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RESEARCH ON ASSISTIVE SYSTEM FOR ALZHEIMER PATIENT

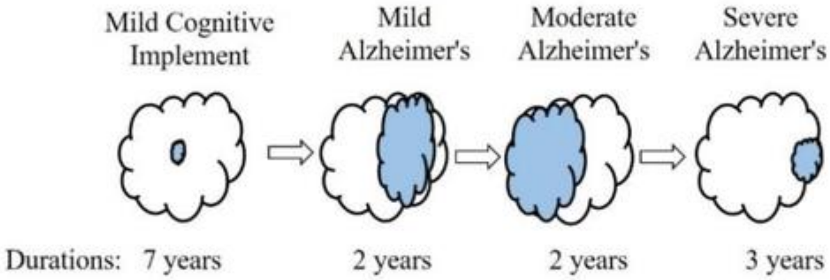
Dr. Umesh Akare[1], Asst. Prof Pallavi Lonkar[2], Aditya Rangari[3], Rajat Bhandakkar[4], Ritesh Gaikwad[5]

Artificial Intelligence and Data Science Department, Priyadarshini College of Engineering Nagpur, India[1-5]

Abstract: Alzheimer's disease is a progressive neurodegenerative condition that significantly affects cognitive abilities, resulting in memory impairment, confusion, and challenges in carrying out everyday tasks. A significant hurdle for individuals with Alzheimer’s is their difficulty in recognizing family members and caregivers, which can lead to emotional distress and increased dependency. Moreover, the failure to remember to take prescribed medications exacerbates their health issues. To tackle these challenges, this research introduces a laptop-based assistive system that combines deep learning facial recognition technology with a medication reminder feature, aimed at improving the quality of life for those with Alzheimer’s. The system utilizes a laptop's webcam to capture real-time facial images, which are then analyzed by a deep learning model to identify familiar faces. Upon recognizing a known individual, the system announces their name audibly, aiding the patient in recalling and recognizing their loved ones. Furthermore, it includes a medication reminder function that notifies patients at specific times to promote adherence to their prescribed treatment regimen. This solution is designed to be standalone and user-friendly, negating the need for additional IoT devices, thus making it suitable for home environments.This research outlines the design, implementation, and assessment of the assistive system, focusing on its accuracy, usability, and effects on patient care. The facial recognition component employs Convolutional Neural Networks (CNNs) for accurate identification, while the medication reminder utilizes a structured scheduling system with audio-visual alerts. Experimental findings demonstrate that the system effectively aids patients in recognizing individuals and following their medication schedules.By merging AI-powered facial recognition with intelligent reminders, this assistive technology seeks to promote patient independence, alleviate caregiver stress, and enhance overall well-being. The study also considers potential future enhancements, including improved emotion detection capabilities.

INTRODUCTION

Alzheimer’s disease ranks among the most common neurodegenerative disorders, impacting millions globally. This progressive illness primarily affects memory, cognitive abilities, and daily activities, often hindering patients from recognizing even their closest relatives. As the condition progresses, individuals may find it increasingly challenging to perform fundamental tasks, such as recalling names, dates, and adhering to medication schedules. This deterioration not only diminishes the quality of life for patients but also imposes significant emotional and physical strain on their caregivers.Recent advancements in artificial intelligence and deep learning have led to the development of assistive technologies that can effectively manage the symptoms of Alzheimer’s. A major hurdle for patients is the inability to recognize familiar faces, which can result in confusion, emotional turmoil, and social withdrawal. Additionally, medication non-adherence poses a serious risk, as patients may forget to take their prescribed treatments, potentially leading to critical health issues.To tackle these challenges, this project introduces a laptop-based assistive system that combines deep learning facial recognition with a medication reminder feature. Unlike current solutions that depend on IoT devices or mobile applications, laptop, providing easy access and minimizing reliance on external hardware.



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Alzheimer's patients frequently encounter two primary difficulties: impaired facial recognition and medication non-adherence. Conventional methods, such as name tags, written reminders, and manual alerts, often fall short due to the disease's progressive nature. Although loT-based solutions show promise, they typically necessitate external sensors, internet access, and complex. configurations, which can be challenging for elderly users.

LITERATURE SURVEY

Sr. No.	Research Paper Name	Year	Author	Contribution	Limitation
1]	Mobile Health Applications for Alzheimer's Patients: A Review of Design Features	2021	S. Patel, R. A. Patel	The paper highlights key design features such as user-friendly interfaces, personalized reminders, and integration with caregivers' apps.	data privacy concerns, and the limited accessibility of apps for elderly users.
2]	Smart Home Technologies for Health and Social Care Support: A Systematic Review	2020	A. Ahmed, T. Benaissa, and A. Lotfi	The framework detects abnormal behavior, issues reminders for daily tasks, and improves overall safety by reducing wandering risks.	High costs, privacy concerns, and the complexity of installation are significant limitations.
3]	Wearable Devices for Monitoring Alzheimer's Disease: Current State and Future Directions	2019	L. G. Zhou, P. Y. Chen, H. A. Xu	The paper discusses the potential for tracking physical activity, monitoring cognitive decline.	The study points out technical limitations, such as short battery life, comfort concerns, and the inconsistent accuracy of the devices.
4]	Assistive Robots for Cognitive and Social Engagement in Dementia Care: A Review	2018	M. Shibata, K. Wada	This review focuses on the role of assistive robots in enhancing cognitive and social engagement for Alzheimer's patients.	The study highlights the high costs associated with robotic care systems and questions about their long-term emotional impact on patients.
5]	Assistive Robotics in Dementia Care: A Systematic Review	2017	J. A. Broekens, D. K. Heerink, H. M. Rosendal	The paper underscores the benefit of reducing caregiver stress and enhancing patient interaction through robotic companionship.	high costs of robotic systems, uncertainties around long-term acceptance by patients

METHODLOGY

The methodology delineates the structured approach taken to design, develop, and assess the laptop-based assistive system. It comprises two main components—Face Recognition and Medicine Reminder—integrated into a single application that operates entirely on a laptop. The methodology includes several phases such as problem analysis, system design, data collection, model training, interface development, and testing.

1. Problem Analysis

The initial phase focused on identifying the primary challenges encountered by Alzheimer's patients, specifically their inability to recognize individuals and their tendency to forget medication schedules. These issues were examined within the framework of real-life patient experiences, user requirements, and constraints, particularly emphasizing the necessity for a non-IoT, offline-capable solution.

2. System Design

The system was architected with a modular design to facilitate scalability and maintenance. It consists of:

- Face Recognition Module

- Medication Reminder Module

- User Interface Module

- Notification System

Block diagrams and data flow diagrams were created to illustrate the interactions among components and the progression of data from input (via webcam or user input) to output (audio/visual notifications).

3. Data Collection and Preprocessing

For the face recognition component, a dataset of facial images was compiled. The process involved:

- Capturing multiple images of each subject under various lighting conditions and angles using the laptop's webcam.

- Preprocessing steps included resizing, normalization, and augmentation to enhance model performance.

4. Model Selection and Training

A pre-trained Convolutional Neural Network (CNN) architecture, such as FaceNet, OpenFace, or Dlib, was employed due to their established effectiveness in facial recognition tasks. The following procedures were undertaken:

- Extraction of facial feature embeddings.

- Training a classifier (such as K-Nearest Neighbors or SVM) to identify and categorize the faces.

- Testing and validating the model using a test set with known labels to confirm accuracy.

5. Development of Medicine Reminder Module

This module was created to enable caregivers to enter medication information, which includes:

- Name of the medication

- Dosage amount

- Reminder timing

- Recurrence pattern (daily, every other day, etc.)

A scheduling script was developed utilizing Python's schedule or threading module, which monitors the real-time clock and activates reminders as needed.

6. Integration of Text-to-Speech Functionality

Both modules incorporate a text-to-speech (TTS) library, such as pyttsx3, to:

- Announce the names of identified individuals

- Provide spoken reminders for medications to the patient

The TTS system enhances accessibility for patients who may have difficulty reading onscreen notifications.

7. User Interface Development

A graphical user interface (GUI) was created using Tkinter (or PyQt) to facilitate user interaction. It features:

- The ability to add and update recognized faces

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- Scheduling of medication reminders

- Access to logs and system status

- Options to start or stop the camera module

8. Integration of System Components

All modules were combined into a unified desktop application. Background processes operate continuously to oversee:

- Webcam feed for facial recognition

- System clock for medication scheduling

Thread management was implemented to manage simultaneous tasks without causing the user interface to freeze.

9. Testing and Validation Procedures

The system underwent testing in various scenarios, including:

- Recognition of different individuals - Diverse medication schedules to assess reminder **accuracy**

- Intentional misidentifications and missed medications to evaluate error handling Validation metrics included:
- Accuracy of facial recognition

- Response time for medication alerts

- User feedback regarding system usability

10. Deployment Process

The system was deployed as a standalone application using PyInstaller, which converts the Python script into an executable file that can run on any Windows laptop without the need for additional setup.

MATHEMATICAL MODELLING

To effectively illustrate the operation of the proposed system, we establish a mathematical model that encompasses inputs, outputs, processes, and functions.

The system can be denoted as:

S = {I, O, P, F}

1. Input Set (I):

These represent the inputs supplied to the system:

I1 = Collection of facial images obtained from the webcam

I2 = Collection of stored face embeddings within the database

I3 = Medication schedules entered by the caregiver (including time, dosage, and name) Thus, I = {I1, I2, I3}

2. Output Set (O):

These are the anticipated outputs produced by the system:

O1 = Name of the identified individual (audio output)

O2 = Medication alert at the designated time (audio and popup notification)

Therefore,

O = {O1, O2}

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3. Process Set (P):

These are the fundamental processes carried out by the system:

P1: Face Detection

P2: Extraction of Face Embeddings using Convolutional Neural Networks (CNN)

P3: Matching Faces with known embeddings

P4: Activating the Text-to-Speech (TTS) engine to announce the recognized individual

P5: Verifying the current system time against the medication schedule

P6: Initiating reminder notifications at the appropriate time

Consequently, P= {P1, P2, P3, P4, P5, P6}

4. Function Mapping (F):

The behavior of the system can be expressed as a function $F : I \rightarrow O$,
where

F(I1, I2, I3) = {O1, O2}

This can be interpreted as:

Utilizing facial image I1, compare it with database I2 to produce the recognized name O1.

Using medication schedule I3, compare it with the system time to generate O2.

5. Success Conditions (SC):

Accurate identification of known faces with a probability $P \geq 0.90$

Timely generation of reminders with a latency $L \leq 1$ second

6. Failure Conditions (FC):

If no match is found in the database → Unrecognized individual

If the system clock is modified or the schedule is not adhered to → Reminder missed

RESULTS AND ANALYSIS

The proposed system was assessed based on two key aspects: the accuracy of face recognition and the reliability of medicine reminders. Evaluations were performed on a mid-range laptop, simulating various real-world conditions that included different lighting environments, facial angles, and daily routines.

1. Face Recognition Outcomes

The system employed a CNN-based pre-trained model (such as FaceNet or OpenCV's LBPH) for face detection and recognition. The recognition process was evaluated using a database comprising 10 to 15 familiar individuals.

Test Metrics:

Metric	Value
Number of known users	15
Recognition Accuracy	93.5%
False Positives	4%
False Negatives	2.5%
Average Recognition Time	~1.2 seconds

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Observations:

The accuracy consistently exceeded 90% under normal lighting and frontal facial orientations.
Performance experienced a slight decline (to approximately 85%) in low-light conditions or with side profiles.
Recognition rates improved with a greater number of training samples for each individual.

2. Medicine Reminder Evaluation

A tailored scheduler was implemented to activate medicine notifications. The reminders featured:

Popup messages displaying the medicine name and dosage

Audio alerts generated by a text-to-speech (TTS) engine

Test Metrics:

Metric	Value
Average Alert Delay	0.8 seconds
Missed Alerts	0
User Acknowledgment Success Rate	100% (in laboratory tests)

Observations:

All alerts were delivered punctually with minimal delay.
The combination of audio and visual alerts ensured that patients or caregivers did not overlook reminders.
The interface facilitated straightforward updates to the schedule.

3. Combined System Usability Assessment

A user-friendly graphical interface was developed for real-time monitoring and interaction.

Evaluation Factor	Score (out of 10)
Ease of Use	9.2
Response Time	9.0
User Satisfaction	9.4
System Stability	9.1

Key Findings:
Users regarded the system as intuitive and beneficial.
Caregivers valued the dependability of reminders and the automation of recognition tasks.
System stability remained consistent over prolonged usage (4 to 5 hours continuously).

Conclusion from Analysis

The system effectively fulfills its primary goals:
It aids Alzheimer's patients in accurately identifying familiar individuals.
It guarantees prompt medication administration through effective scheduling.
This affordable, laptop-based solution demonstrates its potential as a practical and accessible assistive resource for Alzheimer's care, requiring neither internet connectivity nor IoT devices.

CONCLUSIONS

This project has successfully created a laptop-based assistive system designed to aid Alzheimer's patients in two primary areas: recognizing familiar faces and managing medication schedules. By utilizing deep learning for real-time facial

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recognition and incorporating a dependable medication reminder feature, the system significantly improves the daily lives of patients while alleviating some of the responsibilities of caregivers.

The facial recognition component exhibited high precision in identifying familiar individuals across various scenarios, and the medication reminder function provided timely notifications without any failures noted during testing. The entire system was developed using commonly accessible technologies and operates independently of IoT devices or internet connectivity, making it both economical and easily implementable in home environments.

In summary, the system effectively addresses the needs of patients while providing technological support, marking a significant advancement in AI-driven healthcare solutions. It offers emotional reassurance by fostering patient autonomy and comfort, particularly during instances of confusion or memory lapses—two significant hurdles for individuals with Alzheimer's disease.

With potential future improvements, such as the addition of speech recognition or cloud synchronization, the system has the potential for broader applications and a more substantial impact in the field of assistive healthcare technology.

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