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Study of Secure IoT Assistant-Based System for Alzheimer's Disease

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ABSTRACT : This research aims to design a prototype that offers psychological support services and guarantees safe transmission of information so that a family member can look into it in order to protect the individual with AD. Based on a Convolutional Neural Network (CNN), the developed wearable prototype can classify the observed photos into two categories: family members and non-family members. Additionally, our prototype makes it possible to track the AD person's location. The ability for the person with AD and his or her member to communicate via audio messages is another aspect of the produced prototype. Furthermore, our prototype incorporates Todo List to help those with AD by responding to their daily activities. Additionally, our prototype allows caretaker of the patient about their excretion by sensing the wetness.Our prototype is beneficial to those with mild to moderate AD. After deciphering the additional information concealed in the pictures, it helps them remember their relatives and identify other people. Our findings demonstrate that, in comparison to existing benchmark approaches, our prototype achieves great accuracy and precision in identifying the photos of a person with AD.

KEYWORDS: Machine learning, CNN, Classification, Security, Facial Recognition, Location tracking.

I.INTRODUCTION

The fact that AD affects a vast population makes its identification one of the most significant public health concerns. Alzheimer's disease (AD) is a degenerative illness that gradually impairs memory and cognitive function. As of right now, AD has no known remedy. The detection of AD has been studied with deep learning systems. Notably, CNNs' performance for It is important to note that there are some options based on AD support. Most of them encourage Internet of Things applications, but they neglected to look into deep learning and integrate security measures. Thus, to assist Alzheimer's sufferers and enhance their quality of life, our prototype creates a solution based on facial recognition and security capabilities.

II. RELATED WORK

The works that are connected to our paper are briefly described in this part. Two research categories are mentioned in the literature. The first group concentrated on identifying AD, whereas the second one concentrated on helping those who had AD.

This study presents a proposal for an early disease detection application. There are two steps in our application: Segmentation extracted the three areas using the Region of Intert ROI: Hippocampal Cortex and Corpus Callosum. Following that, there are SVM (Support Vector Machine)-based classification steps such as Frontal section (also called coronal): This incision shows the brain's front side. It is obtained on the plane that is opposite to the sagittal and axial incisions. We employed the variation descriptors in this section. of the hippocampal region. This cup, which is axial (or transverse), shows the brain from above. It is correlated with a plane that is opposite the static magnetic field. We are interested in the variation descriptor of cortex in our work. The interhemispheric plan is parallel to the plane where the sagittal cup is located. These are brain views taken from the side. Following the segmentation stage, we recovered the Corpus Callosum variation descriptors.Here used the Support Vector Machine (SVM) to classify each component, and the decision tree was employed to make the ultimate choice[1].

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Disease biomarkers based on pathophysiology may be able to offer objective measurements for disease diagnosis and staging in Alzheimer's disease (AD), a neurodegenerative condition that progresses over time. The assessments of glucose metabolism in a living brain can be done in vivo using FDG-PET metabolism images and neuroimaging scans generated from MRIs. An enhanced early diagnosis of AD is thought to be possible with the combination of several distinct imaging modalities that each provide complementing information. In this study, we use a multimodal and multiscale deep neural network to present a unique deep learning-based framework for the discrimination of AD patients[2] Within the suggested framework, there are two main steps: one is preprocessing images: divide gray matter segmentation into patches of varying sizes from both MRI and FDG-PET images, and extract features from each patch; and next is classification: train a deep neural network to identify patterns that distinguish AD individuals, and use the learned patterns for individual classification[2].

Present two multimodal fusion-based deep learning models that simultaneously process audio and ASR-transcribed speech to determine the degree to which a speaker in a structured diagnostic test has Alzheimer's disease. With words, word probabilities, disfluency features, pause information, and a range of acoustic data, our best model—a BiLSTM with highway layers—achieves an accuracy of 84%. Although forecasting cognitive decline is more difficult, our models outperform word-only models when utilizing the multimodal method including word probabilities, disfluency, and pause information. Furthermore, we demonstrate that multimodal fusion and gating provide significant benefits for AD classification and are capable of handling noisy inputs from acoustic features and ASR hypotheses[3].

Convolutional Neural Networks (CNN), which are regarded as deep learning techniques, perform better than the machine learning techniques currently in use, according to research findings [4]. The convolutional layer, pooling layer, and fully connected layer are the three primary layers of a conventional CNN. Using a machine learning application with the aid of digital image processing, this paper proposes an end-to-end CNN-based framework with detailed steps starting from image acquisition landing at AD-classification to classify scanned MRI images to predict whether or not they have Alzheimer's disease, and to what degree. Adaptive thresholding, unlike conventional methods, dynamically adjusts the threshold for each pixel in digital image processing. Most advanced techniques rely on global thresholds for all pixels, but adaptive thresholding is more versatile, accommodating variations in lighting conditions across the image. Data augmentation enhances training dataset size by generating modified image versions. Crucial for improving model performance with limited samples. Boosts framework accuracy and reduces overfitting risk.

Alzheimer's disease (AD) is an incurable, chronic brain disorder, but available medications can delay its progression. Early detection is crucial for controlling and preventing AD, leading to the design of an end-to-end framework using convolutional neural networks (CNN) for medical image classification in various AD stages. The framework employs simple CNN architectures and transfer learning with a pre-trained VGG19 model on 2D and 3D brain scans from the ADNI dataset. In response to the COVID-19 pandemic, a web application for remote AD checking is proposed, aiding doctors and patients in determining AD stages and providing relevant advice. Evaluation metrics demonstrate the effectiveness of the CNN architectures, achieving promising accuracies of 93.61% and 95.17% for 2D and 3D multi-class AD stage classifications, while the VGG19 model achieves 97% accuracy. This approach addresses computational complexity, memory requirements, and overfitting, making it a viable solution for remote AD assessment[5].

Utilizing deep learning (DL) techniques, we integrate multiple data modalities—specifically, magnetic resonance imaging (MRI) for imaging, single nucleotide polymorphisms (SNPs) for genetic information, and clinical test data—to comprehensively analyze Alzheimer's disease (AD) staging. Stacked denoising auto-encoders extract features from clinical and genetic data, while 3D-convolutional neural networks (CNNs) process imaging data. A unique data interpretation method, involving clustering and perturbation analysis, identifies top-performing features learned by the deep models. Using the Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset, our results demonstrate that deep models outperform shallow models, such as support vector machines and decision trees. Furthermore, the integration of multi-modality data surpasses single modality models in terms of accuracy, precision, recall, and mean F1 scores. The identified distinguished features include hippocampus and amygdala brain areas, along with the Rey Auditory Verbal Learning Test (RAVLT), aligning with existing AD literature[6].

This paper introduces a convolutional neural network (CNN) for the diagnosis of Alzheimer's disease (AD) by integrating multi-modality information from T1-MR and FDG-PET images of the hippocampal area. Unlike traditional machine learning methods, this approach eliminates the need for manually extracted features, utilizing 3D image-processing CNNs to learn diagnostic features for AD. The classifier was trained on paired T1-MR and FDG-PET images from the ADNI dataset, comprising 731 cognitively unimpaired subjects (CN), 647 AD subjects, 441 subjects

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with stable mild cognitive impairment (sMCI), and 326 subjects with progressive mild cognitive impairment (pMCI). The proposed network achieved impressive accuracies of 90.10% for CN vs. AD, 87.46% for CN vs. pMCI, and 76.90% for sMCI vs. pMCI tasks, demonstrating a state-of-the-art performance. Notably, the results emphasize that segmentation is not a prerequisite when employing CNNs for classification, and the combination of two modality imaging data enhances overall results[7].

This study aimed to create an innovative classification system using eigenbrain and machine learning to develop a computer-aided diagnosis (CAD) system for early detection of Alzheimer's disease (AD) subjects and AD-related brain regions. The objective was not to replace clinicians but to offer an assisting tool. The contributions of the paper encompass five key aspects: (i) Generalizing the Eigenbrain to MR images and confirming its effectiveness; (ii) Proposing a hybrid eigenbrain-based CAD system capable of detecting both AD from normal control (NC) subjects and brain regions related to AD; (iii) Demonstrating the method's classification accuracy comparable to state-of-the-art approaches, with detected brain regions aligning with existing literature; (iv) Employing inter-class variance (ICV) and Welch's t-test (WTT) to reduce redundant data; (v) Highlighting the superiority of the POL kernel over linear and RBF kernels for this study[8].

This paper introduces in order to enhance the quality of life for those with Alzheimer's disease and lessen the stress on their carers, the current project intends to develop and deploy a medical system. A Smart Biomedical Aid is a gadget that uses electronics to offer the Alzheimer's patient with round-the-clock stability status monitoring, a map displaying their position, automated medication reminders, and a call button in case of an emergency that the patient may experience during the day. The device is made up of two parts: the patient wears the first, and the caregiver uses the second as an internet of things (IoT) platform application. A motion was used to implement the wearable unit, heart rate sensor, processing unit sensor, global location sensor module (GPS), and LCD display with microcontrollers. An (IoT) platform supports this unit, enabling the caregiver to communicate with the patient from any location. The suggested system design makes use of two components: a platform application that is placed on the caregiver's smartphone and a wearable device worn by the patient. The control unit, display unit, power unit, and sensor unit were the four components that made up the wearable unit. The sensing unit is made up of accelerometer and gyroscope sensors, which are intended to provide information about whether the wearable device is stable and how the patient is doing in order to detect falls, which are common in Alzheimer's patients. By detecting the angular velocity and acceleration about the three axes, the sensors are able to continually identify the location and tilting angles. [9].

In this work, we describe the creation, deployment, and first testing of a voice assistant driven by artificial intelligence that will offer tailored instruction and advice for caretakers about nutrition, food, and cooking for a family member suffering from ADRD. The ADRD caregiver has constant access to helpful advice regarding food, nutrition, and eating habits thanks to this voice assistant. It also suggests meals and food. The advice and suggestions are tailored to each patient's unique circumstances, taking into account their preferences, medical issues, and ADRD stage. Furthermore, the caregiver's time constraints, financial situation, and educational background all play a role in the assistant's recommendations. A voice assistant offers a natural way to interact with technology that requires no training because voice is the most widely used form of communication. This is particularly helpful for older adult caregivers, who make up more than one-third of caregivers, as they could have trouble using other types of technology that call for fine motor skills, strong vision, or hand-eye coordination[10].

The inability of Alzheimer's patients to find their way around is one of their main issues , particularly when they are alone and away from home. The Adriano-based positioning and healthcare system discussed in this paper was created to assist Alzheimer's patients and their caretakers in tracking and monitoring remote vital signs monitoring. The system's output and the case study that was produced demonstrate the system's ability to take over this duty and assist Alzheimer sufferers in a variety of ways.. The developed system can monitor the patient's vital signs, including heart rate and temperature, as well as track their location. Furthermore, the system can save these data to a micro SD card and provide caregivers with the information every five minutes. A temperature and heart rate sensor is utilized to get the patient's vital signs, and the data is sent to the microcontroller for processing[11].

The goal of this work is to enable people with mild (early-stage) and moderate (middle-stage) Alzheimer's disease in continuing to live independently and participate in society. We suggest a smartphone app that makes use of Google Maps for position detection and facial recognition technology. Through the integration of a notification feature, the program seeks to increase everyday communication while also improving users' capacity to do daily chores. Its location detection feature helps keep Alzheimer's sufferers safe by tracking their whereabouts and preventing them from becoming lost. According to the results, the application has helped people with Alzheimer's symptoms and greatly

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improved their quality of life on a regular basis. Therefore, while creating healthcare applications that might have a big influence on the community, our work emphasizes how important it is to use artificial intelligence (AI)-based features, such facial recognition in this particular situation. By creating an application with capabilities like machine learning-based facial recognition, the suggested application has the potential to help all mild-to-moderate Alzheimer's patients and their caretakers. This aids in Alzheimer patients' memory of others in their immediate surroundings and gives them access to a wearable GPS tracking gadget that helps caregivers locate the patient[12].

Reference	Year	Name	Accuracy
1	2016	Diagnosis of Alzheimer diseases in early step using SVM (support vector machine)	90.66%
2	2018	Multimodal and multiscale deep neural networks for the early diagnosis of Alzheimer's disease using structural MR and FDG-PET images	86.4%
3	2021	Alzheimer's dementia recognition using acoustic, lexical, disfluency and speech pause features. robust to noisy inputs	84%
4	2021	A CNN based framework for classification of Alzheimer's disease	97.5%
5	2021	Deep learning approach for early detection of Alzheimer's disease	90.66%
6	2021	Multimodal deep learning models for early detection of Alzheimer's disease stage	NA
7	2019	Diagnosis of Alzheimer's disease via multi-modality 3D convolutional neural network	NA
8	2015	Detection of Alzheimer's disease by three-dimensional displacement field estimation in structural magnetic resonance imaging	92.57%
9	2020	A smart biomedical assisted system for Alzheimer patients	NA
10	2020	A personalized voice-based diet assistant for caregivers of Alzheimer disease and related dementias: System development and validation	NA
11	2020	Design and development of Arduino healthcare tracker system for Alzheimer patients	NA
12	2020	Alzheimer assistant: A mobile application using machine learning	NA

III.IMPLEMENTATION ANALYSIS

A. Support Vector Machine

A Support Vector Machine (SVM) is a supervised machine learning algorithm used for classification and regression tasks. It is particularly effective in high-dimensional spaces and is widely used in various applications, including image classification, text classification, and bioinformatics. The primary objective of an SVM is to find a hyperplane that best separates the data into different classes. In a binary classification scenario, this hyperplane should maximize the margin between the two classes. The margin is the distance between the hyperplane and the nearest data point of each class. SVM aims to find the hyperplane with the maximum margin, as it is believed to improve the generalization performance of the model. Support vectors are the data points that lie closest to the decision boundary (hyperplane) and play a crucial role in defining the optimal hyperplane. These are the only data points that affect the position of the hyperplane.

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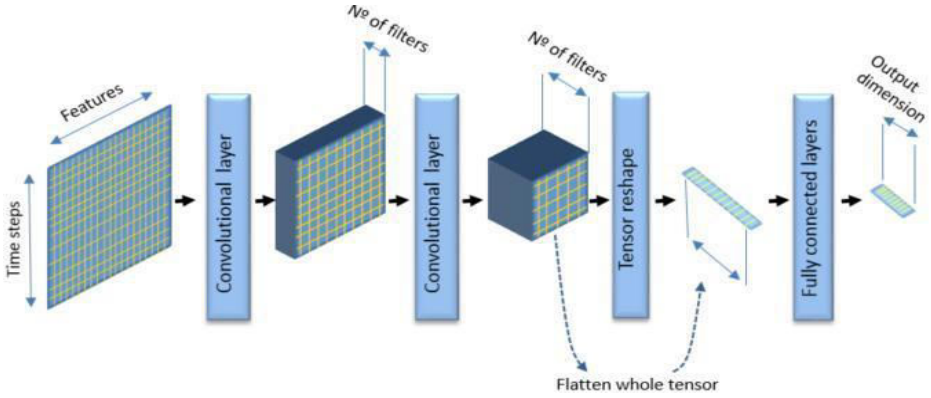
B. Convolutional Neural Network(CNN)

A Convolutional Neural Network (CNN) is a type of deep neural network specifically designed for tasks involving structured grid-like data, such as images and video. CNNs have proven to be highly effective in computer vision tasks like image classification, object detection, and image segmentation. Here are key concepts and components of CNNs; CNNs use convolutional layers to learn local patterns and features in the input data. Convolution involves sliding a small filter (also called a kernel) over the input data, performing element-wise multiplication, and then summing the results. This operation helps the network capture spatial hierarchies of features. Pooling layers are used to reduce the spatial dimensions of the input data. Common pooling operations include max pooling and average pooling. Pooling helps decrease the computational load and the number of parameters in the network, making it more manageable. Non-linear activation functions, such as Rectified Linear Unit (ReLU), are applied to the output of convolutional and fully connected layers. ReLU is commonly used due to its simplicity and effectiveness in introducing non-linearity to the network.



C. Arduino

Arduino is an open-source electronics platform that consists of both hardware and software components. The Arduino board is the physical hardware that forms the core of the Arduino platform. It typically includes a microcontroller, input/output pins, USB connectivity, and a power supply. There are various types of Arduino boards, such as Arduino Uno, Arduino Mega, Arduino Nano, and more, each with its own set of features and capabilities. At the heart of an Arduino board is a microcontroller. The microcontroller processes instructions and interacts with the input/output pins to control electronic components. The most commonly used microcontroller on Arduino boards is the Atmel AVR series, although other variants, like ARM-based boards, also exist. The Arduino IDE is the software tool used to write, compile, and upload code to the Arduino board. It provides a simple and user-friendly interface for programming. The code is typically written in a variation of the C and C++ programming languages.

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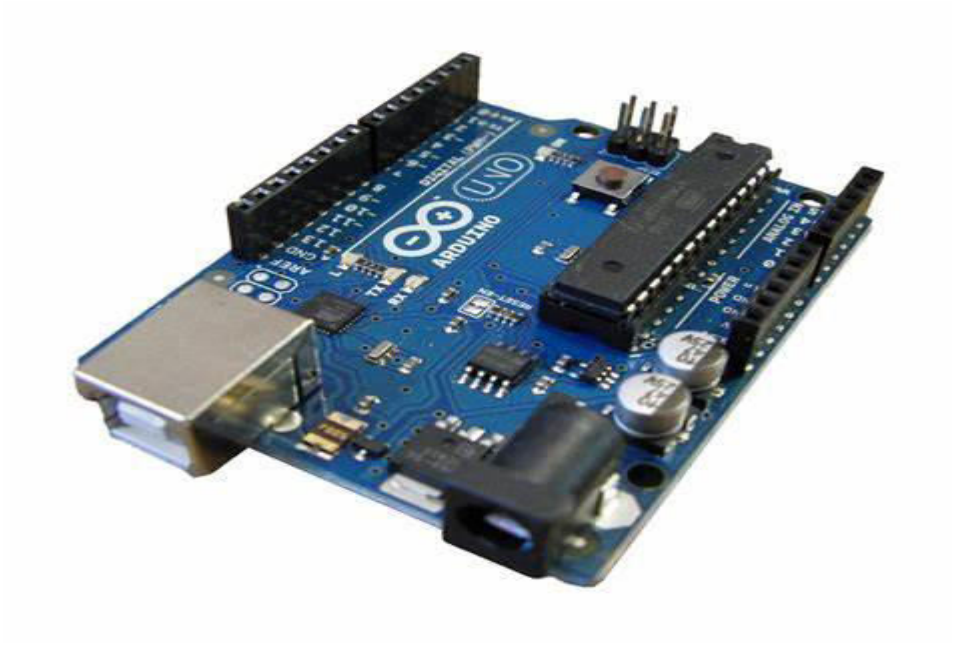

D. Web Cam

Web cameras, often known as webcams, are tiny cameras that are typically mounted on computer monitors or built into laptops and other devices.The primary objective is to capture and transmit movies in real-time, allowing users to record and share videos for use in video chats, conferences, and other applications.An image sensor, a lens, and a microphone comprise the bulk of webcams.The lens's collected optical data is converted into an electrical signal by the image sensor. Furthermore, some webcams come equipped with built-in microphones for audio recording.Webcams can be linked to PCs or other devices via USB, USB-C, or other interface types.Desktop computers and laptops without built-in cameras can still connect to external webcams, even though many modern laptops have built-in cameras.

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IV.CONCLUSION AND FUTURE WORK

This survey aims to collect data regarding IOT-based secure assistance that helps people with Alzheimer's disease manage their daily lives more comfortably. And following this survey, some new technology from various papers, like facial recognition and security features, remain a challenge for the systems that are currently in place to help improve the lives of people with AD; voice assistance is used to identify family members; a suggested prototype enables people with AD to carry out daily activities; a wearable device is linked to an Internet of Things application that allows family members to track the movements of patients and also enables caregivers to monitor the patient's excretion by sensing wetness.

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