Smart AI Device for Alzheimer's Patients

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ABSTRACT

Alzheimer's disease (AD) is a neurodegenerative disorder that leads to progressive memory loss, cognitive decline, and behavioral changes. As the disease advances, it impairs the ability of individuals to perform daily tasks and can cause confusion, disorientation, and anxiety. One of the most concerning aspects of Alzheimer's disease is the increased risk of wandering behavior. Patients may become disoriented and wander outside of safe areas, potentially exposing themselves to harm. Wandering not only puts patients at risk but also places a considerable emotional and physical burden on caregivers, who must remain vigilant at all times.In recent years, advancements in technology have presented new opportunities to improve the quality of care and safety for Alzheimer's patients. The development of smart systems, such as wearable devices, sensor networks, and AI-based solutions, has opened up innovative ways to monitor patients and ensure their safety while maintaining a degree of autonomy. Among these advancements, facial recognition and location tracking technologies have shown great promise in addressing the challenges of patient identification and wandering behaviors.

Keywords: Fully Autonomous Navigation Real-time path planning and dynamic obstacle avoidance.

1. INTRODUCTION

Alzheimer's disease is the most common form of dementia, affecting millions of elderly individuals globally. It is characterized by the gradual degeneration of neurons in the brain, leading to cognitive impairment, memory loss, and changes in behaviour. The disease progresses in stages, with patients eventually losing the ability to recognize loved ones, perform basic tasks, or even communicate effectively. These challenges are compounded by the emotional and physical strain placed on caregivers, who must manage the patient's daily care and monitor their well-being.

One of the most significant risks associated with Alzheimer's disease is wandering. As patients become more disoriented, they may leave familiar environments, such as their homes or healthcare facilities, without realizing the danger of doing so. Wandering behaviour can lead to a variety of safety concerns, including exposure to traffic, falling, or getting lost. In some cases, wandering may result in patients becoming completely disoriented, unable to find their way back home, which can be extremely distressing for both the patient and their caregivers.

1.1 OBJECTIVES

- Sends alerts when the patient leaves a predefined area.
- Recognizes people around the patient using a camera and AI.
- Tracks the patient's location in real time.
- Notifies the caregiver and provides audio feedback to the patient to reduce confusion

2. LITERATUREREVIEW

The prevalence of Alzheimer's disease (AD), a neurodegenerative condition characterized by memory loss, cognitive dysfunction, and behavioral changes, has been on the rise globally, and with it, the challenges for caregiving and patient safety. As the disease progresses, patients experience disorientation, confusion, and wandering behaviors, making safety monitoring a critical issue. Various technological solutions have been explored to enhance the care of Alzheimer's patients, ranging from basic monitoring systems to sophisticated AI-based approaches. This literature review examines existing work in the domains of face recognition, location tracking, and the use of Raspberry Pi in healthcare systems, with a focus on Alzheimer's care.

Face recognition technology has been widely used in security, surveillance, and personal device authentication. In the healthcare context, it has gained attention for its potential to provide an accurate and non-invasive method of identifying individuals, including Alzheimer's patients. Facial recognition offers a solution to the problem of patient disorientation and confusion, as it can help patients recognize caregivers, family members, and themselves.

Several studies have explored the use of face recognition algorithms in Alzheimer's care. A study by Zhang et al. (2017) explored the application of face recognition systems in dementia patients to help them recognize their caregivers and family members. The system utilized a deep learning-based convolutionalneural network (CNN) to improve the accuracy and speed of recognition. However, the study acknowledged that face recognition algorithms can be computationally intensive and may not be suitable for real-time applications in low-resource settings.

The Haar Cascade classifier is another popular algorithm used for real-time face detection. Haar Cascade is known for its efficiency in detecting faces in real-time applications with lower computational demands. Viola and Jones (2001) introduced the Haar Cascade algorithm, which uses a series of simple features, combined with AdaBoost classifiers, to detect faces in images. The algorithm's computational efficiency has made it a preferred choice in various embedded systems, such as the Raspberry Pi, for applications where processing power and memory are constrained.

LBPH (Local Binary Pattern Histograms) is another method that has been successfully applied to face recognition. In comparison to deep learning-based techniques, LBPH is simpler and less computationally demanding, making it ideal for real-time embedded systems like Raspberry Pi. Ojala et al. (2002) introduced LBPH as a texture-based face recognition technique, which has since been widely adopted due to its robustness in varying lighting conditions and its lower computational cost. Several studies have highlighted the potential of LBPH for real-time face recognition in healthcare applications, including Alzheimer's patient identification.

The issue of wandering in Alzheimer's patients is a well-documented phenomenon, with studies showing that wandering behaviors significantly impacts patient safety. According to the Alzheimer's Association (2020), up to 60% of people with Alzheimer's disease will experience wandering at some point during the progression of the disease. This behaviors can occur in both familiar and unfamiliar environments, leading to patients becoming lost or encountering dangerous situations.

3. PROPOSEDWORK

Face Recognition System: The system uses Haar Cascade and LBPH (Local Binary Patterns Histograms) algorithms to identify the Alzheimer's patient. A camera is installed in a designated location (e.g., the entrance or living room), which captures images of the patient. The system matches the detected face with pre-stored templates to identify the individual. Once identified, the system can trigger an audio alert (e.g., a reassuring message or safety reminder) through a connected speaker, helping to reduce disorientation and confusion.

RF Zone Detection System: The system utilizes RF transceivers to monitor the patient's movement within predefined zones (such as a safe area or the home). If the patient moves beyond a safe zone, the system detects the loss of the RF signal and triggers an alert. The system also uses a GPS module to send real-time alerts to caregivers through a mobile app (Blynk), including the patient's location.

Mobile Notifications for Caregivers: Alerts about wandering or patient identification are sent to caregivers' smartphones using an IoT platform like Blynk. This enables caregivers to receive real-time updates and take immediate action if the patient moves outside of a safe area.

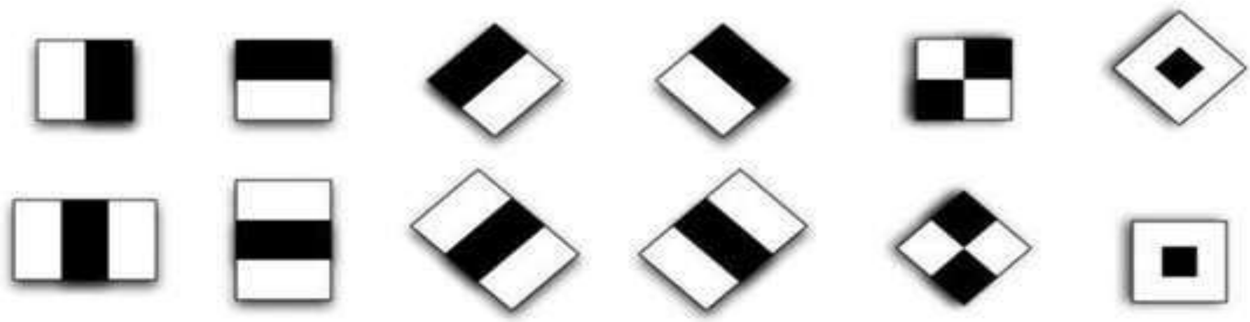


Fig1. Types of Haar Features

Fig2. Haar Features

3.1 Local Binary Pattern (LBP)

For facial recognition process LBP algorithm is used. A great advantage of LBP is that it is illumination invariant. If you change the lighting on the scene all the pixel values will go up but the relative difference between these values will be the same. Local Binary Pattern (LBP) is an efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. When LBP is combined with histograms of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. Using the LBP combined with histograms we can represent the face images with a simple data vector. The LBP requires 4 parameters namely Radius, Neighbors, Grid X, Grid Y. 1. Radius: the radius is used to build the circular local binary pattern and represents the radius around the central pixel. 2. Neighbors: the number of sample points to build the circular local binary pattern. the more sample points you include, the higher the computational cost. For LBP 8 neighbors are used in our system. 3. Grid X: the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is set to 8. 4. Grid Y: the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is set to 8.

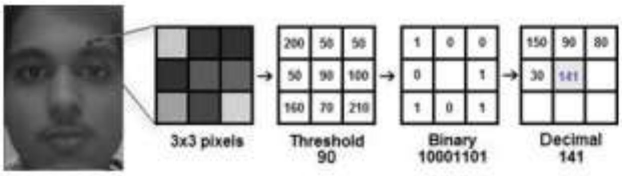


Fig 3.3: LBP

algorithm for a face After the parameters are obtained the first step is to convert the image to grayscale. Next is to obtain a window of 3x3 pixels for the image with intensity of each pixel denoted by any value from 0-255. A central value is then selected to be used as threshold value which will be used to define the new values from 8 neighbours as shown in the figure above. If the intensity of the centre pixel is greater than-or-equal to its neighbour, then we set the value to 1; otherwise, the value is set to 0.

3.2 Peripherals

Generic USB keyboards and mice are compatible with the Raspberry P

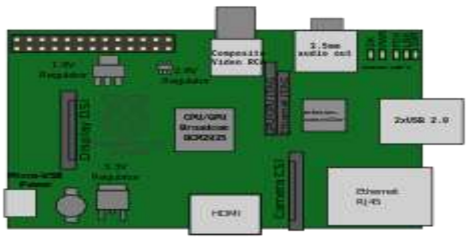
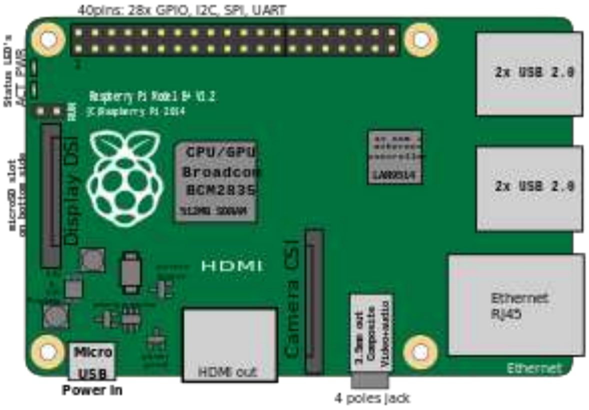


Fig 4.1: Peripherals

Location of connectors and ICs on original Raspberry Pi Model B.



Location of connectors and ICs on Raspberry Pi B+ rev 1.2, and Raspberry Pi 2 Model B.

3.3 USB CAMERA

4. WORKINGPRINCIPLE

Cams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound. Various lenses are available, the most common in consumer-grade webcams being a plastic lens that can be screwed in and out to focus the camera. Fixed lenses, which have no provision for adjustment, are also available. As a camera system's depth of field is greater for small image formats and is greater for lenses with a large f-number (small aperture), the systems used in webcams have a sufficiently large depth of field that the use of a fixed focus lens does not impact image sharpness to a great extent.Image sensors can be CMOS or CCD, the former being dominant for low-cost cameras, but CCD cameras do not necessarily outperform CMOS-based cameras in the low cost price range. Most consumer webcams are capable of providing VGA resolution video at a frame rate of 30 frames per second. Many newer devices can produce video in multi-megapixel resolutions, and a few can run at high frame rates such as the PlayStation Eye, which can produce 320×240 video at 120 frames per second.

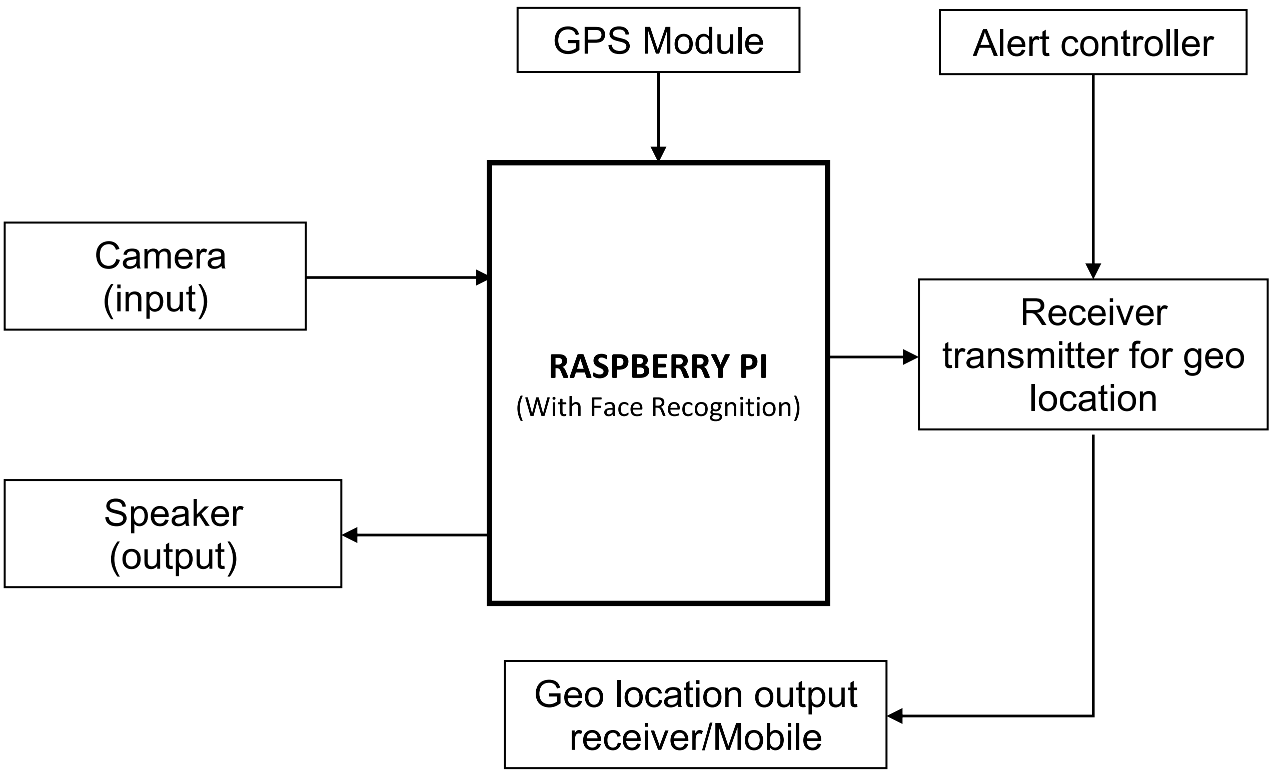
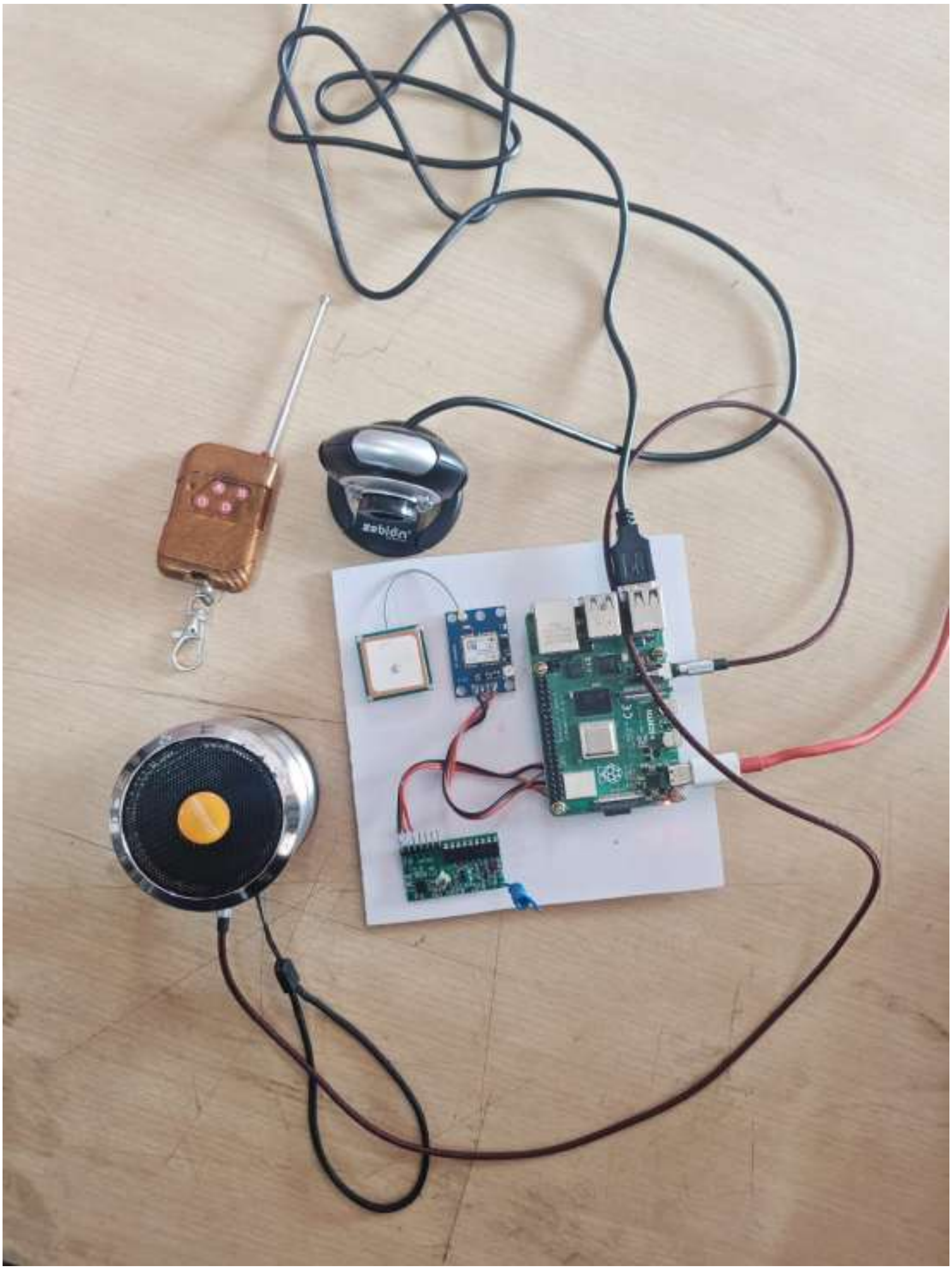


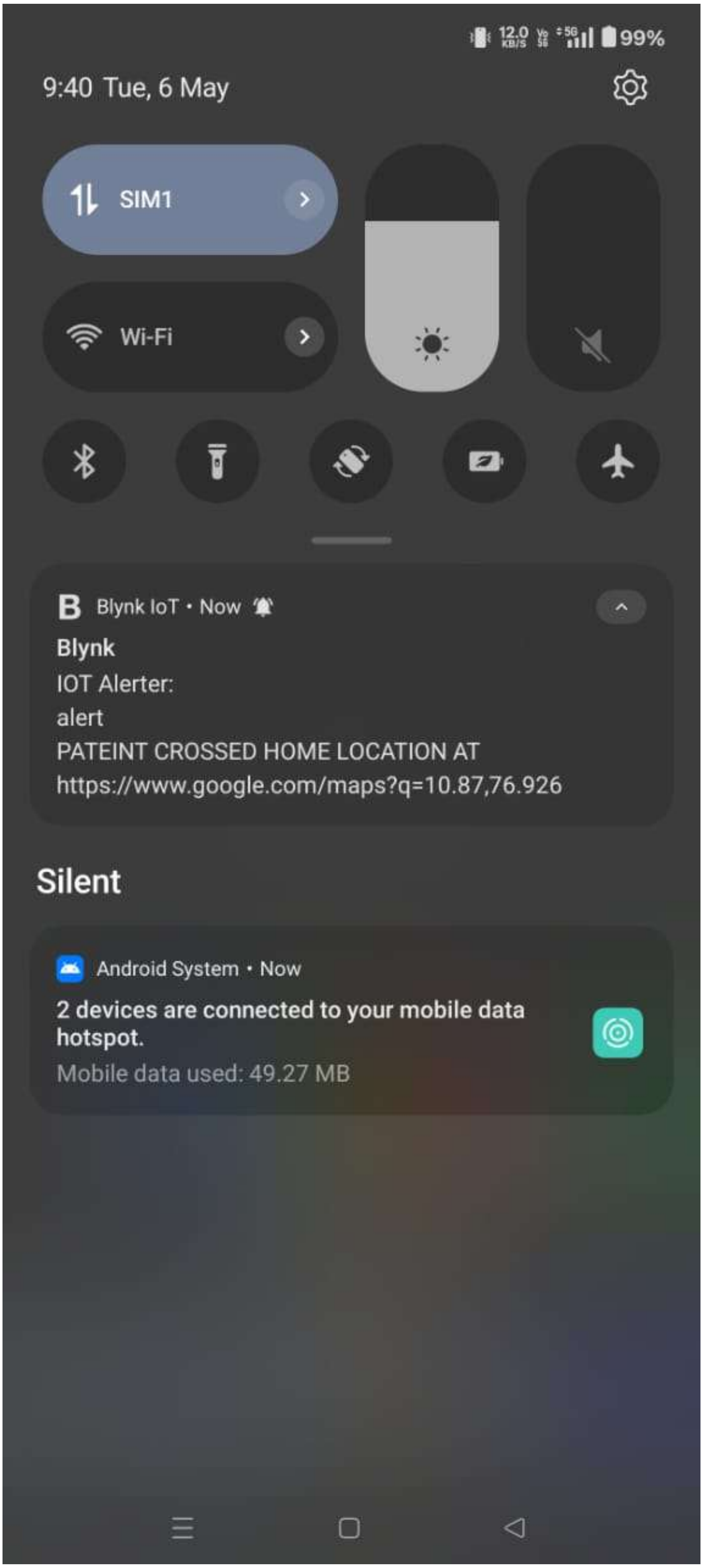
Fig8. Flow Chart

5.RESULTS

Theproposedmodel ofour projectisdisplayed below.Fig 14.Showsthe proposedmodel



6. OUTPUTS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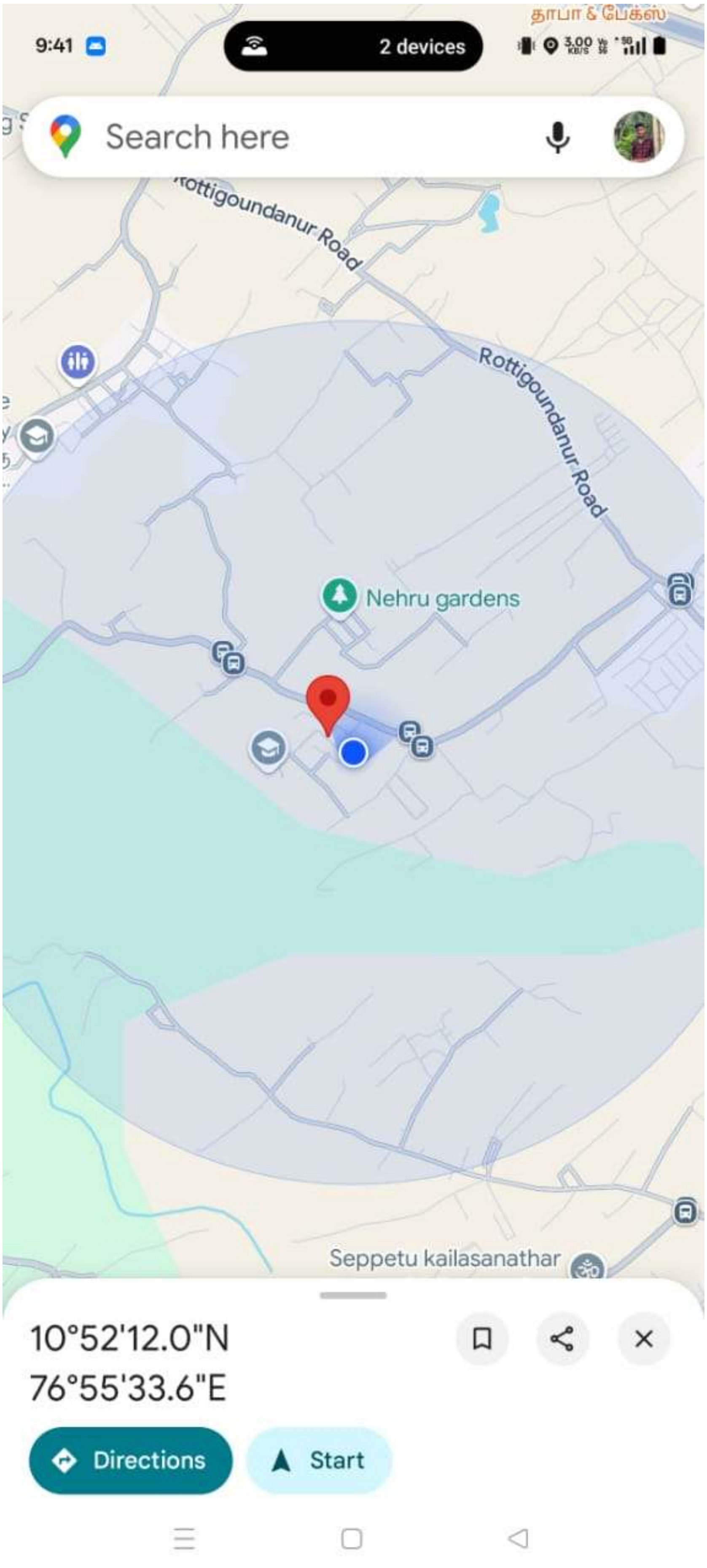
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7. CONCLUSION

As the population ages, the prevalence of Alzheimer's disease is expected to rise, placing increased pressure on caregivers and healthcare systems. The development of smart technologies that assist in patient monitoring and enhance safety is crucial to improving the care and well-being of individuals living with Alzheimer's disease. The system proposed in this paper offers a promising solution by combining AI-powered face recognition with zone-based tracking to provide real-time alerts and notifications. With the Raspberry Pi as the central platform, this system is not only effective and reliable but also affordable and adaptable to different environments. It represents a significant step toward using technology to improve the lives of Alzheimer's patients and their caregivers.

This project not only demonstrates the feasibility of deploying AI on edge devices for health applications but also underscores the potential of open-source hardware and software to democratize access to assistive technologies. While the current implementation has shown promising results, there remains considerable scope for enhancement. Future iterations could incorporate advanced behavioral analytics, fall detection, voice-based interaction for patient comfort, and integration with medical databases for health tracking.

In conclusion, this system represents a significant step forward in the application of technology to support Alzheimer's patients. It reinforces the potential of AI and embedded systems to improve quality of life, ensure patient safety, and reduce the emotional and physical toll on caregivers. By continuing to innovate and refine such solutions, we move closer to a future where intelligent systems play a central role in compassionate and effective elder care.

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