Electronic Systems for Environmental Public Health Monitoring and Exposure Assessment

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ABSTRACT

According to statistics, Alzheimer's is the fourth leading cause of mortality in the US and its annual death toll is steadily rising. Additionally, it has been seen to be developing moderately in Asian nations; by 2050, half of all Alzheimer sufferers would come from these countries. While there are currently no known medications that can entirely cure Alzheimer's, early detection of the disease can help doctors treat patients appropriately, extending their lives and improving their quality of life. A computerised detection system may be employed to help physicians identify Alzheimer's and to detect the disease early. Many CAD systems were created in the past, mostly for the benefit of public health, however the majority of them had poorer accuracy rates. Therefore, it is necessary to design an effective CAD system that can accurately anticipate the presence of AD. In this paper, a CAD system for accurately detecting if a patient has Alzheimer's disease or not was established. Medical professionals may now reliably and swiftly identify a wide range of diseases and ailments with the aid of computer algorithms, artificial intelligence, and medical imaging thanks to the rapidly expanding field of computer-aided diagnosis (CAD).

1. Introduction

Alzheimer's disease (AD) is a brain ailment that is an advanced stage of dementia that gradually worsens memory loss, impairs thinking abilities, and lessens one's capacity to carry out basic duties [1]. In 1906, Dr. Alois Alzheimer gave the illness its name [3]. As a lecturer, he saw a woman who passed away from various mental illnesses. She was exhibiting many symptoms, such as altered behaviour, severe memory loss, and linguistic difficulties [7]. Numerous odd clumps and fibre bundles were found in her brain tissues when they were examined under a microscope after she passed away. The lack of communication between brain neurons, which is in charge of sending information to the body's organs, is another effect of AD. AD first damages the hippocampal region of the brain, which houses memories. Later on, it spreads to other areas of the brain and causes shrinkage [14]. When AD reached its most severe stage, the brain would have greatly shrunk. It has been noted that not every case of memory loss results in AD [2].

Figure 1. Alzheimer Brain (left) and Normal Brain (right)

The majority of AD symptoms vary from patient to patient and are not universal. Although mild cognitive impairment (MCI) is a precursor to Alzheimer's disease (AD), not all MCI patients will go on to have AD. Because AD patients may find it difficult to complete their own responsibilities, the majority of them become anxious, and a small percentage of them become more violent. Compared to a healthy person, the brain of an Alzheimer's patient is noticeably smaller. As the condition worsens,

the brain really shrinks to around one-third of its original size [11]. Figure 1 depicts the shrinkage of the brain in both the normal and Alzheimer's disease-affected brains. The development of an effective Computer Aided Detection system (CAD) that could support radiologists and neurologists in the clinical assessment of Alzheimer disease (AD) is the primary goal of the project [5]. A user-friendly, atomized CAD system is required to analyse MR images from the system through many stages in order to identify Alzheimer's disease in individuals. The created CAD system should be able to anticipate the AD stage, which will assist doctors in selecting the best course of therapy for their patients and offer numerous recommendations on activities, diet, and exercise at that specific time. In this instance, section 1 of the paper examines the introduction, and section 2 discusses the review of the AD detection technique. Section 4 presents a discussion of the suggested diagnostic model, while Section 5 wraps up the project. Section 3 describes how to use the CAD diagnostics system.

Performance Indication of Ad In Public Health Services

The rate of AD-related deaths rose to a high of 55% between 1999 and 2014, and treatment costs also appeared to be rising annually and needed to be decreased. As a result, the rising incidence of AD needs to be addressed because most developing countries, including China and India, are predicted to have seen a rise in patients in recent years and this trend is predicted to continue in the years to come [4]. AD cannot be cured, but it can be managed with a healthy lifestyle. Early identification of AD at an early stage allows for the provision of appropriate treatment, extending the patient's life expectancy and improving their quality of life [3]. When an elderly person exhibits signs of AD, they should be transported right away to see their family doctor, who will review their medical history and work with them to determine the severity of their symptoms. To confirm the results or raise any questions, oral exams could also be performed and recommended to a physician with expertise in neurological disorders. The neurosurgeon might perform an oral evaluation once more and recommend magnetic resonance imaging (MRI). Following the completion of the MRI procedure, the radiologist examines the images to determine the stage of AD and confirms the diagnosis based on the examination of the brain size and anomalies discovered in the scans. [12]. Oral investigation and magnetic resonance imaging are carried out entirely through human interpretation. There's a risk of incorrect prediction because many of the symptoms of AD are closely associated with other memory loss disorders and age-related problems. If an AD is misdiagnosed, it has a significant effect on the patient and his family because there is no known cure. Therefore, a computerised assisted system could be employed to help the radiologist identify AD by MRI and determine its stage [6]. Early in the 1990s, there was a notion to create computer-aided systems (CAD). A few systems were created, but their performance was limited by the absence of sophisticated algorithms. Following 2000, a large number of sophisticated CAD systems were developed and began to produce positive outcomes. In order to decrease False Positives (FPs), the detection accuracy could be further improved. Additionally, the system needs to be able to determine the stage of AD, which would assist radiologists and neurologists in making decisions about course of therapy.

Application of Cad System

The identification of Alzheimer disease in patients is the main objective of the CAD system's development. First, the patients undergo memory impairment testing. If the physician notices any odd behavioural changes, the patient is referred for an MRI scan. A radiologist reviews the images, determines the patient's brain size, and verifies if the patient has AD or not. An efficient CAD system could assist radiologists and doctors in detecting AD in patients because most of the work is done by doctors in person during the entire procedure. This is because any manual error could lead to incorrect

results for the entire diagnostic. Figure 2 displays the architecture of the created CAD system.

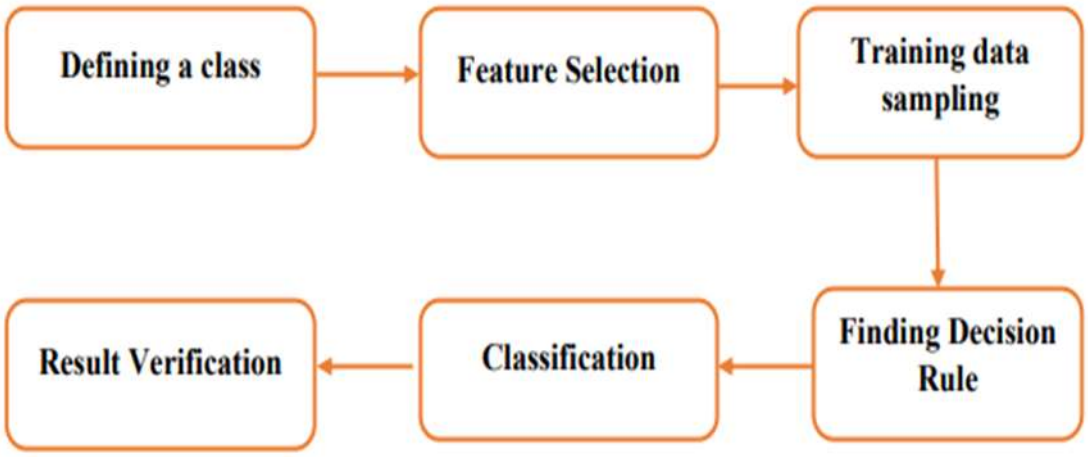

Figure 2. Architecture of CAD system

Phases of the CAD system include segmentation, feature extraction, capture, augmentation, and classification of images. Additionally, the patients' brain sizes are computed so that they can be compared to normal brain sizes. Based on these data, AD is identified in the patients [13]. This paper provides a brief overview of the research technique used in each phase and the performance metrics applied at each level. Several methods are applied and compared with each other in the image enhancement, segmentation, and classification stages. Every algorithm is evaluated for performance, and the top method is chosen to move on to the next round. While detecting AD is the primary goal of the CAD system, it also needs to minimise false positives and false negatives because incorrect detection could have a negative psychological impact on patients, which would lower their quality of life.

Proposed Cad For Public Health

Early Alzheimer's disease detection improves the quality of life for those who have the condition, making it crucial to identify Alzheimer's early on. This may be accomplished by creating a CAD system that would help the radiologist; however, the system would need to have the ability to analyse brain images obtained from MRIs in order to determine whether or not the patient is impacted. The CAD system needs to measure the brain's area and compare it to a normal brain size because AD causes the brain to shrink. This procedure aids in cross-checking the CAD system's output. Five phases are involved in the construction of a CAD system: preprocessing, picture segmentation, feature extraction, classification, and data collecting. Data acquisition, the initial stage of the development process, involves identifying the accessible datasets. The metadata-enabled photos are chosen and downloaded from the dataset [8]. The photographs have been carefully selected to represent various stages of AD, as well as genders and age categories (below and over 65). The image must then be preprocessed. Images may contain noises that are created during the image capture or transfer process. In order to improve the efficiency of the subsequent steps, these noises must be eliminated and the pixel intensity values must be raised. Several processing techniques may be used in this procedure, and the optimal preprocessing technique for the CAD system could then be determined by comparing each technique's performance separately. Choosing the appropriate segmentation algorithm is the third phase in the construction of a CAD system. The Region of Interest and the image must be able to be separated using the segmentation method [15]. Only when the ROI is extracted effectively can the features be extracted. Thus, a few segmentation techniques might be used, and then an effective algorithm might be chosen

to compare how well they performed [9]. Extraction of the ROI's features comes next after the ROI has been chosen. These features have been carefully selected to enable the system to function well during the classification phase. Classification is the last step, and it is carried out in two steps: first, the system is trained using a known set of data, and then it is tested. To ascertain the effectiveness of the system, cross-verification can be carried out in addition to data collection in a 30:70 ratio. The created CAD system needs to be able to determine the patient's AD and its stage. Additionally, it measures the part of the brain that aids in identifying brain shrinkage [10].

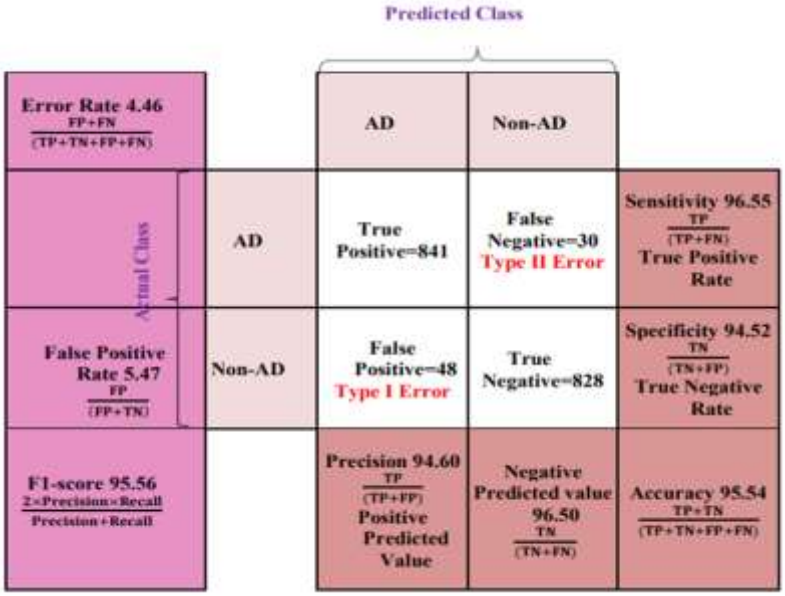

Figure 3. Calculations of Performance Metrics of the Proposed Deep Transfer Learning Model

The estimated values of accuracy, precision, recall, specificity, error rate, false positive rate, negative predicted value, and F1-score are based on the TP, TN, FP, and FN values given in the confusion matrix. According to the confusion matrix, 30 photos were mistakenly classified as AD class when, in fact, they belong to the CN class (FP value of 30, or type I error). On the other hand, the FN value of 48 indicates a type II error, meaning that although the photos were mistakenly classified as CN class, they actually belong to the AD class. Subsequently, the proposed deep transfer learning model estimates each metric's total performance, which is displayed in Figure 3.

2. Conclusion and future scope

The AD stage must be able to be determined by the CAD system, which also has to offer the appropriate treatment plans. Additionally, it could provide advice to carers regarding the tasks that both the AD patient and they must complete. While there are currently no established treatments for AD, early identification can help patients live longer and provide comfort to their doctors and families. The entire procedure needs to be automated, and it can be combined with the current image capture system to obtain, process, and forecast photos. In order to process the MRI image, the designed CAD system needs to operate faster because computation time must also be taken into account in a minimum time.

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