EARLY DETECTION OF ALZHEIMER'S DISEASE USING ENSEMBLE APPROACH

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ABSTRACT:

The project presents a method for detection of Alzheimer’s disease (AD) using Voxel Based Morphometry (VBM) detected features from Magnetic Resonance Imaging (MRI) scans. AD detection with VBM features has been carried out using genetic algorithm for Extreme Machine Learning (ELM), Radial Basis Function (RBF), Support Vector Machine (SVM), Multilayer Perceptron (MLP) network classifier. The learning algorithm is inspired by the fact that a combination of classifying algorithms help in achieving better output and therefore we are using ensemble model. For simulation studies, well known Open Access Series of Imaging Studies (OASIS) data set has been used. The performance of different classifiers is being evaluated on complete features obtained from the VBM analysis and also on reduced features sets from genetic algorithm. The proposed learning algorithm in turn is expected to give high accuracy.

Keywords: Voxel based morphometry, Alzheimer’s disease, Magnetic Resonance Imaging (MRI), Genetic Algorithm, Ensemble learning

[1] INTRODUCTION

Alzheimer’s disease is a long-lasting neurodegenerative disease which starts slowly and enhances over time. The most common early indication is difficulty in remembering recent events (short-term memory loss). As the disease advances, symptoms can include problems with language, disorientation (including easily getting lost), mood swings, loss of
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Motivation, not managing self care, and behavioural issues. As a person’s condition declines, they often withdraw from menage and society. Gradually, bodily functions are lost, ultimately leading to death. Although the speed of progression can vary, the average life expectancy following diagnosis is three to nine years.

The cause of Alzheimer’s disease is poorly understood. About 70 percent of the hazard is believed to be genetic with many genes usually involved. The disease process is associated with plaques and tangles in the brain. A routine diagnosis is based on the history of the illness and cognitive testing with medical imaging and blood tests to rule out other possible causes. Initial symptoms are often mistaken for normal ageing. Examination of brain tissue is needed for a specific diagnosis. There are no medications that can decrease the risk.

In 2015, there were around 29.8 million people worldwide with AD. It most often begins in people over 65 years of age, although 4% to 5% of cases are early-onset Alzheimer’s which begin before this. It affects about 6% of people 65 years and older. In 2015, AD resulted in about 1.9 million deaths. In developed countries, AD is one of the most financially costly diseases. About 40 percent of people with AD also have depression. Unfortunately, identifying depression can be difficult, and the cognitive impairment makes it difficult for the person to articulate his or her feelings. So to overcome all these problems, we are proposing a model which by analyzing MRI scans, will be able to predict whether a particular patient is likely to develop AD in the next 10-15 years. So accordingly pre-emptive measures can be taken.

[2] Literature Review

The main objectives of the proposed project presents a detection of Alzheimer’s disease (AD) using Voxel Based Morphometry (VBM) detected features from Magnetic Resonance Imaging (MRI) scans. AD detection with VBM features has been carried out using projection based sequential learning algorithm for radial basis function network classifier [1]. The learning algorithm is inspired by human meta-cognitive learning principles for self-regulation of what-to-learn, when-to-learn and how-to-learn. It is referred as a Meta-cognitive Radial Basis Function Network (McRBFN). The cognitive component of McRBFN evolves automatically and the learning process is controlled by the meta cognitive component. For simulation studies, well-known Open Access Series of Imaging Studies (OASIS) data set has been used. The performance of the PBL-McRBFN classifier is evaluated on complete features obtained from the VBM analysis and also on reduced features sets from ICA.

The proposed research work is focused on a novel method for detecting the onset of Alzheimer’s disease (AD) from Magnetic Resonance Imaging (MRI) scans are presented [2]. It uses a combination of three different machine learning algorithms in order to get improved results and is based on a three-class classification problem. The three classes for classification considered in this study are normal, very mild AD and mild and moderate AD subjects. The machine learning algorithms used are: the Extreme Learning Machine (ELM) for classification, with its performance optimized by a Particle Swarm Optimization (PSO) and a Genetic algorithm (GA) used for feature selection. A Voxel-Based Morphometry (VBM) approach is used for feature extraction from the MRI images and GA is used to reduce the high dimensional features needed for classification.
This paper presents an approach for Alzheimer's disease (AD) detection from magnetic resonance images using Meta-cognitive Radial Basis Function Network (McRBFN) classifier [3]. We propose a Recursive Feature Elimination (RFE) approach with efficient classification method Projection based Learning-McRBFN (referred as PBL-McRBFN-RFE) to identify the most meaningful imaging biomarkers with a predictive power for AD detection in male persons. The study has been conducted using the well-known open access series of imaging studies data set. The performance results of the PBL-McRBFN-RFE classifier clearly indicates the better performance for AD detection. The proposed imaging biomarkers identification mechanism indicates that in male persons insula region may be responsible for the onset of AD.

This paper presents a detection of Alzheimer’s disease (AD) using Voxel-Based Morphometry (VBM) detected features from Magnetic Resonance Imaging (MRI) scans [4]. The learning algorithm is inspired by human meta-cognitive learning principles for self-regulation of what to-learn, when-to-learn and how-to-learn. It is referred as a Meta-cognitive Radial Basis Function Network (McRBFN). The cognitive component of McRBFN evolves automatically and the learning process is controlled by the meta-cognitive component. The performance of the PBL-McRBFN classifier is evaluated on complete features obtained from the VBM analysis and also on reduced features sets from ICA. The results indicate that the proposed learning algorithm is suitable for accurate detection of AD.

This paper presents various imaging modalities, feature selection and extraction, segmentation and classification techniques [5].

This study aimed to assess the improvement in classification accuracy that can be achieved by combining features from different structural MRI analysis techniques [6]. Alzheimer’s Disease Neuroimaging Initiative (ADNI) database has been used. We compared the classification accuracy achieved with linear discriminant analysis (LDA) and support vector machines (SVM). The best results achieved with individual features are 90% sensitivity and 84% specificity while the combination of all features improved these results to 93% sensitivity and 85% specificity. The most stable and reliable classification were achieved when all available features were combined.

This paper presents that among brain imaging techniques, magnetic resonance imaging (MRI) is considered to be a surrogate to AD as it can measure structural changes in the brain [7]. MRI produces high resolution spatial images with minute abnormality detection property. It provides better visualization of internal structures of the brain as compared to CT scans. Moreover MRI involves no radiations, which could have possible side effects. Extensive studies have been performed for identification of AD using MRI.

The Open Access Series of Imaging Studies is a series of magnetic resonance imaging data sets that is publicly available for study and analysis [8]. Automated calculation of whole-brain volume and estimated total intracranial volume are presented to demonstrate use of the data for measuring differences associated with normal aging and Alzheimer's disease.

[3] METHODOLOGY
The framework of our proposed method is shown in Fig. 1. Firstly, from all MRI scans the morphometric VBM features are extracted using the SPM12 software. Next, high dimensional VBM features are reduced using the genetic algorithm. Finally, the reduced features are used for classification using Ensemble model. The following sections present a brief description of the MRI data, VBM approach for feature extraction, Genetic algorithm for feature reduction, and also description of the Ensemble model used for classification.

Figure: 1. Functional block diagram

[3.1] MRI Dataset
It is very important to identify the structural changes in the brain on magnetic resonance imaging (MRI) scans for the study of psychiatric and neurological diseases. MRI can be used to detect and exclude treatable causes of cognitive impairment and it has become very important in the differential diagnosis of disease, in tracking disease advancement, and for research purposes. Pathological changes in the brain which results in the cell loss manifest as loss of brain tissue, which can be detected by structural MRI.

The data used in our study is obtained from the publicly available Open Access Series of Imaging Studies (OASIS). The OASIS dataset contains 198 elder persons (aged between
59-96) and all of it has been used in our study. Of the 198 people, 100 have been diagnosed with AD and 98 had no AD.

[3.2] Feature extraction using Voxel Based Morphometry (VBM)

A large number of automated techniques have been developed which allow us to do the assessment of atrophy across large groups of subjects eliminating need for time-consuming manual measurements or subjective visual assessments. Voxel based morphometry (VBM) is one such technique that has grown in popularity since its introduction. And very much because it's relatively easy to use and has provided biologically plausible results. It uses statistics to identify differences in brain anatomy between groups of subjects, which can be used to infer the presence of atrophy or less commonly, tissue expansion in subjects with disease.

This technique uses MRI scans and essentially performs statistical tests across all voxels in the image to identify volume differences between the groups. For example, to identify differences in patterns of regional anatomy between groups of subjects, a series of tests can be performed at every voxel in the image. There are three steps which are involved in feature extraction using VBM namely, unified segmentation, smoothing and statistical testing.

From the voxel locations of significant areas obtained from VBM, grey matter tissue probability values are extracted as features.

![Figure: 2. Steps in VBM](image)

[3.3] Feature reduction using Genetic Algorithm

Genetic algorithm is basically a method for decoding optimization problems. It is based on the Darwin's theory of natural evolution specified in the origin of species. GA is based on the concept of survival of the fittest. Just as in the nature the fit species remain intact, while the unfit species are eliminated. Similarly, out of a many solutions available, only the more fit solutions are survived, while the less fit solutions are discarded. GA represents the solutions in the form of chromosomes (features) and the fitness of the chromosomes is evaluated. The more fit solutions are selected for the replication using the crossover operator. The mutation operator is used to maintain the diversity the population. The more fit chromosomes replace less fit chromosomes and the process continues till the optimal solution is found on the basis of some pre-specified criteria. GA is based on population of multiple points as compared to t conventional approaches which are based on
single point. The major advantage of GA is that it can be used in such type of situations where the numerical or mathematical models fail. As it is an advanced algorithm, one can effortlessly view the progress within each iteration.

**[3.4] Ensemble model for classification**

This is the block where final classification takes place. Currently various classification algorithms are available like SVM, MLP etc. And each algorithm has its own pros and cons. Also, the performance of any algorithm might be subjective to type of data that we’re working on. A algorithm may perform better on one particular dataset while some other algorithm may outperform the first algorithm on a different dataset. So we are proposing an ensemble model for this classification model, where different classification algorithms will be run in parallel fashion on same data and results are generated by every algorithm. After this, by using voting method the final result or class will be decided. This model will enable us to combine advantages of all the algorithms which in turn will help us to attain much better accuracy than the use of each algorithm individually.

Different classification algorithms such as Radial Basis Function (RBF), Multilayer Perceptron (MLP), Extreme Learning Machine (ELM), Support Vector Machine (SVM) are used in this ensemble model.

**[4] ANALYSIS AND DISCUSSION**

A few methods have been proposed for the detection of Alzheimer's disease using machine learning but none of them works efficiently when provided with different kinds of data. So the model presented in this paper proposes to overcome the shortcomings in the previously suggested models by using an algorithm that takes advantage of ensemble model and attains better accuracy for classification. As the machines are taking over humans in terms of analysis and predictions we are dependent on it for all the important calculations and results. So this model i.e Detection of Alzheimer's using machine learning is definitely one of the tools to look forward to as this technology can be used in the medical field where maximum risk is involved. Humans are prone to make errors where as machines give the most optimized and feasible solutions with minimum error.

**[5] CONCLUSION**

There is a lot of research into risk factors associated with Alzheimer’s disease, so there may be lifestyle measures we can take to potentially reduce our risk and enjoy a healthier life more generally. By identifying and controlling your personal risk factors, you can maximize your chances of lifelong brain health and take effective steps to preserve your cognitive abilities. The problem of early detection of AD using MRI can be formulated as binary classification and can be solved using machine learning techniques. Studies have shown that the tissue loss in the hippocampus and the entorhinal cortex could be indicators for early AD. Major shortcomings in the use of the ROI methods are dependent on tracer expertise and are erroneous. To overcome these shortcomings, whole-brain morphometric methods have been employed for accurate AD detection. Voxel based morphometry (VBM) is a completely
automatic image analysis approach for identifying the amount of gray matter or white matter differences between the normal persons and AD patients. And ensemble model takes advantage of different algorithms and gives better results. Hence we conclude that using ensemble model, we are able to design system that helps in prediction of Alzheimer’s well in advance and with much better accuracy.

REFERENCES