

Classification of Tissues for Detecting the Multiple Sclerosis Lesions in Brain MRI

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Abstract

Detection of the Multiple Sclerosis (MS) Lesions on magnetic resonance image (MRI) is most important as a disease activity and surgical purpose in medical field. We propose an approach to provide a tissue segmentation while appearing an inflammatory disease. The two stage of classification process uses in this method 1) a Bayesian classifier that performs a brain tissue classification at each voxel of reference and follow-up scans using intensities and intensity differences, and 2) a random forest based lesion-level classifier provides a identification of an inflammatory diseases. The method is evaluated on sequential brain MRI of 160 subjects from a separate multi-center clinical trial. The proposed method is compared to the manual identification and gives better performance, sensitivity with fault detecting rate than manual identification. For new lesions greater than 0.15 cc in size, the classifier has near perfect performance (99% sensitivity, 2% false detection rate), as compared to ground truth. The proposed method was also shown to exceed the performance of any one of the nine expert manual identifications.

Keywords

Bayesian classifier, Lesion level Random forest classifier, an inflammatory disease, Multiple Sclerosis (MS) Lesions, Magnetic Resonance Imaging (MRI).

I. Introduction

In medical image processing the detection of new Multiple Sclerosis (MS) lesions or an inflammatory diseases that is an inflammatory disease on Magnetic Resonance Imaging (MRI) is important as a disease activity and surgical purpose. Brain Magnetic Resonance Imaging (MRI) is widely used in surgical and diagnosis purpose in that the image processing is used to give the result. Brain tissues classified as three ways that is, White Matter(WM), Gray Matter(GM), Cerebrospinal Fluid(CSF). Multiple sclerosis (MS) is a chronic autoimmune disorder affecting movement, sensation, and bodily functions. It is caused by destruction of the myelin insulation covering nerve fibers (neurons) in the central nervous system (brain and spinal cord). MS is a nerve disorder caused by destruction of the insulating layer surrounding neurons in the brain and spinal cord. This insulation, called myelin, helps electrical signals pass quickly and smoothly between the brain and the rest of the body. When the myelin is destroyed, nerve messages are sent more slowly and less efficiently. Patches of scar tissue, called plaques, form over the affected areas, further disrupting nerve communication. The symptoms of MS occur when the brain and spinal cord nerves no longer communicate properly with other parts of the body. MS causes a wide variety of symptoms and can affect vision, balance, strength, sensation, coordination, and bodily functions.

Multiple sclerosis affects more than a quarter of a million people in the United States. Most people have their first symptoms between the ages of 20 and 40; symptoms rarely begin before 15 or after 60. Women are almost twice as likely to get MS as men, especially in their early years. People of northern European heritage are more likely to be affected than people of other racial backgrounds, and MS rates are higher in the United States, Canada.

MS is very rare among Asians, North and South American Indians, and Eskimos. Multiple Sclerosis (MS) is appear in this area but, it is also possible to find some of them in the gray matter. [It is a progressive disease characterized by disseminated demyelination of nerve fibers of the brain and spinal cord. It begins slowly, usually in young adulthood, and continues throughout life with periods of

exacerbation and remission. The first signs are often paresthesias, or abnormal sensations in the extremities or on one side of the face. Other early signs are muscle weakness, vertigo, and visual disturbances, such as nystagmus, diplopia (double vision), and partial blindness.

II. Related Work

Cohn Elliott, Douglas L. Arnold, D. Louis Collius, Tal Arbel gives brief information about Automated segmentation of multiple sclerosis lesions in brain MRI by using 1) Stochastic model. (ii) Markov model to increase the load correlation but, less accuracy [1]. Petronella Anbek, H.c. Bisschops and Jeroen Vander Grand suggested that the probabilistic segmentation of white matter lesions in MR imaging by using K-Nearest Neighbor method to increase the accuracy but, the computational time is increased [2]. Baseem A. Abdullah, Mel-Ling Shyu, Terri A. Scanduna, Nigel John gives brief details about the segmentation of Multiple Sclerosis Lesions in brain MRI is used to provide accurate edges but, the design is complex [3]. Anjum Hayet, Gandal, Ahmad Khan gives brief information about a review of automated techniques for brain tumor detection from MR images for an Identification of brain tissues and detect the diseases. It used to provide high sensitivity [4]. M. Eifadal, J. Zhang, H. Denn suggested that the abnormality detection of brain MR image segmentation by using Iterative Conditional Mode Algorithm but, it gives less accuracy [5]. Muhamad Abdel. Mottaleb, Baseem A. Scandura contributed that a topology-preserving approach to the segmentation of brain images with multiple sclerosis lesions by using T2-Weighted techniques but, it have computational complexity [6]. V.B. Padole, D.S. Chaudhari, K.K. Mektha gives brief description about brain MRI Segmentation by using T1 and T2 weighted spatially constrained Fuzzy C-means clustering to provide Effective performance and robust to noise [7]. Michel J. Berg, Sken Ebholm, Edward A. Ashton suggested that the accuracy and reproducibility of manual and semiautomated quantification of Ms lesions by MRI Geometrically Constrained Region Growth Method. It required large time for computation [8]. Mareel Bose, Fabrico Hertz, Jem-Paul gives brief

idea about automated change detection in multimodal serial MRI: application to MS lesions evolution by using joint histogram equalization method. It used to reduce the fault but, sensitivity is less[9]. Reza Forghanl, Alan C. Evans gives brief information about the automation “Pipeline” Analysis of 3-D MRI Data for clinical Trials: Application to MS is used enhance to detect small treatment effects[10]. A. Criminist, J. Sholton, A. Blake Los Angeles suggested that the discriminative, Semantic Segmentation of brain tissue in MR images by using random decision forest classifier. It gives accurate classification but, CSF is most difficult to label accurate[11]. Guido Gorig, Daniel Wolli, Alan Colchester gives brief information about exploring the discrimination power of the time domain for segmentation and characterization of lesions in MRI data by using spatial analysis .It provide high sensitive to detect fluctuation structures[12]. Stevan L. Hartmann, Mitchell H. Parks, Benoit. M. Dswart gives idea about the automatic 3-D segmentation of internal structures in brain MR Images is difficult to find the regions[13]. Fernand. S. Cohen, Zhengweiyang, Jonathan Nissanov suggested that the automatic Matching of homologous histological Sections for identification and curve matching, robust to non- uniform sampling noise [14].

III. Proposed System

The histogram equalization is an approach to enhance a given image. The approach is to design a transformation $T(.)$ such that the gray values in the output is uniformly distributed in $[0, 1]$. Histogram equalization yields an image whose pixels are (in theory) uniformly distributed among all gray levels. Sometimes, this may not be desirable. Instead, we may want a transformation that yields an output image with a pre-specified histogram. This technique is called histogram specification. The Sobel operator is used in image processing, particularly within edge detection algorithms. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively terms of computations. On the other hand, the gradient approximation which it produces is relatively crude, in particular for high frequency variations in the image. It use many situations in medical image processing for Brain MRI new lesion detection that is surgical purpose, diagnosis, tumor detection. of a histogram provides useful information for contrast enhancement. The histogram equalization is an approach to enhance a given image. In terms of histograms, the output image will have all gray values in “equal proportion”. This technique is called histogram equalization.

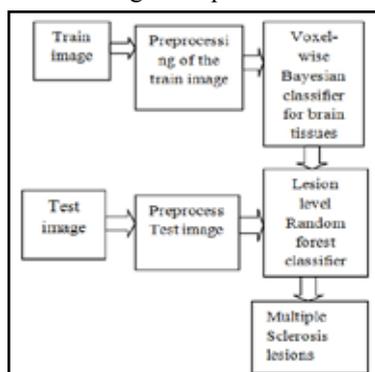


Figure 1: Block diagram

Any one of the training image get from one particular data base. In that image is gray level which have few levels compare to RGB image. It use many situations in medical image processing for Brain MRI new lesion detection that is surgical purpose, diagnosis, tumor detection.

A. Preprocessing of the train image

Histogram equalization: Histogram provides a global description of the appearance of the image. If we consider the gray values in the image as realizations of a random variable R , with some probability density, histogram provides an approximation to this probability density.

B. Voxelwise Bayesian Classifier

The Bayesian Classification represents a supervised learning method as well as a statistical method for classification. Assumes an underlying probabilistic model and it allows us to capture uncertainty about the model in a principled way by determining probabilities of the outcomes.

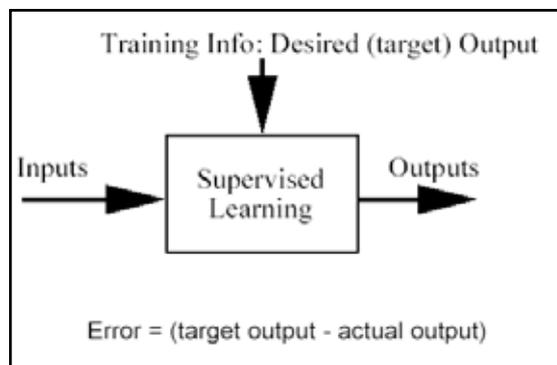


Fig. 2: Schematic diagram of Bayesian classifier

Bayes classifier employs single words and word pairs as features. It allocates user utterances into nice, nasty and neutral classes, labelled +1, -1 and 0 respectively. This numerical output drives a simple first-order dynamical system, whose state represents the simulated emotional state of the experiment’s personification

C. Preprocessing of the test image

1. Median filtering

The median filter is a nonlinear digital filtering technique, often used to remove noise. Median filtering is very widely used in digital image processing because it preserves edges while removing noise. The median filter is a sliding-window spatial filter. It replaces the value of the center pixel with the median of the intensity values in the neighborhood of that pixel. Median filtering is a nonlinear operation often used in image processing to reduce “salt and pepper” noise. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. Median filters are particularly effective in the presence of impulse noise, also called ‘salt – and – pepper’ noise because of its appearance as white and black dots superimposed on an image.

2. Edge detection using SOBEL

The Sobel operator performs a 2-D spatial gradient measurement on an image. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. The Sobel edge detector uses a pair of 3x3 convolution masks, one

estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows). A convolution mask is usually much smaller than the actual image. As a result, the mask is slid over the image, manipulating a square of pixels at a time or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations. On the other hand, the gradient approximation which it produces is relatively crude, in particular for high frequency variations in the image.

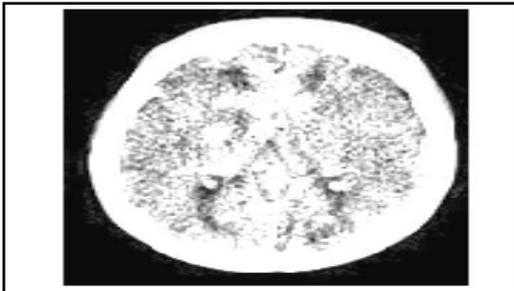


Figure 3 : Edge detection

The Sobel operator represents a rather inaccurate approximation of the image gradient, but is still of sufficient quality to be of practical use in many applications. More precisely, it uses intensity values only in a 3×3 region around each image point to approximate the corresponding image gradient, and it uses only integer values for the coefficients which weight the image intensities to produce the gradient approximation.

D. Train image/test image matching

The test image going to rotate by using geometrical rotated signals for match the position of both train and test image. Test and train image is compare to detect differences b/w that images. The convolution of two functions is an important concept in a number of areas of pure and applied mathematics such as Fourier Analysis, Differential Equations, Approximation Theory, and Image Processing. Nevertheless convolutions often seem unintuitive and difficult to grasp for beginners. This project explores the origins of the convolution concept as well as some computer graphic and physical interpretations of convolution which illustrate various ways the technique of smoothing can be used to solve some real world problems

E. Lesion level random forest classification

This section gives a brief overview of random forests and some comments about the features of the method. We assume that the user knows about the construction of single classification trees. Random Forests grows many classification trees. To classify a new object from an input vector, put the input vector down each of the trees in the forest. Each tree is grown as follows:

If the number of cases in the training set is N , sample N cases at random - but with replacement, from the original data. This sample will be the training set for growing computed for each pair of cases. If two cases occupy the same terminal node, their proximity is increased by one. the tree.

If there are M input variables, a number $m \ll M$ is specified such that at each node, m variables are selected at random out of the M and the best split on these m is used to split the node. The value of m is held constant during the forest growing.

Each tree is grown to the largest extent possible. There is no

pruning.

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E. Principal Component Analysis

Principal Component Analysis (PCA) is the general name for a technique which uses sophisticated underlying mathematical principles to transforms a number of possibly correlated variables into a smaller number of variables called principal components. The origins of PCA lie in multivariate data analysis, however, it has a wide range of other applications, as we will show in due course. PCA has been called, 'one of the most important results from applied linear algebra' and perhaps its most common use is as the first step in trying to analyse large data sets. Some of the other common applications include; de-noising signals, blind source separation, and data compression. In general terms, PCA uses a vector space transform to reduce the dimensionality of largedata sets. Using mathematical projection, the original data set, which may have involved many variables, can often be interpreted in just a few variables (the principal components). It is therefore often the case that an examination of the reduced dimension data set will allow the the user to spot trends, patterns and outliers in the data, far more easily than would have been possible without performing the principal component analysis.

1. Give the query image as the input.
2. Convert the input from BMP to data file.
3. Perform Discrete Cosine Transform on the dataset.
4. Extract 3×3 matrix based on subjective analysis.

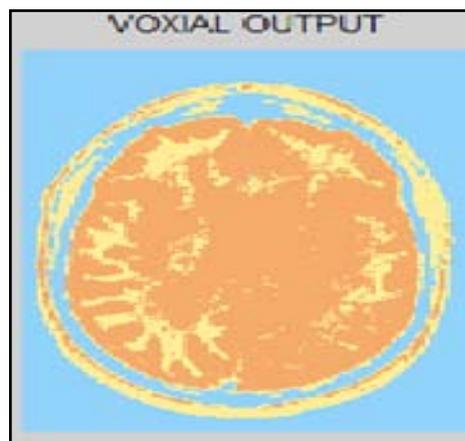
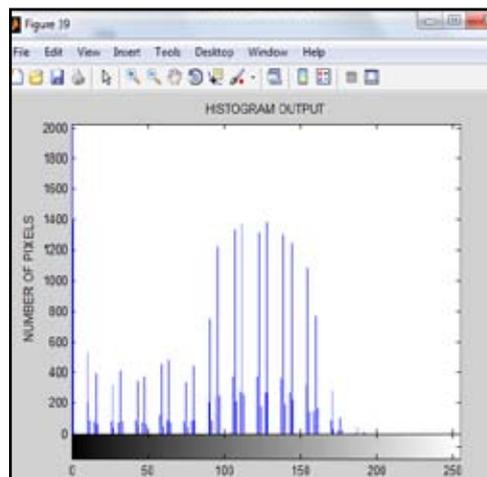
5. Perform covariance on the 3X3 matrix.
6. Generate characteristic equation from the covariance matrix and solve for maximum Eigen value.
7. Perform comparison of Eigen values by Least Mean Square Algorithm (LMS).

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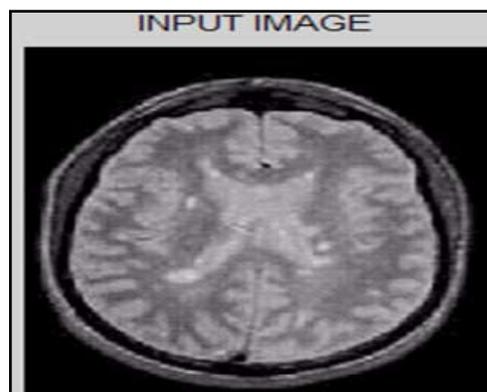
Approximation Theory, and Image Processing. Nevertheless convolutions often seem unintuitive and difficult to grasp for beginners. This project explores the origins of the convolution concept as well as some computer graphic and physical interpretations of convolution which illustrate various ways the technique of smoothing can be used to solve some real world problems. Most of the options depend on two data objects generated by random forests. When the training set for the current tree is drawn by sampling with replacement, about one-third of the cases are left out of the sample. This data is used to get a running unbiased estimate of the classification error as trees are added to the forest. It is also used to get estimates of variable importance. An inflammation is determined by considering contiguous (defined by 18-connectedness in three dimensions) sets of voxels labelled as new lesion. The subset of new lesion candidates that meet a minimum size requirement of three voxels (as is the clinical norm) form the input to a second, lesion-level classification stage using a random forest classifier. A random forest is a discriminative classifier that consists of an ensemble of decision tree classifiers, where the final classification is determined by summing the votes cast by each individual tree. Using random subsets of training data and features for each individual tree helps prevent overfitting.

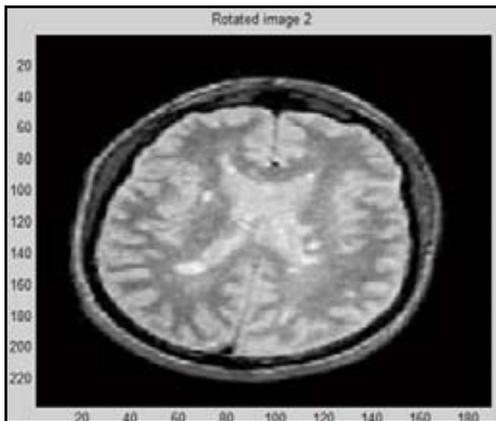
IV. Implementation

Train image

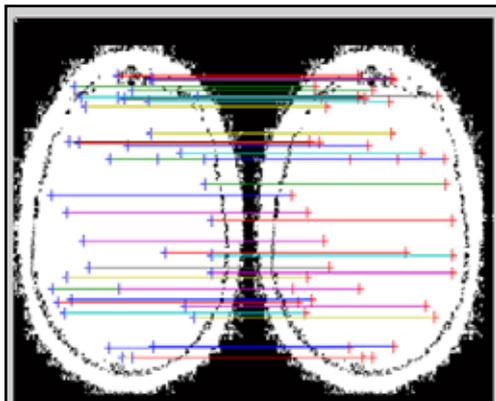


Test image

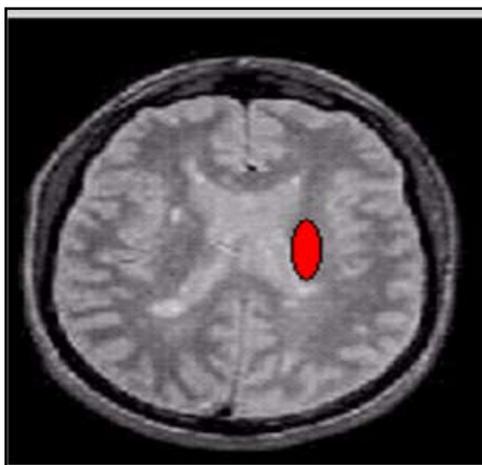




Less level Random Field



An inflammation detection



V. Conclusion and Future Enhancement

We have presented a framework for automated detection of new MS lesions using a two-stage classifier that first performed a joint Bayesian classification of tissue classes at each voxel of reference and follow-up scans using intensities and intensity differences, and then performed a lesion-level classification using a random forest classifier. The new lesion classifier allows for trade-off of sensitivity and specificity through the use of a user-specified confidence threshold (or target sensitivity). Sample points of operation showed that our classifier is able to detect new lesions as small as three voxels with a sensitivity and false detection rate and a sensitivity with false detection rate as compared to a reference standard. Comparisons to manual identification of new lesions using only sequential FLAIR scans showed better performance than any individual expert rater and comparable performance to consensus segmentation combining manual identification of new lesion from nine independent raters. In future Classification of tissues and the Multiple Sclerosis(MS) Lesions will detect by using Principal Component Analysis. It provide less computational time and also give better performance.

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