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Fusion Based Brain Tumor Detection Using Machine Learning

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Abstract: ***The growth abnormal cells in the brain are the main cause for Brain Tumor. There are various types of brain tumor that exist. The brain tumor is mainly classified as Benign and Malignant. The rate at which the brain tumor grows and its location may vary greatly which also determines how it could affect the function of the nervous system of the effected person. In this paper we use fusion of medical images (MRI image) and machine learning (SVM) for the diagnosis and classification of the type of brain tumor. Fusion of image is used in the reduction of both uncertainty and redundancy while extracting every possible useful information from that particular image. Support Vector Machine is a supervised machine learning algorithm which is used to provide more efficiency in the field of classification. As a result fused image contains more information than that of the source images. Fused images extract the features that involve texture and wavelet. The SVM classifier mainly classifies the tumor based on the extracted, trained and tested features. The experimental result proves that better performance would be achieved by using fusion based brain tumor detection using machine learning which has been proposed in this paper.***

Keywords: Machine Learning, Feature Extraction, SVM, Image Processing, MRI, Segmenting

1. Introduction

1.1 Brain Tumor

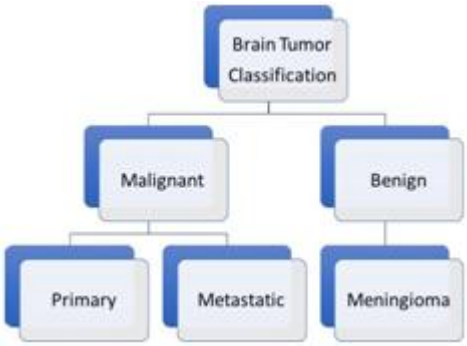


Figure 1: Classification of the brain tumor

When abnormal cells form within the brain, brain tumor occurs. There are two main types: Malignant or cancerous tumor and Benign or non-cancerous. The cancerous or malignant tumors can be divided into primary tumors, develop within the brain, and secondary tumors which could have spread from elsewhere, also known as brain metastasis. The symptoms and vulnerability of the brain tumor vary depending on the location, size and the part of the brain tumor it involves. The cause of the brain tumor is usually unpredictable. There is no particular age that a person could be affected by brain tumor; anyone from children to very elderly person could be affected. But now a days children are more exposed to brain tumors. The common type of brain tumor for an adult is Benign and for the children is usually Malignant. The risk factors in brain tumor are that they can even lead to death. There are many ways in the diagnosis of these brain tumors: Computed Tomography, Magnetic Resonance Imaging (MRI), Tissue Biopsy etc., in which the Magnetic Resonance Imaging (MRI) gives at most results for the diagnosis process.

1.2 Machine Learning

Machine Learning is a unique mathematical model that can be used to perform a particular task without using any of the explicit instructions or programs. It is a part of Artificial Intelligence. The computer systems can make decisions and predictions on their own, without being explicitly programmed. Machine Learning trains the system by building the mathematical model of the sample data. The machine Learning algorithm can be used in variety of applications such as email filtering, computer vision, text categorization and detection of network intruders. Machine Learning is closely related to Artificial Intelligence, Computational Statistics, Data Mining and Data Analysis which helps it in making decisions and predictions. Machine Learning is also known as Predictive Analysis. Hence they also have a range of application in the Business field, Medical field, Stock market pricing and even in the sports. Machine Learning has three broad categories:

(1) Supervised Learning
(2) Unsupervised Learning
(3) Semi-Supervised Learning.

In Supervised Learning the algorithm builds a mathematical model from a data set that contains both input and desired output. In Unsupervised Learning the algorithm builds a mathematical model from a data set that contains only input and no desired output labels. In Semi-supervised Learning the algorithm builds a mathematical model from incomplete training data, where a portion of the sample input does not have labels. $Z = x^2+y^2$

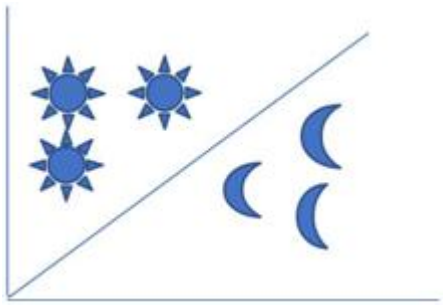
1.3 Support Vector Machine

Support Vector Machine is one of the superior Supervised Machine Learning algorithm. It is used for both classification and regression challenge. They are based on hyperplane. They are mainly used in the classification field

as it is a fast and dependable classification algorithm. They are used in applications which involves cancer diagnosis, text categorization, face recognition, data analysis etc., since they depend on supervised machine learning they provide better results. Hyperplane is simply a line in two-dimensional which acts as a boundary between two classes. Now let us understand hyperplane by considering the example – Given a pair of co-ordinates.

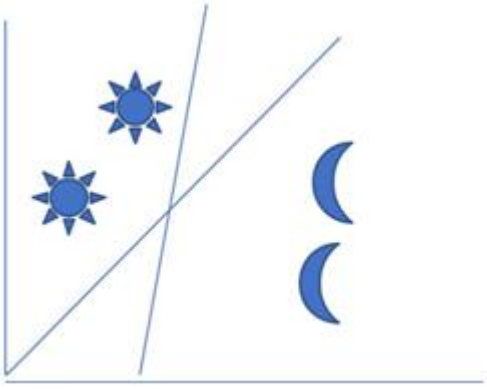
Case 1:

Two different categories or classifications can be easily partitioned using the hyperplane.



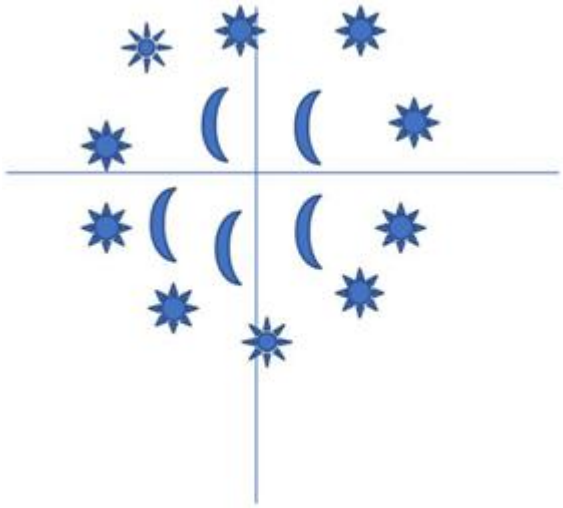
Case 2:

When there are two hyperplanes, the hyperplane which has the largest distance between each of the classification is taken as the margin.



Case 3:

In case of Non linear scenarios.



1.4 Image Preprocessing

The process that involves changing the nature of any image in order to improve its pictorial information or to render it more suitable for autonomous machine perception is known as image processing. Digital Image Processing is concerned with the use of computer in order to change the nature of a digital image. The images can be improvised methods or techniques:

1) Enhancing the edges of an image makes the image appear sharper and more defined.
2) Removing "Noise" from the particular image gives more precise representation of that picture. Noise removes random errors present on the image. A common problem in data transmission is "Noise".

There are various kinds of Noise each of which requires unique methods for removing it from the picture.

3) The pictorial representation of the image is also improved by the means of obtaining the edges of the message. This helps in identifying the estimated object measurements present in the picture.
4) Restoration of image i.e. removing the damages of the image is also an important task to be considered in order to perfectly process the image
5) Segmentation of the image which involves sub-dividing the images into constituent and precise segments or fragments which helps in isolating and identifying familiar objects.

Figure 2: Image Preprocessing

1.5 Image Fusion

The term image fusion describes the process by which all the necessary and important information are gathered from multiple images amalgamated into a fewer image, but usually a single image. This amalgamation into a single image has the at most efficiency in accuracy and is informative and consist all the needful and necessary information. Image Fusion technique is not used to reduce the data but is a process used to combine the relevant information from multiple images into a single image, which has a result that is more informative than any of the input images. There are many techniques for image fusion such as High Pass Filter, Discrete Wavelet Transform, Uniform Rational Filter Bank and Laplacian Pyramid. In this paper we will be using Discrete Wavelet Transform. The main feature of this image fusion is that they provide both high spatial and high spectral information in a single image.

In [4], the paper explores different medical image fusion methods and comparing them based on the performance parameters. Fusing MRI and CT images provide information. Hence Image Fusion Technique used provides more information than the images individually.

In [5], the proposed system first finds the Area of Interest (AOI) for the particular image and will fuse the related document in the Non area of Interest (NAOI). This system is used to remove the noisy pixels that are present.

2. Proposed System

The proposed system in this paper is that sequences of techniques mentioned below are done in order to achieve expected efficient results.

2.1 Input MRI Images

The input image is two MRI images which are placed at different angles that help in further stages to get the expected results. By using two MRI images we would get a more precise resource for the fusion and classification process.

2.2 Image Preprocessing

The image preprocessing is a process in which the image is made to go through certain changes which helps in improving the pictorial representation of both the input images. The preprocessing process for both the images is done separately. This helps in extracting the needful information from that particular image. Preprocessing is a certain type of operation which is performed at the lowest-level of abstraction. In this preprocessing stage, unwanted distortion and errors are being suppressed.

In [1], the paper has proposed a diagnosis methodology with the help of the support vector machine which is implemented as the following:

Image Database 2) Image Preprocessing 3) Feature Extraction 4) SVM Training 5) SVM Classification 6) Target Identification

This paper has achieved 82% accuracy; positive predictive value 81.48%, True Positivity is 22, True Negativity 5, False Positivity 22.

In [2], the paper is based on Discrete Wavelet Transform using light boost filtering. This is applied on large number of registered images of various categories multimodality images. Hence this preserves more information compared to the pixel based and regional based methods.

In [3], the proposed system is used to partition hyperspectral bands into sub groups prior to Principal Components Transformation. Hence the hyperspectral bands and the quality of the obtained RGB images are quantitatively assessed.

2.2.1 Noise Removal

The term noise is unmethodical errors present in the image. By removing noise we can extract a more meaningful feature from the image. The noise removal technique used here is Gaussian Noise Reduction Technique. This helps image enhancement and smoothing of the image to keep the features intact. Hence only the unwanted errors are being removed while the important features of the MRI images being undisturbed.

2.3 Image Fusion

The Image Fusion is a mathematical tool which is used in the enhancement of the resource and features which is to be extracted from the MRI images used. Here the two input MRI images are being combined are fused into a single image. This single image consists of more necessary information than that of these individuals input images. Since the input MRI images are in black and white, the image fusion technique used helps in better extraction of the features from the image. The Image Fusion technique being used here is the Discrete Wavelet

Transform. This provides efficient multi-resolution sub-band decomposition. The Discrete Wavelet Transformation technique is a specific technique which

decomposes the input into various levels of hierarchy which are specified further as high pass and low pass. Hence all the details and features from the image are extracted. These features then undergo a decomposition process and finally only the necessary information is being selected using an optimization criterion. We use Discrete Wavelet Transformation here as it is one of the most efficient image fusion techniques which considers all the four-values are four-quadrants. Hence takes their average and combines them. By doing this technique all the necessary features are consider without missing out any of them.

2.4 Segmentation

Segmentation is done in order to subdivide or partition those of that features extracted from the fusion technique. The segmentation technique used here is Otsu's method which is used to simplify the images which are easier to analyze and used in the reduction of Gray level image to a Binary image. This is mainly done to locate objects. Hence this process helps in finding the similarities and dissimilarities.

2.5 Feature Extraction

Feature Extraction is a reduction process where the features are reduced to more manageable features to build derived values intended to be informative and non-redundant. The technique use here is Haar feature based Cascade, is an object detection method for images. Here the image is a classified as positive images and negative images. This provide maximum coverage of the image for extracting the features. The main feature of this algorithm is that it combines all the driven features into a single image.

2.6 SVM Classification

The classification methodology is used to classify the features accordingly and retrieves which group the feature belongs. The classification method used is the Support Vector Machine of machine learning. The SVM Machine Learning is a supervised Machine Learning algorithm which is used in both classification and regression challenges. The process involves 40*12 matrix where the 40 is the trained set images and the 12 is the features. Hence they check for this combination in the trained data sets and hence provide the necessary results. These data sets are trained are fed beforehand using the Machine Learning algorithm. SVM is used in this paper as SVM has predefined values in MATLAB and has enhanced features in Binary Image values.

By performing the above we get the correct type of brain tumor which helps the physician to analyze the tumor and treat them accordingly.

3. Proposed Architecture

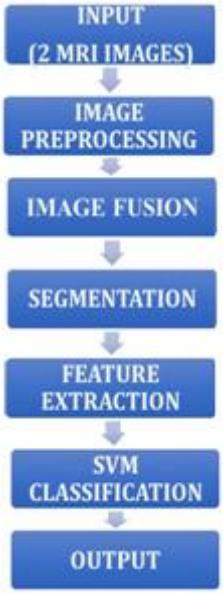


Figure 3: Architecture diagram

4. Result

The following are the screenshots of the project output:

Figure 4: Malignant type of tumor detection

4.1 Output

The output is a text which describes whether the corresponding Brain Tumor Benign or Malignant.

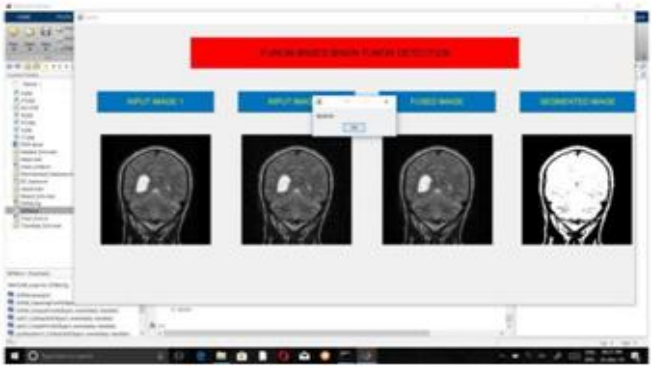


Figure 5: Benign type of tumor detection

5. Conclusion

This paper about the brain tumor using machine learning and fusion algorithm combines various modality of medical images to produce a high quality fused image with high spatial and spectral information which is highly useful in the process of classification and segmentation. Fused image with more information improved performance of image analysis algorithm used in different medical diagnosis applications.

The Support Vector Machine is a supervised machine learning technique which is used in this paper for brain image fusion and k-clustering features are extracted from the brain image. The brain tumor region is segmented with the help of the features that has been extracted and adaptive SVM classifier helps to identify whether the tumor is Benign or Malignant. The proposed system achieved 80.48% sensitivity, 99.8% specificity and 99.69% accuracy. Thus the proposed system provides a coherent method for brain tumor diagnosis. Hence the same prototype presented in this paper can be further enhanced and can be used for various other applications as well.

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