SECURE IOT ASSISTANT BASED SYSTEM FOR ALZHEIMER'S DISEASE

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Abstract---Alzheimer's disease is a degenerative neurological condition marked by memory loss, cognitive decline, and behavioral disturbances. Traditionally, Alzheimer's care has focused on manual interventions and caregiver support, which can be stressful and difficult to maintain, especially as the disease develops. There is a need to develop a secure and automated system with little to no human intervention with that we can help both the caregivers and the concerned patients.

I. INTRODUCTION

Alzheimer's disease, a progressive neurological disorder, poses significant challenges for individuals affected by the condition and their caregivers. As the most common cause of dementia, Alzheimer's gradually impairs cognitive function, memory, and daily functioning, requiring constant support and assistance to lead a quality life. With millions of people impacted globally, Alzheimer's disease is a major global health concern. Alzheimer's disease is becoming more common as people get older, which puts a pressure on families, caregivers, and healthcare systems. The urgent need for efficient treatments and solutions to lessen the burden of the disease is highlighted by this outbreak.

In this paper we will discuss about how to help and support individuals with Alzheimer's and their caregivers by designing and developing a secure IoT-based system to address the identified challenges and help them lead a healthy and easy life. The use of IoT technology presents a great opportunity for revolutionizing Alzheimer's care by enabling continuous monitoring, remote support to improve safety. The key features of the project include personalized reminders, prompts, and alerts based on individual cognitive abilities and preferences, enhancing user engagement. The system prioritizes user-centric design principles to ensure ease of use and accessibility for individuals with Alzheimer's and their caregivers.

II. BACKGROUND

This section consists of different subsections that are related to the project. Figure 1 represents these concepts,
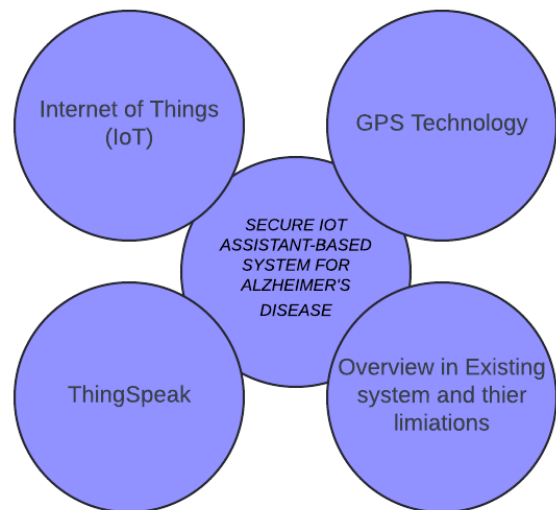

Figure 1. Concepts related to the proposed idea

A.   Internet of Things

In the last decade, IoT technology has had a significant impact on many facets of human life, including industry, transportation, education, agriculture, medicine, and health[1]. This technology makes use of sensors to determine the condition of the environment around it. The involvement of IoT in the project enables advanced monitoring, personalized assistance, remote access, and security features that enhance Alzheimer's disease care and support for both patients and caregivers. By leveraging IoT technology, the project aims to improve patient outcomes, enhance safety, and promote

independence and quality of life for individuals living with Alzheimer's disease.

Traditional care models often fall short in providing timely and proactive support, leading to increased caregiver burden, healthcare costs, and diminished quality of life for both patients and caregivers[3]. In this context, the integration of IoT technology offers a promising avenue for transforming Alzheimer's care, enabling continuous monitoring, personalized interventions, and remote support to enhance safety, independence, and well-being, privacy, and affordability[1][7].

B.   An Overview on Existing Systems

Many existing systems offer generic solutions that do not account for the individualized needs, preferences, and abilities of patients with Alzheimer's and some lack connectivity features, making it difficult to remotely monitor patients or share information with healthcare providers. Also, the cost of existing Alzheimer's care solutions, including hardware, software, and ongoing support, may be prohibitive for many patients and caregivers[7]. This cost barrier may limit access to essential care and support services. The limitations of existing systems highlights the need for innovative solutions that addresses the personalized care and needs of patients with Alzheimer's, enhance connectivity and collaboration among caregivers and healthcare providers, prioritize security and privacy, offer holistic support, and ensure scalability and affordability[3].

C.   ThingSpeak

ThingSpeak is an Internet of Things (IoT) platform and data analytics service developed by MathWorks. It enables users to collect, visualize and analyze data produced by IoT devices or sensors in real time[5]. IoT devices and sensors deployed in the living environments of Alzheimer's patients can capture a variety of data, including temperature, motion, and activity levels[6]. ThingSpeak provides APIs and interfaces that allow these devices to securely submit data to the cloud platform.

D.   GPS technology

GPS enables the real-time tracking of automobiles, assets, and humans. This is useful in the logistics and transportation sectors for management of fleets, package tracking, and optimization of routes. GPS tracking is also employed in personal safety applications, such as monitoring the whereabouts of children, the elderly, and pets. GPS technology offers continuous monitoring of the individual's location, allowing caregivers and healthcare professionals to watch them remotely. This is useful when people with Alzheimer's wander or become confused, as it allows them to be swiftly located and kept secure.

E.   Alzheimer's disease

Alzheimer's disease, a progressive neurological disorder, poses significant challenges for individuals affected by the condition and their caregivers. As the most common cause of dementia, Alzheimer's gradually impairs cognitive function, memory, and daily functioning, requiring constant support and assistance to lead a quality life. With millions of people impacted globally, Alzheimer's disease is a major global health concern. Alzheimer's disease is becoming more common as people get older, which puts a pressure on families, caregivers, and healthcare systems. The urgent need for efficient treatments and solutions to lessen the burden of the disease is highlighted by this outbreak.The generality of Alzheimer's disease is on the rise globally, fueled by aging populations and increased awareness and diagnosis[3][4].

As a result, there is a growing demand for innovative approaches to address the complicated needs of individuals affected by the condition. The background of the work underscores the urgent need for innovative solutions in Alzheimer's care, the potential of IoT technology to address these challenges, and the rationale for developing a secure, user-friendly assistant system tailored to the unique needs of individuals with Alzheimer's.

III. REVIEW OF RELEVANT WORK

Alzheimer's disease is a big concern for the people that get affected and also the close ones of the affected because the care needs to be maximum and time to take care of them needs to be more than usual.

Some of the researchers discussed around this topic and the devices they suggested developing to aid the Alzheimer's patients are, providing timely response and reducing the expense. This technology has the ability to keep a close eye on the actions of Alzheimer's patients both at home and form a remote place. It can also notify family members and medical professionals of the precise position and time of the accident as well as any severe situations[1].

A discussion on available solutions and limitations were conducted In the field of healthcare, IoT offers several applicability, measures of health and behavior can be tracked by evaluating and collecting health-related data and the individuals' personal living experience and environments. The different modules included in these review of devices are

radio frequency identification (RFID), near field communication (NFC), sensors, Bluetooth, ZigBee, global positioning system (GPS), and cameras. This study emphasizes that these IoT devices have some strengths and weaknesses and their application to Alzheimers's disease will increase their limations[2].

Further, a study on assistive technology to aid the Alzheimer's patients were discussed. It is based on addressing the complex needs of the Alzheimer's patients and their caregivers. The potential for IoT technology to improve the safety, management, and monitoring of these patients has been the subject of numerous research. to determine the clinical effectiveness and practical implications of IoT solutions in the treatment of Alzheimer's and amnesiac patients, thorough validation studies and longitudinal evaluations are desperately needed[3].

In studying and learning the research papers related to the project which is developing a device to ease the hardships of the Alzheimer's patients, some of the existing devices and solutions were discussed, some of them have limitations, one of which is not designing based on the individual needs. In this project, we focus on incorporating the specific needs of different individuals affected by Alzheimer's and approach by addressing not only cognitive aspects but also focusing on daily routines, medication and overall safety and put together to system to satisfy the needs.

IV. DESIGN AND METHODOLOGY

The Proposed idea is to develop a device to aid Alzheimer's patients that involves combination of hardware setup, firmware development, and software. ESP32 micro controller is responsible for reading the data from the Heart rate sensor, GSM, GPS, Pushbutton which interface to display the sensor readings and to display sensor reading to ThingSpeak with MQTT (Message Queuing Telemetry Transport) allows for real-time data streaming and bidirectional communication between IoT devices and the ThingSpeak platform. ThingSpeak is an IoT platform that enables the collection, analysis, and visualization of data from IoT devices. Implemented include real-time heart rate monitoring with alerts for abnormal readings, GPS- based location tracking with geo-fencing capabilities to alert caregivers of potential wandering, GSM-based emergency communication for immediate assistance, and medication reminders through the OLED display and buzzer. Figure 2, represents the approach of the design of the proposed idea.
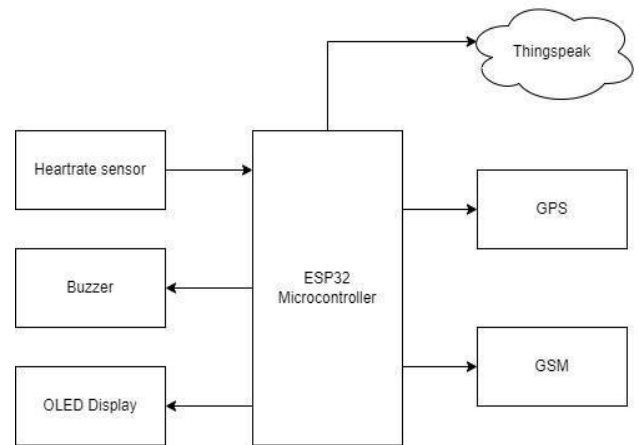

Figure 2: Design of the proposed idea

Based on the requirements, the system architecture would be designed, incorporating the various components mentioned in the abstract, such as the ESP32 microcontroller, GPS module, GSM module, heart rate pulse sensor, OLED display, and buzzer. The system would also include environmental sensors, such as motion detectors and door/window sensors, to monitor the individual's activities and living environment. The hardware components would be carefully selected, considering factors like reliability, power efficiency, and ease of integration. The ESP32 microcontroller would serve as the central processing unit, responsible for collecting and processing data from the connected sensors and modules.

The software development phase would involve programming the ESP32 to handle data acquisition, processing, and transmission. The system would be designed to securely transmit and store data on a cloud platform like ThingSpeak, ensuring data privacy and security through encryption and access controls. The NTP Server is used to provide accurate and synchronized timekeeping across the various components and functionalities of the system. Figure 3, represents the workflow of the proposed idea. It serves as a reliable time source, enabling precise scheduling and delivery of personalized reminders, prompts, and alerts based on the individual's cognitive abilities and routines.
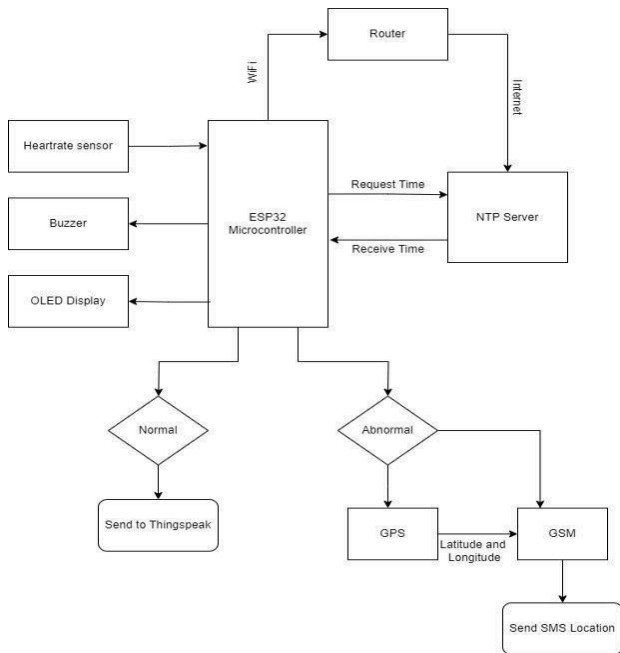
Figure 3: Workflow of the idea

The testing methods employed for the Alzheimer's care IoT project described would be crucial in ensuring the system's reliability, accuracy, usability, and effectiveness in providing personalized care and support to individuals with Alzheimer's disease and their caregivers. One of the primary testing methods would involve unit testing of individual hardware components, such as the ESP32 microcontroller, GPS module, GSM module, heart rate pulse sensor, and environmental sensors. These tests would verify the proper functioning of each component individually, ensuring that they meet the desired specifications and requirements. This testing would ensure that the various hardware and software components can work together cohesively, exchanging data and performing tasks as intended. It would also evaluate the system's ability to handle different data types and formats, as well as its capability to process and analyse the collected data effectively.
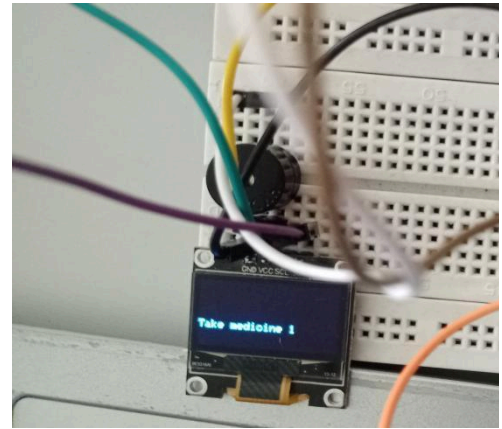

Figure 4. Personalized reminders.

Figure 5: Prompts and alerts

V. RESULTS

The main findings and their consequences after successfully constructing the Secure IoT Assistant Based System for Alzheimer's Disease include successful monitoring of vital signs such as heart rate and location in real-time, providing timely assistance to individuals affected by Alzheimer's disease. The inclusion of OLED displays and tactile interfaces facilitated user interaction and feedback, enhancing the usability of the system for both patients and caregivers. Simple and intuitive interfaces allowed caregivers to configure set medication reminders, and receive emergency alerts seamlessly.
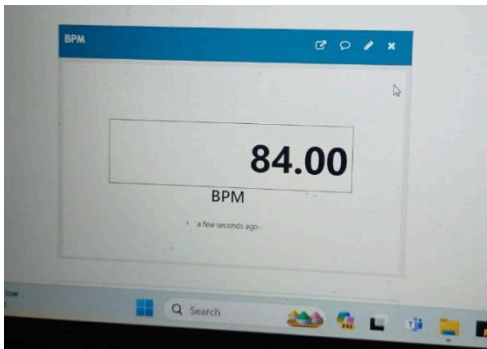
Figure 6. Health Monitoring.

The system can empower patients to perform daily tasks with reminders and assistance, promoting a sense of autonomy for longer. Caregivers can receive alerts and monitor vital signs remotely, offering peace of mind and potentially reducing the need for constant supervision. The system could be adaptable for various home environments and integrate with other smart home devices. Secure communication protocols ensure the privacy and integrity of collected data, protecting sensitive information like location, vitals, heart rate. The System represents a significant advancement in the care and support with Alzheimer's disease. By leveraging IoT technologies, secure communication protocols, and advanced data analytics, the system addresses several critical challenges associated with Alzheimer's care such as Enhanced Safety and Independence, Privacy and Security, Personalized Care and Support, Scalability and Adaptability.
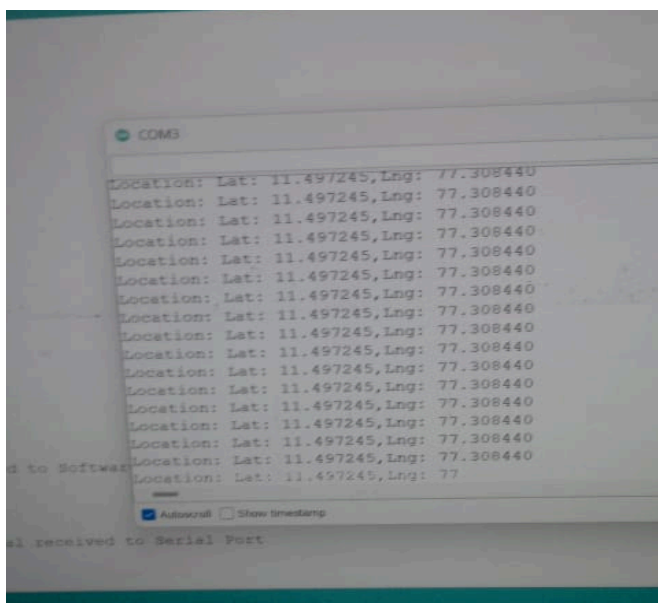

Figure 6: Location tracking.

VI. CONCLUSION

In conclusion, the "Secure IoT Assistant-Based System for Alzheimer's Disease" improves Alzheimer's care to a greater extent by utilizing IoT technology to boost safety, offer comprehensive support, and enhance the general well being of those who struggle with Alzheimer's and their caregivers. This idea of the proposed system is to make the life of the people who are affected by Alzheimer's, while doing that it may not be always possible to monitor them. There are some exceptions like technical limitations of such reliability of sensors, internet connectivity.

REFERENCES

[1].   I. Suhail and S. Pillai, "IoT enabled applications for Healthcare decisions," 2022 International Conference on Decision Aid Sciences and Applications (DASA), Chiangrai, Thailand, 2022, pp. 47-54, doi: 10.1109/DASA54658.2022.9765251.

[2]. S. S. Aljehani, R. A. Alhazmi, S. S. Aloufi, B. D. Aljehani and R. Abdulrahman, "iCare: Applying IoT Technology for Monitoring Alzheimer's Patients," 2018 1st International Conference on Computer Applications & Information Security (ICCAIS), Riyadh, Saudi Arabia, 2018, pp. 1-6, doi: 10.1109/CAIS.2018.8442010.

[3]. D. Surendran, J. Janet, D. Prabha and E. Anisha, "A Study on devices for assisting Alzheimer patients," 2018 2nd International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)I- SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2018 2nd International Conference on, Palladam, India, 2018, pp. 620-625, doi: 10.1109/I-SMAC.2018.8653658.

[4].   S. N. Siri, H. B. Divyashree and S. P. Mala, "The Memorable Assistant: An IoT-Based Smart Wearable Alzheimer's Assisting Device," 2021 IEEE International Conference on Computation System and Information Technology for Sustainable Solutions (CSITSS), Bangalore, India, 2021, pp. 1-6, doi: 10.1109/CSITSS54238.2021.9682788.

[5].   Waleed Salehi, Gaurav Gupta, Surbhi Bhatia, Deepika Koundal, Arwa Mashat, Assaye Belay, "IoT-Based Wearable Devices for Patients Suffering from Alzheimer Disease", Contrast Media & Molecular Imaging, vol. 2022, Article ID 3224939, 15 pages, 2022. https://doi.org/10.1155/2022/3224939

[6].   Thakur, Muskan & Kumar, Ajay & Chatterjee, Indranath. (2023). IoT-enabled solutions for Alzheimer's disease management: innovations and opportunities. Neuroscience Research Notes. 6. 10.31117/neuroscirn.v6i4.255.