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Image Segmentation and Classification of Brain Tumor Detection

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Abstract: *In this paper, we propose a color-based segmentation method that uses the K-means clustering technique to track tumor objects in magnetic resonance (MR) brain images. The key concept in this color-based segmentation algorithm with K-means is to convert a given gray-level MR image into a color space image and then separate the position of tumor objects from other items of an MR image by using K-means clustering and histogram-clustering. Experiments demonstrate that the method can successfully achieve segmentation for MR brain images to help pathologists distinguish exactly lesion size and region. In our proposed method, to find the stages of tumor whether it is in Initial, Intermediate or Final stage we used the technique Artificial Neural Network. In order to classify the stages using ANN, we have to implement two algorithms namely Back propagation and Feed forward methods. Thus the final result is obtained as the stages of brain tumor.*
Keywords: *K-means clustering, Histogram, magnetic resonance, artificial neural network*

I. Introduction

Some of the techniques for the detection of tumor:

- A CT (computerized axial tomography) scan, which is a type of X-ray that builds up a two dimensional picture of the brain to show the position of tumor.
- An MRI (magnetic resonance imaging) scan is a advanced technique uses magnetic fields, instead of X-rays, to build up a picture of the brain.
- An EEG (electroencephalogram), which is a painless test that records the electrical activity of the brain.
- An X-ray of the blood vessels (angiogram) to show the position of the tumor.

II. Magnetic Resonance Imaging

Nuclear Magnetic resonance (NMR) has recently emerged as a powerful imaging technique in the medical field, because of its high resolution capability and potential for chemical specified imaging. It uses magnetic fields and radio frequency signals to obtain NMR images are essentially map of the distribution density of hydrogen nuclei and parameter reflecting their motion, in cellular water and lipids.

III. Image Processing:

Modern digital technology has made it possible to manipulate multi-dimensional signals with systems that range from simple digital circuits to advanced parallel computers. The goal of this manipulation can be divided into three categories.

- Image processing: image in-> low-level image out
- Image analysis: image in-> measurements out
- Image understandings: image in-> high-level description out

A.Steps involved in image processing**:**
These are the steps followed in image processing technique,

- Image Acquisition
- Image Enhancement
- Image Restoration
- Color Image Processing
- Wavelets and Multi-resolution Processing
- Compression
- Morphological Processing
- Segmentation
- Representation & Description
- Object Recognition

IMAGE ACQUISITION:

Image acquisition is the first step involved in image processing. This involves pre-processing such as scaling. This mainly involves squiring an image. An image can be acquired with the help of any equipment.

IMAGE ENHANCEMENT:

Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out details that are obscured, or to highlight features of interest of an image. Image enhancement is a subjective area.

IMAGE RESTORATION:

Image restoration is the area that deals with improving appearance of an image. Image restoration is an objective area. It is based on mathematical or probabilistic models of image degradation.

COLOUR IMAGE PROCESSING:

Color is the basis for extracting features of interest in an image. Color image processing is an area this have been gaining importance because of the significant increase in the use of digital images over the interest.

COMPRESSION:

Compression deals with the techniques for reducing the image required for saving an image, or the bandwidth required to transmit it. Image compression is familiar to most users of computers in the form of image file extensions, such as the jpeg file extension used in the JPEG image compression standard.

SEGMENTATION:

Segmentation procedures partition an image into its constituent parts or objects. The more accurate the segmentation, the more likely region or all the points in the region itself.

RECOGNITION:

Image segmentation is typically used to locate objects in images. The result of image segmentation is a set of regions that collectively cover the entire image. Each of the pixels in the region is similar with respect to some characteristic such as color, intensity, or texture. Recognition is the process that assigns a label to an object based on its descriptors.

SEGMENTATION:

- Medical Imaging
  - Locate tumors and other pathologies
  - Measure tissue volumes
  - Computer – guided surgery
  - Diagnosis
  - Treatment planning
  - Study of anatomical structure
  - Locate objects in satellite images (roads, forests, etc.)
- Face recognition
- Fingerprint recognition
- Automatic traffic controlling systems
- Machine vision

IV. Types Of Image Segmentation:

Some types of segmentation:

- Cluster method
- Histogram based methods
- Edge detection methods
- Region growing method

CLUSTERING METHODS:

The K-means algorithm is an iterative technique that is used to partition an image into K clusters. The basic algorithm is:

1. Pick K cluster centers, either randomly or based on some heuristic.

2. Assign each pixel in the image to the cluster that minimizes the variance between the pixel and the cluster center.
3. Re-compute the cluster centers by averaging all of the pixels in the cluster.
4. Repeat steps 2 and 3 until convergence is attained.

In this case, variance is the squared or absolute difference a pixel and a cluster center. The difference is typically based on pixel color, intensity, texture and weighted combination of these factors. K can be selected manually, randomly or by a heuristic.

V. Histogram-Based Methods:

Histogram –based methods are very efficient when compared to other image segmentation methods because they typically require only one pass thought the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image. Color or intensity can be used as the measure.

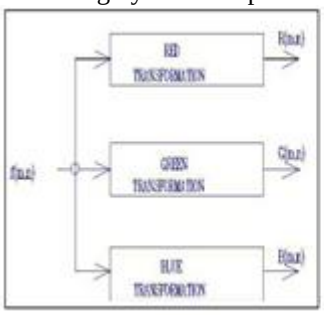
A refinement of this technique is to recursively apply the histogram-seeking method to clusters in the image in order to divide them into smaller clusters. This is repeated with smaller and smaller clusters until no more clusters are formed. One disadvantage of the histogram-seeking method is that it may be difficult to identify significant peaks and valleys in the image in the technique of image classification distance metric and integrated region matching are familiar

.

COLOR SPACE TRANSFORMATION:

PSEUDO COLOR TRANSLATION

Original MR brain image is a gray-level image insufficient to support fine features. To obtain more useful features and enhance the visual density, the proposed method applies pseudo-color transformation, a mapping function that maps a gray-level pixel to a color-level pixel by a lookup table in a predefined color map. An RGB color gradually maps gray-level values 0 to 255 into blue-to-green-to-red color. map contains R, G, and B values for each item. Each gray value maps to an RGB item.



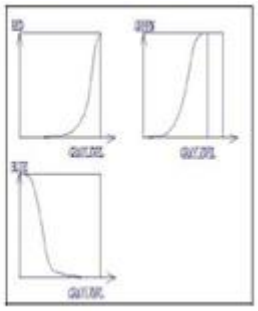


Fig Pseudo color transformations **Fig Examples of pseudo maps**

RGB (Red Green Blue)

The RGB color model is an additive color model in which red, green, and blue light are added together. RGB uses additive color mixing and is the basic color model used in television or any other medium that projects color with light. It is the basic color model used in computers and for web graphics, but it cannot be used for print production.

This is an additive color system based on tri-chromatic theory. RGB is easy to implement but non–linear with visual perception. It is device dependent and specification of colors is semi–intuitive.

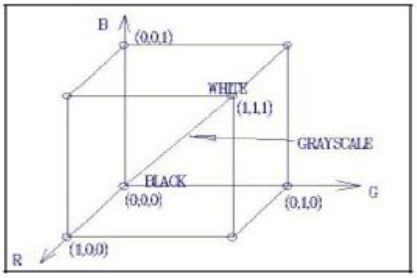
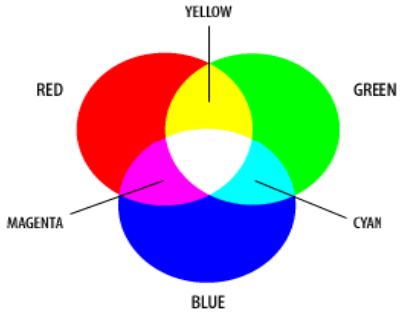


Fig . RGB color cube

The secondary colors of RGB – cyan, magenta, and yellow – are formed by mixing two of the primary colors (red, green or blue) and excluding the third color. Red and green combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue in full intensity makes white. Red, green, and blue are the primary stimuli for human color perception and is the primary additive colors.



COLOR SPACE TRANSLATION:

Color is the brains reaction to a specific visual stimulus.The reason for this redundancy is that the eye's retina samples color using only three broad bands, roughly corresponding to red, green and blue light.

- ✓ **Brightness:** the human sensation by which an area exhibits more or less light.
- ✓ **Hue**: the human sensation according to which an area appears to be similar or proportions of two, of the perceived colors red, yellow, green and blue.
- ✓ **Colorfulness**: the human sensation according to which an area appears to exhibit more or less of its hue.
- ✓ **Lightness**: the sensation of an area's brightness relative to a reference white in the scene.
- ✓ **Chroma:** the colorfulness of an area relative to the brightness of a reference white.
- ✓ **Saturation**: the colorfulness of an area relative to its brightness.

VI. Clustering Techniques:

CLUSTERING ALGORITHMS:

This system is implemented using four Clustering algorithms. They are,

- K-means Algorithm
- Self Organizing Maps
- Hierarchical Clustering
- Fuzzy C-Means Algorithm

VII. Classification Using Artificial Neural Network:

ARTIFICIAL NEURAL NETWORK:

An artificial neural network, often just named a neural network, is a mathematical model inspired by biological neural networks. A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases a neural network is an adaptive system changing its structure during a learning phase. An artificial neural network is an interconnected group of nodes, akin to the vast network of neurons in a brain.

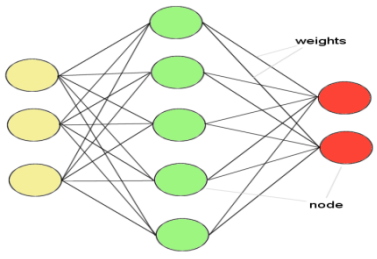


Fig. Artificial neural networks

Neural network models in artificial intelligence are usually referred to as artificial neural networks (ANNs); these are essentially simple mathematical models defining a function $f: X \rightarrow Y$ or a distribution

over X or both X and Y, but sometimes models are also intimately associated with a particular learning algorithm or learning rule. An ANN is typically defined by three types of parameters:

1. The interconnection pattern between different layers of neurons
2. The learning process for updating the weights of the interconnections
3. The activation function that converts a neuron's weighted input to its output activation.

ALGORITHMS IN ANN:

BACK PROPAGATION ALGORITHM:

The back propagation algorithm has emerged as workhorse for the design of a special class of layered feed forward networks known's as multilayer perceptions (MLP).A multilayer perceptron has an input layer of source nodes and an output layer of neutrons (i.e., computation nodes). These two layers connect the network to the outside world. In addition to these two layers, the multilayer perceptron usually has one or more layers of hidden neutrons, which are so called because these neutrons are not directly accessible. The hidden neutrons extract important features contained in the input data.

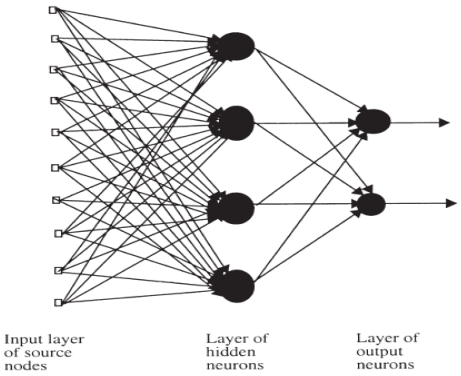


Fig. fully connected feed forward with one hidden layer and one output layer.

For feed – forward network algorithm, the information is carried out in two ways,

- ✓ Information flow is unidirectional
- o Data is presented to Input layer
- o Passed on to Hidden Layer
- o Passed on to Output layer
- o Information is distributed

VIII. Classification Of Tumor Stages By Ann:

The tumor stages are classified by the technique of Artificial Neural Network. The tumor is classified by **Back Propagation Algorithm.** In Artificial Neural Networks, the network should be trained initially and then using trained networks, classification were developed. The training of networks is similar to human brain. In ANN, back propagation algorithm was chosen to clarify tumor stages. But ANN doesn't take image as input; but it takes the values of the image. The back propagation algorithms uses three layers for classifying and are the input layer, hidden layer and output layer.

Here, the hidden layer is 3. Input and output layers are taken as 1. The hidden layer consists of weight and bias values. In case of hidden layer, the parameters like epoch, time, performance and gradient are calculated. In this hidden layer progress takes place in every step.

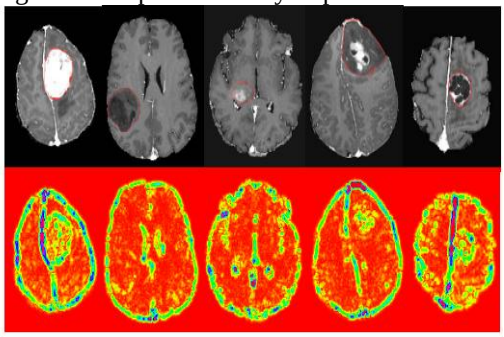


Fig.7.3 Illustration of different brain tumor types and the corresponding texture images. From left to right: meningioma, glioma grade II, III and IV and metastasis.

IX. Conclusion

- Pattern recognition
- Character recognition
- Face Recognition
- Sonar mine/rock recognition
- Navigation of a car
- Stock-market prediction
- Pronunciation

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