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A SURVEY ON FEATURE SELECTION FOR DEMENTIA DISEASES USING SVM

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Abstract: - In this paper we discuss about the feature selection method used for dementia images. This feature selection is performed before surgery in particular with analysing MRI. Dementia is a category of brain disease. It causes decrease in the ability to think and remember. The advantages and disadvantages of these technologies also considered.

Keywords: Computer Aided Diagnosis, Dementia, Feature Selection, Support Vector Machine.

I. INTRODUCTION AND METHODS

Image processing is the method to convert images for which the input is an image and the output also may be an image. The acquisition of images is referred to as imaging.

Image processing consists of two methods Analog and Digital image processing. The pictorial representation of data is stored in analog form is known as analog image. Storing the data in digital form is known as digital image processing [1].

Image processing consists of three steps:
- Import the image by digital photography.
- Analyse and manipulate the image.
- The result will be also an image

Medical imaging is the process of creating visual representations of the interior of a body for clinical analysis. Medical imaging establishes a database of physiology to identify abnormalities.

Dementia is also known as senility which is a type of brain disease. The disease causes decrease in ability to think and remember. The symptoms are emotional problems, language problem and decrease in motivation. The most common type of dementia is Alzheimer's disease. The dementia which be prevented by decreasing risk factors. During an early period they never diagnosed the disease but there needs a diagnostic methods. The accurate diagnostic
Methods are used for understanding the disease and to develop the treatments.

Computer-aided diagnosis is procedures in medical imaging. Imaging techniques in X-ray, MRI and ultrasound diagnostics yield a great deal of information, which is used to analyse and evaluate in a short time [4]. CAD is used to scan digital images. CAD is a technology which is used to combine elements of artificial intelligence and digital image processing. CAD can be used for diagnosis of dementia using the SVM.

MRI is a magnetic resonance imaging. It is a test which uses magnetic field and radio waves to make an image of body. It provides the information about the structure of the body. MRI is widely used in hospitals for diagnosis of diseases.

MRI data collected from the Alzheimer's disease neuroimaging Initiative classifying Alzheimer's disease (AD) patients, mild cognitive impairment (MCI) patients who converted to AD, MCI patients who did not convert to AD, and cognitively normal controls (CN).

Feature selection is the process of selecting a subset of relevant features which can be done by using SVM. Some features can be removed without much loss of information. Feature selection is a research area in data mining because it improves comprehensibility. The two feature selection methods are direct approach and iterative approach. The direct approach is a filter method and iterative approach is a wrapper method. Filter method which is used to remove the least relevant features from the data set. For all iteration the wrapper method is used to select the subset of features for the next iteration. The evaluation of feature selection includes two measures such as SVM weight vector and the SVM P-maps.[6][7]

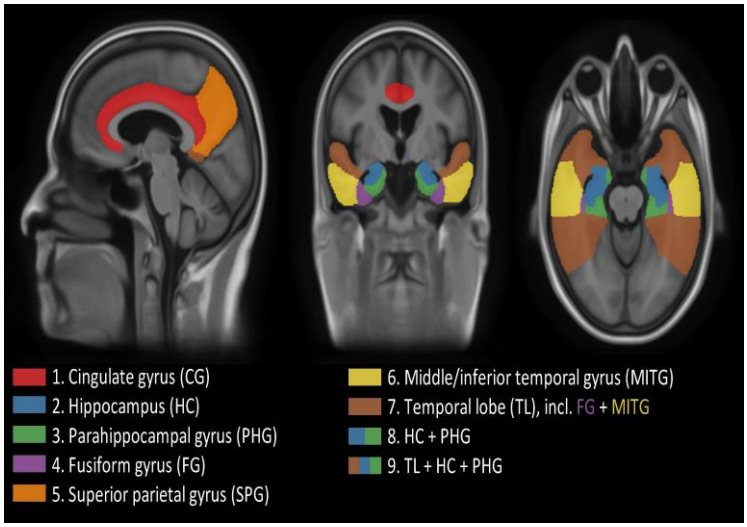

Fig.1 Feature selection based on previous knowledge, adapted from [9].

Recursive feature elimination is a wrapper feature selection method. The wrapper method is an iterative method. The classifier is trained several times for all iteration. Recursive feature elimination method is a common wrapper method. RFE is used to rank the relevant features and the lowest rank features are eliminated.

Support vector machine is used to analyse data and it is used for classification. A support vector machine constructs a hyper plane which can be used for classification. Consider a training set each belongs to one of two categories. First category in which the SVM builds a model that assigns some examples and the other is non-probabilistic binary linear classifier.

II. RELATED WORK

1. Cancer Classification using Support Vector Machines and Relevance Vector Machine based on Analysis of Variance Features by A.Bharathi and A.M.Natarajan[2]

The objective is to find the smallest set of genes which ensure accurate classification. There are three folds to find the minimum subset:

- The burden and noise arises are reduced
- The cost is reduced
- There is more investigation between the small numbers of genes and cancer development.

The proposed system consists of some important genes and the classification for those important genes. Cancer classification consists of all genes in the training data set and the classification capability of the two gene combinations.
The proposed system uses Support Vector Machine (SVM) and Relevance Vector Machine (RVM). By using effective method such as SVM and RVM leads to accurate classification. The relevance vector machine used to increase the accuracy of classification. The proposed method performs the cancer classification which gives the better accuracy.
The drawback of the paper, it does not suitable for large data base. There may be some loss of data in gene expression. The algorithms developed for recovering data are costlier. Informative gene selection is an important problem arising in the analysis of microarray data.

2. MRI-Based Automated Computer Classification of Probable AD versus Normal Controls by Simon Duchesn[3].

Neurodegenerative diseases can be classified as neuronal dysfunction, abnormal loss, and cognitive impairment. Automated computer classification (ACC) is used for diagnosis of complex diseases. When the method is presented with real life the accuracy of ACC is assessed. The ACC performance is assessed in leave-one-out experiments. The accuracy of the paper is 92% when based on the least square twin.
The final diagnosis of the disease can't be derived using structural imaging. The structural imaging has shifted from one of possible causes of dementia to one of *the* disease that can identified at a very early stage.
The technique used in the paper is automated computer classification (ACC).The goal of ACC is to achieve the individual classification. ACC technique can be objective, quantitative and practical. The efficiency and accuracy of the paper is relatively high. The goal of the paper is evaluation of robustness of ACC method.
The drawback of the paper, it is difficult to implement in a clinic without a dedicated research group. Some techniques cannot be used in regular clinical practice. An unequal scan found in a day-to-day clinical operation.

3. Voxel-based dementia classification of AD, MCI and controls for the CAD Dementia data set by Esther E.Bron and Marion Smits. [4]

Computer-aided diagnosis of neurodegenerative disease distinguishes Alzheimer's disease from normal controls. The SVM is used for classification. The features based on voxel-based morphometry. The features are selected and divided. Then the features are normalised to zero. Pair wise classifications were performed as AD/CN, AD/MCI, and MCI/CN.
There are some methods such as CAD Dementia addresses multi-class classification therefore we combine pair wise predictions to make a final prediction. Next the subjects in the CAD Dementia data set are younger than the ADNI. Last, priors were optimized on the training set.
Based on the performance five algorithms were chosen to be evaluated on the CAD Dementia. First, chose the original method. Next four other methods were chosen with the highest accuracies on the training set. The performance of the algorithms will not be included in the ranking of the CAD Dementia challenge.
The drawback is that the SVM classifier which does not suit for large data set. Some data sets and methodology were used for evaluation therefore the algorithm for computer-aided diagnosis of AD and mild cognitive impairment (MCI) are difficult to compare.

4. Spatial and anatomical regularization of SVM for brain image analysis by R´emi Cuingnet. [5]

SVM is increasingly used in analyses of brain image. Brain images are registered which is used for surgery and the tests are performed to detect any differences. The support vector machines (SVM) methods are used to overcome the limits of univariate analyses. It allows capturing of complex multivariate relationships in the data and is applied to the individual classification. The output can be analysed to localize spatial patterns.
A framework is used in proposed system. The framework consists of background information on SVMs and regularization operators. The regularization operator provides a flexible approach to model proximity. The framework is used for classification of MR images.
In SVM the information used for classification is encoded in the kernel. Force the classifier function to some transformations which can be done (i) by directly engineering a kernel to locally invariant SVM, (ii) by generating artificially transformations from the training set, (iii) by using a combination called kernel jittering.
Therefore for analysis of brain image regularization operators used to add spatial consistency to SVM. There is a derivation proposed to 3D image features. The important point is that the proposed system makes the results more consistent.
Two types of formulation: discrete viewpoint and continuous viewpoint. The paper introduces two types of proximity: spatial proximity and anatomical proximity.

The drawback is that the proposed system is not specific to structural MRI. The use of regularization will not improve the accuracy. The optimal margin lacks spatial coherence and makes anatomical interpretation difficult. When the differences are spatially complex, the sensitivity of the approaches is limited.

5. Variable Selection and Feature Extraction through Artificial Intelligence Techniques

In this method, the input variables can be defined as feature selection and feature extraction. By selecting the original inputs the feature selection can reduce dimensionality. The feature extraction performs the transformation to generate the features which are more significant.
Feature selection is a process which transforms high dimensional data into low dimensional data. The several feature selection approaches:

- The Principal Component Analysis (PCA) is the most feature extraction method. It reduces the number of available variables
- The Linear Discriminate Analysis (LDA) which reduces the dimensionality of the discriminatory information. The Latent Semantic Analysis finds co-occurrences in document. The main objective is to produce the mapping called Latent Topic Space.
- The Independent Component Analysis (ICA) is used to find a linear representation of non-Gaussian data. It is used to extract features.

Variable selection reduces the dimension of the dataset. It consists of different fields such as machine learning, pattern recognition, data mining, medical data, etc. It is classified into three categories: filter method, wrapper method and embedded methods.
The advantage is it has low computational complexity. The disadvantage is that the method cannot optimize the model in learning machine.
The popular filter approaches are:

- Chi-square approach
- Correlation approach
- Correlation method
- Information Gain

Wrapper method uses the machine learning to select the subset of variables based on the predictive power. The basic idea is to use the prediction to evaluate the effectiveness of the subset of variables.
The embedded approach, the feature selection part formed into the training procedure. The features are irrelevant when the scaling factor is small. The features are relevant when the scaling factor is large.

6. An Introduction to Variable and Feature Selection [7].

This method presents the objective of variable selection is three-fold: improving the prediction performance of the predictors, providing faster and more effective predictors, and providing a better understanding of the process that generated the data.
Consider two examples for the new application domains: one is gene selection and text categorization. In the gene selection, the variables are gene expression corresponding to the abundance of mRNA in a sample number of patients. The initial filtering brings the number of variables to a few thousand. In the text categorization, the texts are represented by ‘bag of words’ and the pruning of least frequent words reduce the number of words.
Benefits of the paper: facilitating data visualization and data understanding, reducing the requirements, reducing times, the curse of dimensionality to improve performance. The feature construction yields improved performance.
The disadvantage is that the problem of finding a variable useful to build a good predictor and the problem from pragmatic. The problem occurs during ranking in all relevant variables. To build a machine learning application, the paper does not follow the work flow. Complexity is progressively introduced throughout the method.

7. Automatic classification of patients with Alzheimer’s disease from structural MRI: A comparison of ten methods using the ADNI database [8].

In this paper the performance of ten approaches were evaluated. Three classification methods were performed: CN versus AD, MCI who had converted to AD and MCI who had not converted to AD. The results obtained from the DARTEL registration. DARTEL significantly improves the classification and which leads to lower results in only two cases.

The development of machine learning algorithms is capable of dealing with high dimensional data. Several methods are developed for automatic classification of patients. The classification of AD and CN obtain high accuracy. The goal is to compare different methods for classification of patients.
Ten methods were evaluated. Five voxel-based approaches: a direct approach, an approach based on a volume of interest, an atlas-based approach and few other approaches. These approaches were evaluated: a direct one similar, an atlas based one and an approach using the regions found. Two methods based on the volume and the shape of the hippocampus.
Three classifications were performed to compare the different approaches. The first one is the classification between CN and patients with AD. The second is the classification between CN and MCI converters. The third one is the classification between MCI non controls versus MCI controls.
The disadvantage is that the use of feature selection did not improve the performance. Alzheimer's disease is a growing health problem.

8. Multimodal classification of Alzheimer's disease and mild cognitive impairment [9].

In this method, the proposed system combines three modalities of biomarkers. It combines MRI, FDG-PET, and CSF biomarkers. By using a kernel combination method it is used to discriminate between AD and healthy controls.
The linear SVM is used to evaluate the classification. The evaluation is for selecting most discriminative MR and FDG-PET features. The feature selection method is used to select the most discriminative MR and FDG-PET features. The combined methods results in better performance.
Alzheimer's disease (AD) is the most common form of dementia. The early stage of AD is known as mild cognitive impairment. The existing pattern classification methods use individual modality of biomarkers for diagnosis of AD. The most important modality of biomarkers for AD is fluoride oxy-glucose positron emission tomography (FDG-PET). Different biomarkers provide the information which can be useful for diagnosis of AD.
The existing classification methods can be divided into three categories, voxel-wise tissue probability, cortical thickness and hippocampus volumes. The effective features for classification are extracted from the atrophic regions.
The data used in the preparation were obtained from the Alzheimer Disease Neuroimaging Initiative (ADNI).The primary goal is to test whether serial MRI or other biological markers can be combined to measure the progress of MCI.
The main disadvantage is that the use of feature selection does not improve the performance. There is a difficulty in interpreting the model since models are used in the ensemble learning. Some issue may limit its use in medical applications. There may be some problem in conversion from binary-class classification to multi-class classification.

9. Feature selection using factor analysis for Alzheimer's diagnosis using 18F-FDG PET images [10].

A computer-aided diagnosis is used for improving the accuracy of Alzheimer's disease (AD). The proposed system is based on the selection of voxels using t-test and a reduction of the feature dimension.
There are three different classifiers: Two multivariate Gaussian models, with linear and quadratic function, and a support vector machine. The accuracy can be obtained by using SVM. The proposed system achieves the better classification performance.
Alzheimer's disease is the common cause of dementia. It is a severe health problem. The information provided by a careful clinical examination which helps in diagnosis of Alzheimer's disease. An emission computed tomography (ECT) is used as a diagnostic tool. The variables are model as a combination of factor and factor loading. The factor loading will be used as a feature vector which reduces the dimension of the problem.
A disadvantage is that due to complex model the over fitting occurs. Early diagnosis remains being a difficult task. When the number of samples is small problem may occur. The Linear and quadratic discriminate functions will obtain very poor performance.

10. Feature ranking based nested support vector machine ensemble for medical image classification [11].

In this a method for classification of structural magnetic resonance images (MRI) of the brain is introduced.Support Vector Machine (SVM) is used for classification and SVM is applied for classifying patients with neurological diseases such as Alzheimer's disease (AD) and autism spectrum disorder (ASD).
Based on the t-statistics between the voxel intensity values and class labels image voxels are ranked. The voxel subsets are selected based on the rank value. SVM classifier is trained on each subset of voxels. Some methods can be applied for classifying patients.

Early detection of autism spectrum disorder (ASD) and Alzheimer's disease (AD) can improve prognosis. The diagnosis of the disease is based on the clinical evaluation. Early detection of the disease does not always have high accuracy in clinical evaluation.

The supervised classification framework consists: training images with known labels, the relevant features are selected; an SVM classifier is trained on the features. The features are calculated from region of interest (ROI). ROIs can be predefined or learned from the data. The features which capture different patterns of structural degeneration should be trained with a classifier to obtain high performance. The machine learning such as ensemble learning and feature ranking improves the supervised classification framework. Two steps involved in the method:

- Generation of nested feature subsets.
- The training and testing using SVM ensemble classifiers.

In generation of nested feature subsets, the relevant features are selected to avoid over fitting and to improve the ability of the classifier.

The disadvantage is that the feature selection strategy based on ranking individual voxels could not be enhanced by ranking clusters of voxels instead of individual ones.There may be a problem when selection of the optimal feature set for the classification.

III. RESULTS

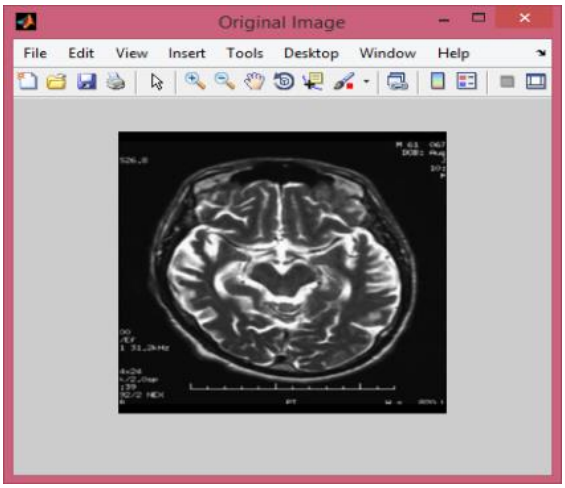

Fig 1.Input Image

An input will be an MRI images. The feature selection is done by using the SVM classification. By selecting the features the accuracy is calculated.

```
                Actual Classes
-------------0--------1-----
Predicted|
  Classes|
_________|____________________
       0 |     7.0 |     3.0
       1 |     0.0 |     11.0
-----------------------------------------
-----------------------------------------
                Actual Classes
------------------------------0--------1-----
True Positive                 |    7.00 |    11.00
False Positive                |    3.00 |    0.00
False Negative                |    0.00 |    3.00
True Negative                 |    11.00 |    7.00
Precision                     |    0.70 |    1.00
Recall or Sensitivity         |    1.00 |    0.79
Specificity                   |    0.79 |    1.00
-----------------------------------------
Model Accuracy is 0.86
```

Fig 2 .Feature selection

IV. CONCLUSION

This survey concludes that the feature selection for the dementia disease images can be done by using the SVM classifier. The SVM includes filter and wrapper selection methods. As comparing both, the wrapper method is more efficient than the filter method. So the wrapper method should be used for the better feature selection for dementia patients before their surgery.

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A Brief Author Biography

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