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Automated Detection of Alzheimer's Disease using MRI Imaging: A Survey from an Image Classification Perspective

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Abstract- Alzheimer's disease is a hopeless, dynamic neurological brain issue. Prior detection of Alzheimer's problem can help with legitimate treatment and anticipate cerebrum tissue harm. A few factual and machine learning models have been abused by analysts for Alzheimer's disease identification. Examining magnetic resonance imaging is a general perform for Alzheimer's disease identification in medical research. This paper reviewed the state-of-the-art of image classification techniques to diagnose human brain Alzheimer disease. The review covered feature extraction and classification of Alzheimer disease image classification techniques, image modalities used the dataset and trade off for each technique. Toward the end, the surveys demonstrated the change of image classification methods, for example, to expand exactness and affectability value and to be practical utilized for computer aided diagnosis are a major challenge and an open research. It compares the reported performance of many recently published Alzheimer identification algorithms.

Keywords-Alzheimer Disease, Feature Extraction, Magnetic Resonance Imaging, Image Classification.

1. INTRODUCTION

Alzheimer disease is a kind of dementia that is extremely tough to prevent as well as has no enduring cure. This disease destroys the memory and mental functions of brain of a human being. This disease is a type of disorder that causes destruction of brain cells, which prompts loss of memory and changes in considering and ocher cerebrum capacities. Alzheimer's disease should be detected very early so that preventive measure can be taken. Image classification plays a significant role in computer-aided-diagnosis as well as it is a huge challenge on image investigation tasks. This challenge related to the usage of methods and techniques in exploiting image processing result and classification methods and subsequently validating the image classification result into medical expert knowledge.

The basic objective of medical images classification isn't just to attain high precision yet in addition to differentiate that elements of human body are tainted by the malady. MRI information is delivered by imaging modalities [1].

The problem of this field is how to extract the image as well as classify the extraction result into the related pattern then recognize with understand that parts of human brain is affected by the Alzheimer disease from image classification result. Additionally medical image classification has three main steps such as preprocessing, feature extraction and classification [1].

After preprocessing step then it requires to extract features of interest part from the image for further investigation. The reason of the image classification method is to map the input variables (image data) become the output variables (to characterize one definite class which is disease or else no disease class) [2]

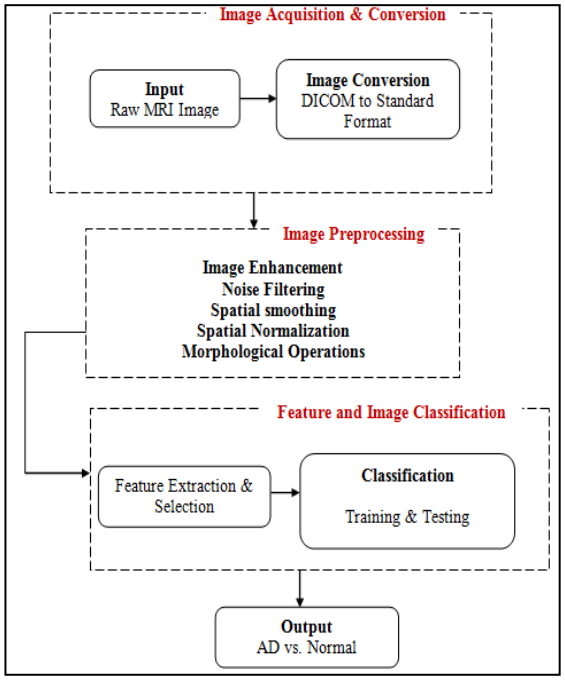

Figure 1: Phases of Image Classification Process

2. ALZHEIMER DISEASE AND MAGNETIC REASONANCE (MR) IMAGE ANALYSIS

An image is considered as an illustration of an object with specific properties which are employed in

image processing. The resource of medical images data is generated from Biomedical Devices, which use the imaging techniques like Computed Tomography (CT), Magnetic Resonance (MR) Imaging and mammogram [3]. A powerful magnetic field is used in Magnetic Resonance Imaging method (MR) for the nuclear magnetization alignment of hydrogen atoms in water molecules. MR became the standard of cross-sectional imaging modalities that useful to visualize soft tissues (such as muscle, brain), fat and bone.

Alzheimer's infection is described by loss of neurons as well as neurotransmitters in the cerebral cortex and certain subcortical locales. This misfortune results in gross decay of the influenced areas, incorporating degeneration in the worldly projection and parietal flap, and parts of the frontal cortex and cingulate gyrus. Degeneration is likewise present in brainstem cores like the locus coeruleus. It has the following signs [4],

- Difficulty in reading and writing causing impaired speaking.
- More abusive, anxious, or paranoid.
- Loss of empathy and changes in behavior.
- Worsening ability to take in new information.
- Poor understanding and decision-making ability.

Stages of Alzheimer disease:

Basically, it has following three stages as follows [4]:

- Mild Stage (Early Stage)
- Moderate Stage (Middle Stage)
- Severe Stage (Final Stage)

3. LITERATURE REVIEW

Cárdenas-Peña et al. [5] have built up a profound learning model utilizing focal piece arrangement and contrasted the administered pre-preparing approach with two unsupervised introduction strategies, auto encoders and key part investigation (PCA). Their investigation demonstrates that SAE with PCA beats three concealed layers SAE and accomplishes an expansion of 16.2% in general arrangement precision.

Liu et al. [6] have built up a multimodal stacked auto encoder organize utilizing zero-covering procedure. Their objective was to anticipate loss of any data of the picture information. They have utilized SVM to order the neuro imaging highlights acquired from MR/PET information.

Suk et al. [7] built up an auto encoder arrange based model for AD determination and utilized a few complex SVM portions for order. They have extricated low-to mid-level highlights from attractive current imaging (MCI), MCI-converter basic MRI, and PET information and performed order utilizing multi portion SVM.

Morra et al. [8] looked at a few model's exhibitions for AD location including progressive AdaBoost, SVM with manual element and SVM with computerized highlight. For building up these classifiers, normally predefined highlights are extricated from the MRI information. In any case, preparing a classifier autonomous from the component extraction process may result in problematic execution because of the conceivable heterogeneous nature of the classifier and highlights.

Beheshti et al. [9] consolidated voxel-based morphometry and Fisher Criterion for highlight determination and decrease over the whole cerebrum, trailed by SVM for grouping. The entire mind procedures have demonstrated high discriminative power for individual judgments. Kloppel et al. Utilized direct SVM to distinguish AD patients utilizing T1 weighted MRI checks. Dimensional decrease and varieties techniques were utilized by Aversen.

Aguilar et al. [10] investigated the classification execution of symmetrical projections to inactive structures, choice trees, artificial neural networks (ANN), and SVM dependent on 10 features chose from 23 volumetric plus 34 cortical thickness factors.

Olfa Ben Ahmed et al. [11] used an administered learning approach. It utilizing visual similitude between MRI enabled us to give the clinicians semantic closeness, and in this manner could possibly bolster their symptomatic choice. PCC and Hippocampus highlights combination enhance precision on MCI case recovery. Over a scope of tests, valuable level of acknowledgment rates were accomplished with a little signature sizes for both CHF and SIFT descriptors.

Kloppel et al. [12] developed a supervised method using linear SVM to group the gray matter segment of T1-weighted MR images on a high dimensional space, treating voxels as coordinates and intensity value at each voxel as their location.

4. FEATURE EXTRACTION AND SELECTION

Features are an important measurement for image understanding, especially the feature representation of the segmented region that used for object classification and analysis [13]. The common techniques of Feature extraction are:

Table1. Categories of Feature Extraction

S.No	Features	Description
1	**Statistical Pixel Level**	It provides quantitative information about the pixels such as mean, variance, and a histogram of the gray values of pixels in the region.
2	**Shape**	It provides information about shape characteristic of the region boundary; include circularity, compactness, moments, chain-codes, and Hough transform.
3	**Texture**	It provides information about the local texture within the region of the image, which is calculated using the second-order statistical histogram or co-occurrence matrices.
4	**Relational**	It provides information about the relational and hierarchical structure of the regions related to a single object or a group of objects.

4.1 FEATURE SELECTION FOR CLASSIFICATION PROCESS

Feature selection utilized to determine the significant features that most suitable for the classification task. Selection of correlated features for dimensionality diminution in the classification task can develop the computational effectiveness as well as classification performance. The final set of features can be determined through data correlation, clustering, and analysis algorithms to discover similarity patterns in the training data. It has the following methods,

4.1.1. LINEAR DISCRIMINANT ANALYSIS (LDA)

The reason of LDA technique is to detection a linear combination of features that able to provide the best probable separation between various classes of data in the feature space. This can decrease dimensionality space for classification and also give better classification exactness.

4.1.2. PRINCIPAL COMPONENT ANALYSIS (PCA)

This is a proficient technique of dimensionality reduction of a data set with a big number of interrelated variables. However, for data with sparse distribution and noise, PCA technique may not give optimal selection of features [14].

4.1.3. GENETIC ALGORITHMS BASED OPTIMIZATION

This is a robust method for search optimization which uses natural selection principles. It utilizes prior data and using selection for survival, and is able to adapt to the specific parameter issues. The parameters are encoded as binary strings that are associated with the fitness measurement [14].

5. IMAGE CLASSIFICATION PROCESS

The selected features of image region that are generated from feature selection are used in object classification. In the MR imaging analysis, features and measurements can also be used for interpret the result using knowledge-based model and classification methods [14]. Feature and image classification techniques namely:

5.1 STATISTICAL CLASSIFICATION METHODS

The categories of these methods are an unsupervised and supervised approach. The unsupervised methods cluster the data based on their separation in the feature space, include K-means and fuzzy clustering. On the other hand, a supervised approach needs training data, test data, and class label to classify the data, include probabilistic methods like the nearest neighbor and Bayesian classifier.

5.2 RULE-BASED SYSTEMS

The system analyzes the feature vector using multiple sets of rules that are designed to test specific conditions in the feature vector database to set off an action. The rules consist of two parts: condition premises and actions, which are generated based on an expert knowledge to deduce the action when the conditions are satisfied. The action which part of the rule could change the database state or label of a feature vector based on a specific state of analysis. Usually, a rule-based system consists of three sets of rules: supervisory or strategy rules, a focus of attention rules, and knowledge rules.

The supervisory or strategy rules control the analysis process and provide the control actions include starting and stopping action. The strategy rules determine which rules would be tested during the analysis process. The focus-of-attention rules provide specific features within analysis process by accessing and extracting the information or features from the database. Subsequently, the rules convey the information from the input (database) into the activity center where the implementations of knowledge rules are scheduled. Finally, the knowledge rules analyze the information related to the required conditions then execute an action that changes the output database.

5.3 NEURAL NETWORK CLASSIFIERS

Artificial neural network paradigms for feature classification, object recognition and image interpretation namely back-propagation, radial basis function, associative memories, and self-organizing feature maps. At that time fuzzy system-based approaches have been applied in artificial neural networks for better classification and generalization result.

5.4 RELEVANCE VECTOR MACHINE (RVM) FOR CLASSIFICATION

The Relevance Vector Machine (RVM) combines regression, classification, and a Bayesian probabilistic principle. The other models for pattern classification utilizing theoretical approaches include kernel-based classifier and linear programming perturbation-based methods [14].

6. CONCLUSION

MR image classification is an interesting research area, it combines the diagnosis problem and analysis purposes in the medical field. This paper has provided the detailed review of image feature extraction, selection and classification techniques for diagnosis of human brain Alzheimer's disease. The improvement of image classification techniques will increase accuracy rate as well as subsequently feasible to be employed for computer-aided-diagnosis.

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