

3.2 Software & IoT Framework

- Embedded firmware for real-time data acquisition
- Threshold-based anomaly detection algorithm
- Cloud database for remote monitoring
- Caregiver notification interface (SMS/App)

The device continuously monitors patient vitals and movement. If abnormal patterns (e.g., sudden fall, irregular heart rate, or boundary crossing) are detected, an automated SOS alert with GPS coordinates is sent to caregivers.

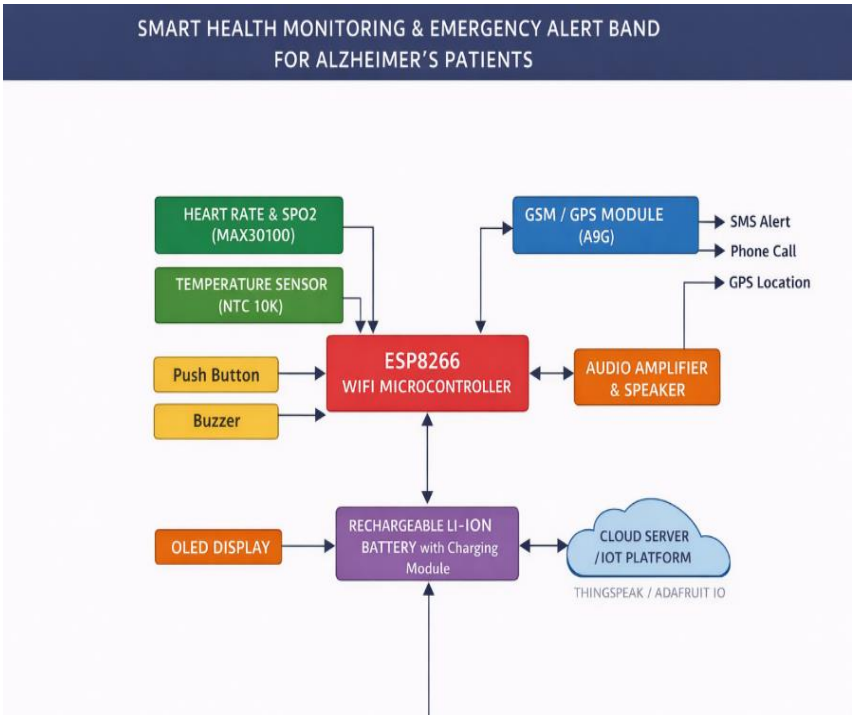
4. METHODOLOGY

The methodology for designing and implementing smart wearable devices for Alzheimer's patients focuses on a multilayered approach that integrates hardware sensors, real-time data processing, and wireless communication to address the specific safety and health monitoring needs of this demographic.

1. Sensor data acquisition through ADC and communication protocols (UART/I2C).
2. Data preprocessing and filtering to remove noise.
3. Threshold-based event detection for abnormal activity identification.
4. GPS coordinate extraction and validation.
5. GSM-based transmission of emergency alerts.
6. Cloud synchronization for remote monitoring and logging.

Power optimization techniques such as sleep-mode operation and scheduled data transmission are implemented to enhance battery life.

5. BLOCK DIAGRAN



6. RESULTS AND DISCUSSION

The system was tested under real-time conditions. Key observations include:

- Accurate GPS tracking within acceptable error margins.
- Reliable GSM-based alert transmission.
- Continuous heart rate monitoring with stable readings.
- Efficient power consumption enabling extended operational hours.

The device successfully identified simulated emergency conditions such as sudden motion changes and triggered timely alerts.

7. ADVANTAGES OF THE PROPOSED SYSTEM

- Real-time location tracking
- Automated emergency alerts
- Remote caregiver monitoring
- Low power consumption
- Compact and wearable design
- Cost-effective solution for home-based care

8. FUTURE ENHANCEMENTS

- Integration of AI-based behavioral prediction models
- Fall detection using machine learning algorithms
- Mobile application with real-time dashboard visualization
- Integration with hospital management systems
- Encrypted cloud communication for enhanced data security

9. CONCLUSION

This research presents a smart wearable device designed specifically for Alzheimer's patients to enhance safety and caregiver support. By combining embedded hardware, physiological monitoring, and IoT connectivity, the system provides real-time tracking, automated alerts, and remote health monitoring. The developed solution offers a scalable, reliable, and affordable approach to assistive healthcare technology, improving both patient independence and caregiver confidence.

10. REFERENCES

[1] M. Alotaibi and A. O. Alfaki. "The role of M-health applications in the fight against Alzheimer's: current and future directions" (August 2018). [Online]. accessible at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6131227/.

[2] Auens Q. H. Al-Neami and Qaisar A. Ahmed. January 2020. "A Smart Biomedical Assisted System for Alzheimer Patients." [Online]. Accessible: https://www.researchgate.net/publication/343585605_A_S_mart_Biomedical_Assisted_System_for_Alzheimer_Patients.

[3] Marcello I. Jotter and F., Bernice Elgera, Maurizio C., and Alessandro S. Pappagallo (2017), Intelligent Assistive Technology for Alzheimer's Disease and Other Dementias: A Systematic Review, Journal of Alzheimer's Disease 56 1301–1340.

[4] Manikandan J., Lakshmi P.S., Sai K.P., Y. Jaya Chandra, and M. Umaditya Hanuman (2020). Fisher Faces Algorithm-Based Open CV Face Detection and Recognition, International Journal of Recent Technology and Engineering, 8(5).

[5] Anandi V. Law, Momo R. Roosan, Y. Li, D. Roosen, A. Baskys, and E. Kim. "Scoping review: using mHealth applications to empower caregivers of people with Alzheimer's disease." July 2021. [Online]. Accessible: https://www.nature.com/articles/s41746-021-00506-4.

[6] F. Pennic. October 2024: "CareYaya Unveils AI-Powered Smart Glasses to Assist Dementia Patients." [Online]. Accessible at https://hitconsultant.net/2024/10/29/careyaya-unveils-ai-powered-smart-glasses-to-assist-dementia-patients/.

[8] "14 Best Smart Home Devices to Help AginginPlacein 2024 ". (accessed Nov 19, 2024). [Online]. Available: https://www.nytimes.com/wirecutter/reviews/smart-homefor-seniors/.