WanderVision : Enhancing Dementia Care with Artificial Intelligence and Augmented Reality

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***Abstract*— This paper is an advanced application of Augmented Reality to form an intelligent navigation system designed for support towards individuals with dementia. This system aims to identify and mark paths that are safe in guiding users through complex environments and, ultimately, toward a safer and more immersive experience in navigation. Assisted with occlusion handling it will be able to enhance user awareness by overlaying critical safety cues within the user's field of view dynamically. This is even more enhanced beyond just the aspect of navigation, as with the integration of computer vision technologies, providing solutions on medicinal and dietary requirements supporting lifestyle choices towards a healthier living and personal safety. Concentration on safety and assistance towards health issues adequately comes under the general scope of the project, which may help ensure greater independence and personal autonomy in the lives of persons with dementia-managing life's routine activities or dealing with episodes of cognitive disorientation. This AR-based system would directly deliver personalized health and safety insights to users with an aim to enhance the autonomy and resilience of individuals with dementia, providing practical support in leading safer, more empowered lives.**

Keywords*— *augmented reality, artificial intelligence, paths, dementia, computer vision

I. INTRODUCTION

Dementia is a severe global issue with millions of individuals and also taxing the caregivers who care for the patients. Most of these patients suffer memory loss and confusion during the latter stages of their illness, raising the likelihood of injury and the requirement of continuous care. The main objective of the Wander Vision initiative is to address these problems through AR as well as AI in order to develop a system that enhances the safety and independence of dementia patients.

Building on the work established by Wander Guardian Project; Wander Vision is about real-time, context-aware information to guide users safely and properly through a complex environment. The system uses advanced sensors with occlusion handling techniques to identify the safety of paths while offering the users an immersive experience to enhance decision making for their movements. Through wearing a similar device to the Oculus.

A wander vision means making sure the system is intuitive and accessible, an activity that does not demand prior knowledge to operate. We also strive to adopt assistive technology that means aiding recognition of people and objects.[1]

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Dementia is a complex, increasingly prevalent neurological condition affecting millions, characterized by progressive cognitive decline, memory loss, and disorientation. This condition does not only affect the people suffering from it but also causes much emotional, physical, and financial burden to their caregivers; patients often require constant supervision for safety reasons. As the patient's disease advances, confusion and disorientation episodes may occur, leading him to greater risk for accidents and wandering behavior with injuries and fatalities. These issues underscore the need for innovative, effective solutions that ensure patients' safety and autonomy, even while relieving burdens on caregivers.

The uniqueness of such challenges in patients who have dementia and their caregivers necessitates the development of the Wander Vision project. It exploits the potential of Augmented Reality (AR) and Artificial Intelligence (AI) to enhance a system for the promotion of the independence and safety of dementia patients in daily life. Wander Vision takes a step forward in patient care and offers real-time guidance that is context-aware to empower patients with much greater confidence as they navigate complex environments.

Wander Vision is built with AR functionality that provides real-time, context-aware information so that patients can determine safe paths in making their movements while the system takes care of sensors and occlusion handling to monitor and signal out safe paths while marking areas or objects that should not be passed. This guided walkthrough might assist dementia patients to perform more freely while reducing the occurrence of accidents.

Another innovation within the project is its wearable AR device that seems to be modeled on an Oculus and has navigation and safety prompts directly available in the field of vision to the patient. Technology is intuitive and accessible, not requiring previous technical knowledge for the use of the device, an aspect suitable for the target group with dementia. Through visual signals and warnings, the patient is guided along safe routes that promote maintaining independence with the least risk of causing harm.

Apart from the navigation system, Wander Vision boasts of assisted recognition technology that will help in supporting dementia patients. It will use a friendly interface for friends and the most visible items around, thus aiding patients to circulate and freely execute normal active life without the need for constant shelter. Such supplementation is expected to aid in reducing confusion and loneliness cases of dementia patients and enhance their quality of life.

Although this Wander Vision project improves the quality of life of dementia patients, it should also make the work of caregivers easier by automating processes for tracking, monitoring, and notifications on safety. On the other hand, the reduction of constant monitoring would also reduce the stress level of the caregivers and channel their energy to other parts of patient care.

II. Literature Review

Augmented Reality (AR) and Virtual Reality (VR) technologies have become increasingly sophisticated, offering new possibilities for navigation, healthcare, and user interaction. There are still lots of challenges such as occlusion handling, real time processing, and user engagement. Application Development, in this case, will be executed under the WanderVision project. The application would bring the latest AR/VR technology with dynamic occlusion detection into the development of a safer and efficient transportation system. Many research works focus on AR/VR systems development - handling various tasks from understanding context to navigation, occlusion handling, and even interaction.

Takada et al. apply wearable sensors to provide real-time, context-sensitive navigation assistance. Connected AR devices typically include a device that is sensitive to the user's movements, therefore creating dynamic information with the help of fluid transitions of the display. Despite their effectiveness, such systems present several challenges like annotation filtering and context detection which may hinder their performance particularly in complex environments [1].

Sharma et al. discussed considerable advancements in the creation of AR for navigation, including AR glasses that include applications such as driving, pedestrian, and indoor navigation. Such systems tend to be close to the actual and virtual components when assisting the user in navigation. As noted by Sanaullah et al., however, privacy and ways users are forced to interact with the system through more fluid integration of displays across various scenarios are some of the problems faced [2][3].

The areas of research emerging are those studied by Wang et al., which are critical for the management of occlusions in VR and, more specifically, for keeping away the inefficiencies arising due to obstacles in a VR environment. Managing Occlusions: Using Head-Mounted Displays and Tracked VR Systems A difficulty arises in directly managing occlusions as proposed by Lee et al. Since most of these techniques often fail to deliver an appropriately clear and unbroken experience for the user in the presence of occlusions [4][5].

III. Wander Vision

Wander Vision: Enhancing Dementia Care with Artificial Intelligence and Augmented Reality is a research initiative that addresses the wandering problem caused by the cognitive decline due to Dementia, it does so by utilizing AI and AR technologies in care provision. "Wander Vision" presents a new and unconventional approach to caring for and managing this critical issue, combining advanced technology with humane treatment.

AI is the major driver that allows for the effective use of predictive analytics, deducing the best possible personalized care. By analyzing behavioral changes in patients, this AI system can predict wandering and provide a detailed anamnesis if caregivers intervene promptly through the alarm system. Consequently, the frequency of accidents decreases, and patient safety increases. Additionally, the AI software can be connected to smartwatches that monitor vital signs and register the patient's location in real time, providing beneficial information to concerned parties.

Another feature of AR is its capability to alter a patient's environment by overlaying virtual information onto the real world. AR enhances the environment by creating digital overlays, such as visual guides within "Wander Vision." This system sets visual cues to help patients avoid dangerous situations and navigate back home. Furthermore, AR can facilitate interactive environments that promote cognitive health and reduce anxiety, helping patients remain calm and focused, thus minimizing the chance of wandering. Object recognition further enhances this feature by enabling the system to identify household items, assisting patients in managing daily routines and reinforcing their sense of independence.

"Wander Vision" is more than just a high-tech product; it is a comprehensive dementia care solution. Through the implementation of AI and AR, it confronts the wandering problem while enriching patients' lives, enhancing their autonomy, dignity, and safety. Our future work will focus on "Wander Vision," aiming to set a new standard in dementia care that provides hope and favorable outcomes for patients and their families.

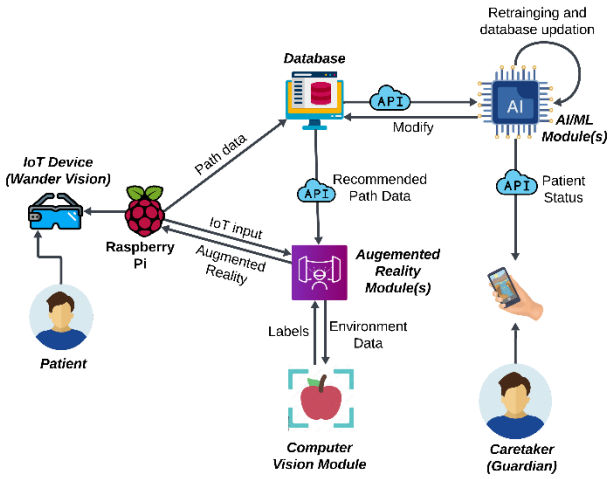

Fig 1: Architecture Diagram of WanderVision

IV. Computer Vision and Augmented Reality

A. Dementia Assistant Recognition Module

The facial and object recognition system, built on a Raspberry Pi platform, enables real-time identification of familiar faces and medication to aid in personalized dementia care. The system utilizes Python-based libraries to achieve high accuracy and efficiency within the constraints of the Raspberry Pi's processing power.[6][7]

The Wander Vision system aims to detect familiar faces such as familiar faces and family members and specific objects such as medication and food to support contextual understanding and memory reinforcement for dementia patients.

B. Recognition Process Utilizing

the python supported 'face_recognition' library, that leverages deep learning to recognize faces by encoding facial features into a 128-dimensional embedding, using the concept of deep metric learning. Upon detection of a known individual, the system displays a comforting cue or the person's name on the AR display, helping the patient recall relationships and enhancing their sense of security and familiarity.[8]

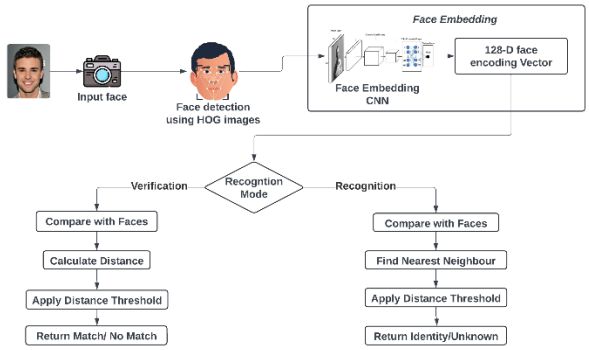

Fig 2: Architecture of the face_recogntiton Library

For object identification, including medication labels, the system uses Optical Character Recognition (OCR) capabilities powered by the 'easyocr' library. When a medicine is recognized, details about its purpose or dosage are displayed in the AR interface, reducing reliance on caregiver instructions and supporting patient independence.[9]

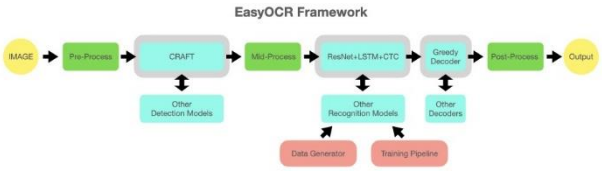

Fig 3: Architecture of easy OCR

The Raspberry Pi Camera Module captures images or video sequences for processing. This data is then analyzed by the face_recognition and easyocr libraries, which run efficiently on the Raspberry Pi with lightweight machine learning models suitable for real-time, on-device computation.

C. Indoor Navigation and Augmented Reality

Utilizing Unity's Navigation Mesh (NavMesh), the system maps the indoor layout, consisting of obstacles, walls, and key locations. By pre-generating paths to essential areas, the NavMesh allows the system to chart efficient routes that prioritize safety and accessibility.

The AR system projects navigation aids, such as lines, which are dynamically adjusted based on the user's current location. These cues provide clear orientation guidance using dynamic path adjustment; calculating whether the user has deviated from the right path. The system marks important locations, such as medication storage, restrooms, or living areas, with destination-specific cues. This feature helps patients easily identify these places with confidence.

Multiple components from Unity assist in the formation of the system. ARCore component manages environmental understanding and depth perception, ensuring that paths and cues align accurately with physical surroundings, resulting in stable overlays. The XR Plugin Management provides cross-platform compatibility, supporting flexibility in display hardware and enabling future scalability, while the Line Rendering Experimental Setup

V. Experimental Setup

The hardware and software components of the experimental setup for Wander Vision were carefully selected to create a robust and scalable system for enhancing dementia care.

A. Hardware Components

Raspberry Pi serves as the central IoT hub for the system, handling image capture, recognition tasks, and data transmission. Running on Raspbian OS, the Raspberry Pi is configured to support both facial recognition and object recognition by using face_recognition and easyocr library.

The Raspberry Pi camera module V2 is connected to the Raspberry Pi and captures real-time video or images, which are processed for facial and object recognition.

An LCD display connected to the Raspberry Pi serves as the AR display interface, where navigation cues and recognition notifications are visualized for the user. This display acts as a user interface, presenting real-time feedback to patients, such as face or object recognition cues and navigation directions.

B. Software Components

The Raspberry Pi operates on Raspbian OS, a lightweight Linux-based operating system optimized for Pi hardware. The operating system supports Python-based scripts that control image capture, manage data processing, and communicate with the AR module.

The face_recognition library, implemented in Python, is used for facial recognition tasks, allowing the system to identify known individuals. Upon detecting a recognized face, the system generates a visual prompt on the AR display, assisting patients in identifying caregivers or familiar people.

The easyocr library handles OCR-based recognition for medication labels, providing the user with guidance on medicine purpose or dosage. Recognized text data from the OCR process is converted into display notifications, enabling the patient to understand the purpose of each recognized object (e.g., "Contains Sugar, You are allergic to Sugar"). The Unity platform is employed to design an AR environment that assists in indoor navigation, specifically tailored to the dementia care setting.

Using Unity's Navigation Mesh (NavMesh) system, a virtual representation of the indoor layout is created, with designated paths to common areas and essential destinations. Unity libraries are majorly used in deploying visual cues to the patients or the users. ARCore enables environmental understanding, depth estimation, and alignment of visual overlays, ensuring that visual cues appear naturally within the physical environment. XR Plugin Management facilitates cross-platform compatibility for future scalability, allowing the AR experience to be tested or deployed on various AR-supported devices. Unity's rendering system displays lines, guiding users through the environment with clear, intuitive cues.

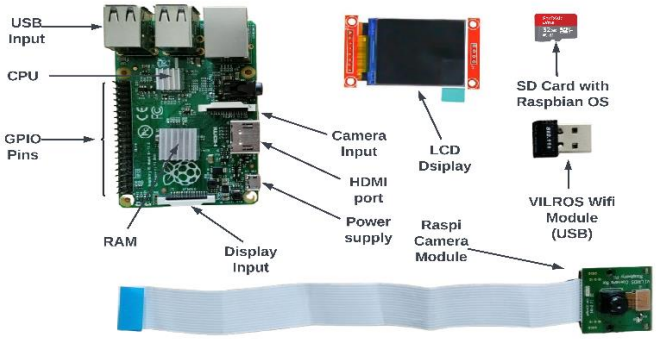

Fig 4: Hardware Components of WanderVision set up

VI. Result

The Wander Vision system successfully demonstrated the ability to provide facial and object recognition, live video streaming, and augmented reality (AR) navigation through a laptop-based interface, showcasing its potential to support dementia patients in a controlled indoor environment.

A. Recognition Performance

The facial recognition module reliably identified familiar faces, such as caregivers, in real-time, and the object recognition component accurately detected specific medications. Notifications for identified faces and objects were displayed through visual AR cues on the laptop screen, offering contextual reminders and reinforcing memory support for the patient. Despite varied lighting and moderate visual obstructions, the recognition module performed consistently in the controlled setting, providing reliable cues that were immediately understood by users.

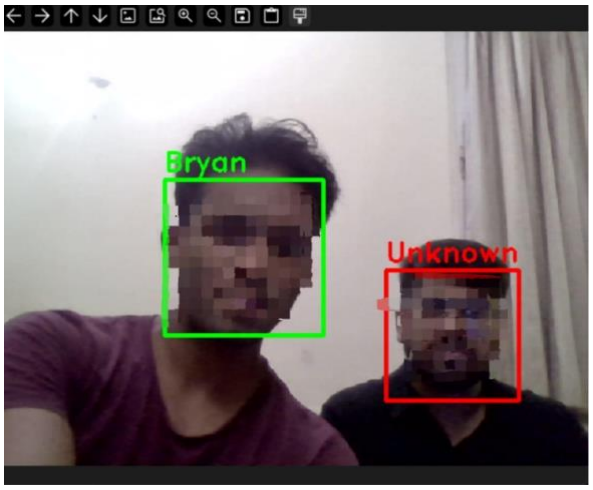

Fig 5: Face Recognition Results

Fig 6: Optical Character Recognition (OCR) Results

B. Live Streaming

The live streaming functionality on the laptop facilitated continuous observation of the patient's interactions within the environment, with minimal latency, ensuring smooth communication between the image capture, recognition, and AR display stages. This real-time flow allowed for instant feedback and dynamic AR-based prompts without noticeable delay, supporting seamless interaction and consistent support for patient autonomy. This feature is essential for the success of the system in real-life applications where timely responses are critical.

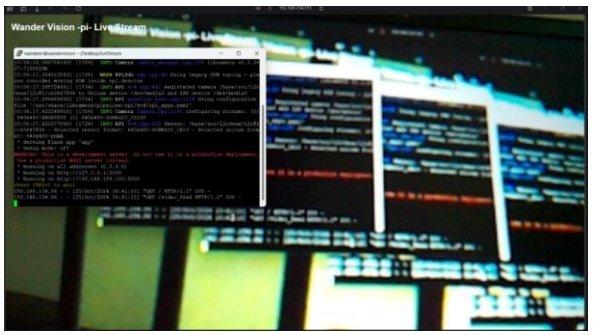

Fig 7: View of Live Stream

C. AR Navigation and Guidance

The Unity-based AR navigation on laptop based device provided clear visual markers for guiding the patient throughout the indoor setting. Navigation paths were dynamically displayed based on the user's location, allowing for effective redirection in case of deviations. Patients were able to intuitively follow AR cues projected on the laptop screen, achieving navigation goals such as reaching specific rooms or objects. The use of NavMesh in Unity helped map accessible routes around obstacles, effectively minimizing confusion and enhancing ease of movement. Creation of prefabs helped in tracking and rendering the lines and distance.

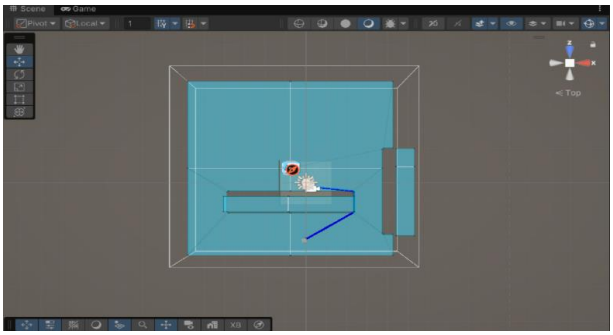

Fig 8: AR Navigation Results: The blue line represents the recommended(safest) path from source to destination

VII. Future Aspect and Conclusion

The Wander Vision project envisions a future where augmented reality, IoT, and computer vision work in tandem to foster a supportive environment for dementia patients. By implementing Home Safety Monitoring, object detection can alert patients or caregivers if appliances like stoves are left on beyond need. Obstacle Detection and Fall Prevention will help patients navigate safely by identifying obstacles like furniture or stairs, while Recognizing Dangerous Objects will detect hazardous items such as knives, warning users to prevent injuries. This adaptable framework supports ongoing enhancements to address evolving patient safety needs. For Augmented Reality, the primary need for improvements stems from its inability to navigate on mobile devices. Additionally, integrating Google Maps and terrain recognition would enable location-based guidance, helping patients navigate familiar outdoor areas and adapting cues for safety on different surfaces. Incorporating daily routine tasks would assist patients in staying active. Finally, introducing interactive AR-based cognitive exercises could reinforce memory by engaging patients with familiar elements in enjoyable activities. These enhancements would transform Wander Vision into a comprehensive support system for dementia care.

The proposed enhancements for Wander Vision underscore its potential to significantly improve dementia care. These advancements not only aim to enhance patient independence and safety but also promote cognitive well-being, ultimately fostering a more supportive and independent environment for individuals living with dementia.

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