

Shape Feature Extraction of Brain MRI Using Slope Magnitude Method for Efficient Image Analysis

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ABSTRACT: Magnetic Resonance Imaging (MRI) is one of the best technologies currently being used for diagnosing brain and brain diseases. Brain is diagnosed at advanced stages with the help of MRI image. Segmentation is an important process to extract suspicious region from complex medical images. Automatic detection of brain through MRI can provide the valuable outlook and accuracy of earlier brain diseases detection. Feature extraction process started with shape and edge information extracted from the original MRI is the basis for every efficient image analysis system. The paper discusses novel image processing methods based on shape features extraction of brain using slope magnitude technique. The slope magnitude method is applied for all edge detection operators and the efficiency of segmentation is measured by the parameters such as global correction error and peak signal to noise ratio. The proposed method outperforms the existing methodologies that involve conventional edge detection approaches.

KEYWORDS: Slope magnitude, Brain MRI, image segmentation, boundary based techniques, feature extraction

1. INTRODUCTION

The properties of MR images have a strong influence on the usefulness of specific segmentation methods. In brain MRI analysis, image segmentation is commonly used for measuring and visualizing the brain's anatomical structures, for analyzing brain changes, for delineating pathological regions, and for surgical planning and image-guided interventions. In the last few decades, various segmentation techniques of different accuracy and degree of complexity have been developed and reported in the literature. Brain MRI segmentation is an essential task in many clinical applications because it influences the outcome of the entire analysis.

In general, shape descriptor is some set of numbers that are produced to describe a given shape feature. A descriptor attempts to quantify shape in ways that agree with human intuition (or task-specific requirements). Usually, the descriptors are in the form of a vector. Shape descriptors should meet the following requirements: The descriptors should be as complete as possible to represent the content of the information items. The descriptors should be represented and stored compactly. The size of descriptor vector must not be too large. The computation of distance between descriptors should be simple; otherwise the execution time would be too long. The rest of the paper is organized as follows to propose a new system for image analysis using shape based segmentation. Section 2 reveals the existing methodologies in literature survey. Section 3 discusses the different features that enable image segmentation. Section 4 discusses shape based edge detection and its significance. Section 5 involves slope magnitude method based shape extraction using different operators such as Canny, Robert, Perwitt and Sobel. Results and conclusion are discussed in section 6 and 7.

II. LITERATURE SURVEY

Rohini Paul Joseph and Senthil Singh(2014) says Image segmentation plays a significant role in image processing as it helps in the extraction of suspicious regions from the medical images. In that paper they have proposed segmentation of brain MRI image using K-means clustering algorithm followed by morphological filtering.

Hongyuan Zhu, Jianmin Zheng, Jianfei Cai explains Object-level Image Segmentation Using Low Level Cues. That paper considers the problem of automatically segmenting an image into a small number of regions that correspond to objects conveying semantics or high-level structure.

Vinita Dixit (2014) explains image acquisition, preprocessing and enhancement, image segmentation, classification and volume calculation steps in image Processing Techniques for Automatic Detection of Tumor in Human Liver based on automatic detection.

Arpita Mittal explains Morphological Image Processing Techniques. Their main aim is Image Enhancement of Bio-Medical MRI Images Using Morphology technique.

III. FEATURE EXTRACTION

Huge amount of information is necessary to signify an image, which occupies huge amount of memory and time. The features are extracted from an image in order to decrease the amount of data, memory and time. The extracted features have the related information of an image. It can be employed as an input to the classifier for image classification and segmentation. The kinds of attributes extracted from a Brain MRI images are categorized as:

1. Shape Features
2. Intensity Features
- 3 Texture Features

- **Shape Features**

Shape offers the geometrical information of an object in an image. The shape characteristics such as centroid, eccentricity, area, perimeter, circularity, shape index, solidity, orientation, euler number are regarded.

- **Intensity Features**

Intensity based characteristic is one of the most extensively applied feature. The intensity characteristics are mean, median, mode, skewness, kurtosis, energy, entropy.

- **Texture Features**

Texture is a feature of an image that offers higher order description of an image and comprises information about the spatial distribution of tonal differences or gray tones. The texture extraction characterizes the homogeneity or resemblance among areas of an image. Texture feature categorizes magnetic resonance image of brain into gray matter, white matter, cerebrospinal fluid and tumor region.

IV. ROLE OF SHAPE FEATURE

Shape feature extraction[9] and representation plays an important role in the following categories of applications:

Shape retrieval: searching for all shapes in a typically large database of shapes that are similar to a query shape. Usually all shapes within a given distance from the query are determined or the first few shapes that have the smallest distance.

- Shape recognition and classification: determining whether a given shape matches a model sufficiently, or which of representative class is the most similar.
- Shape alignment and registration: transforming or translating one shape so that it best matches another shape, in whole or in part.

- Shape approximation and simplification: constructing a shape with fewer elements (points, segments, triangles, etc.), so that it is still similar to the original. Many shape description and similarity measurement techniques have been developed in the past. A number of new techniques have been proposed in recent years. There are 3 main classification methods as follows:
 - contour-based methods and region-based methods [1]. This is the most common and general classification and it is proposed by MPEG-7. It is based on the use of shape boundary points as opposed to shape interior points. Under each class, different methods are further divided into structural approaches and global approaches. This sub-class is based on whether the shape is represented as a whole or represented by segments/sections (primitives).
 - Space domain and transform domain [2]. Methods in space domain match shapes on point (or point feature) basis, while feature domain techniques match shapes on feature (vector) basis.
 - Information preserving (IP) and non-information preserving (NIP). IP methods allow an accurate reconstruction of a shape from its descriptor, while NIP methods are only capable of partial ambiguous reconstruction. For object recognition purpose, IP is not a requirement.

V. EDGE DETECTION

Edge detection is the difficulty of fundamental importance in image study. Edge detection methods are commonly applied for discovering discontinuities in gray level images. Edge detection is the most general strategy for identifying significant discontinuities in the gray level. Image segmentation techniques for identifying discontinuities are boundary based methods. Edge detection can be prepared by means of either of the subsequent techniques. Edges are local alters in the image intensity. Edges usually happen on the boundary between two areas. Significant characteristics can be extorted from the edges of an image (e.g., corners, lines, curves). For image study, Edge detection is a significant attribute. These attributes are applied by higher-level computer vision algorithms (e.g., recognition). Edge detection is employed for object detection which serves different applications like medical image processing, biometrics etc. Edge detection is a dynamic region of research as it makes easy higher level image study. There are three dissimilar kinds of discontinuities in the grey level like point, line and edges.

Different edge detection operators are:

- ✚ Sobel Edge Detection Operator
- ✚ Prewitt Edge Detection Operator
- ✚ Canny Edge Detection Operator
- ✚ Robert Edge Detection Operator

• Sobel edge detection

Sobel operator is applied by Sobel edge detection. Sobel operator is a slope operator. Gradient communicates to the first derivative. The Sobel operator executes a 2-D spatial gradient measurement on an image. Normally it is applied to discover the estimated complete gradient magnitude at each point in an input grayscale image.

The Sobel edge detector employs 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 generally much smaller than the real image. Accordingly, the mask is slid over the image, influencing a square of pixels at a time.

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} \quad (1)$$

$$G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad (2)$$

• Canny edge detection

First, Canny edge detector algorithm engages the smoothing of image. That is deduction of noise from the image. After that gradient of the image is calculated by feeding the smoothed image through convolution operation with the derivative of the Gaussian in both the vertical and horizontal directions. Hereafter, non maximum suppression is used.

The intention of this step is to change the blurred edges in the image of gradient magnitude to pointed edges. This is mainly made by protecting all local maxima in the gradient image and removing everything else.

• **Prewitt edge detection**

The Prewitt operator employs two 3×3 kernels which are convolved with the original image to work out approximations of the derivatives one for horizontal changes.

Prewitt edge detector is an appropriate way to estimate the magnitude and orientation of an edge.

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} \quad G_y = \begin{bmatrix} -1 & 0 & +1 \\ -1 & 0 & +1 \\ -1 & 0 & +1 \end{bmatrix} \quad (3) \quad (4)$$

* **Robert edge detection:**

The Roberts gradient operators are used to detect edges applying a horizontal and vertical filter in sequence. Both filters are applied to the image and then slope magnitude method could be applied to extract the connected edges in the image.

$$G_x = \begin{bmatrix} +1 & 0 \\ 0 & -1 \end{bmatrix}$$

$$G_y = \begin{bmatrix} 0 & +1 \\ -1 & 0 \end{bmatrix} \quad (5), (6)$$

V. SLOPE MAGNITUDE METHOD

The problem with edge extraction using gradient operators is detection of edges in only either horizontal or vertical directions.

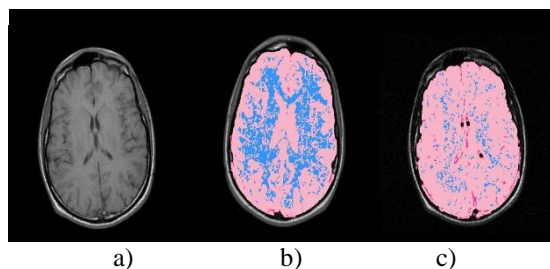
Shape feature extraction requires the extracted edges to be connected in order to reflect the boundaries of objects present in the image. Slope magnitude method is used along with the gradient operators (Sobel, Prewitt, Robert and Canny) to extract the shape features in form of connected boundaries.

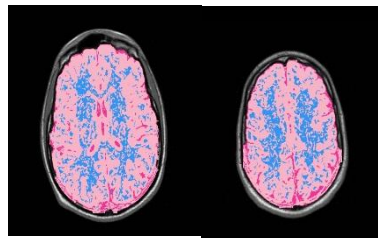
The process of applying the slope magnitude method is given as follows. First one needs to convolve the original image with the G_x mask to get the x gradient and G_y mask to get the y gradient of the image. Then the individual squares of both are taken.

Finally the two squared terms are added and square root of this sum is taken as given in equation

$$G = \sqrt{G_x^2 + G_y^2} \quad (7)$$

For the sample image shown in figure a the shape features extracted using the gradient operators Sobel, Prewitt, Roberts and Canny are respectively shown in figure b, c, d and e.





d) e)

- a): original image
b): Shape extracted using Slope Magnitude Technique with Canny Operator.
c): Shape extracted using Slope Magnitude Technique with Sobel Operator
d): Shape extracted using Slope Magnitude Technique with Prewitt Operator
e): Shape extracted using Slope Magnitude Technique with Robert Operator

VI. RESULTS AND DISCUSSIONS

The performance of proposed technique a database of 100 variable T2 slice images of Brain MRI is utilized. To segmentation effectiveness is assessed by **Global Consistency Error (GCE)** and **Peak Signal to Noise Ratio (PSNR)**[7].

Global Consistency Error:

The Global Consistency Error (GCE) measures the extent to which one segmentation can be viewed as a refinement of the other. Segmentations which are related are considered to be consistent, since they could represent the same image segmented at different scales. The formula for GCE is as follows(8),

$$GCE = \frac{1}{n} \min \{ \sum_i E(s1, s2, pi), \sum_i E(s2, s1, pi) \}$$

Where(8), segmentation error measure takes two segmentations S1 and S2 as input, and produces a real valued output in the range [0:1] where zero signifies no error. For a given pixel pi consider the segments in S1 and S2 that contain that pixel.

PSNR (Peak Signal to Noise Ratio):

PSNR represents region homogeneity of the final partitioning. The higher the value of PSNR the better is segmentation. PSNR in decibels (dB) is computed by using:

MAE is the mean absolute error of the segmented image computed as follows

$$PSNR = 10 \log_{10} \left(\frac{255^2}{MAE} \right) \quad (9)$$

$$MAE = \frac{1}{MN} \sum \sum |F(i, j) - f(i, j)|$$

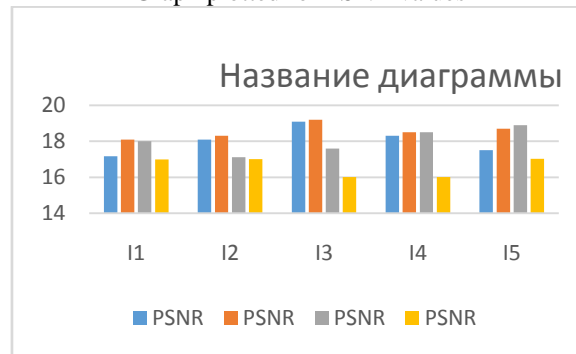
F (i, j) - segmented image, f (i, j) - source image that contains M by N pixels.
(10)

The performance evaluation of the proposed system is checked with the GCE&PSNR by testing with 5 images using PSNR using slope magnitude ans shape extraction.

As per the study, the efficiency of the Robert edge detection is evaluated to be high.

I/p image	PSNR				GCE			
	C	S	P	R	C	S	P	R
I1	17.17	18.1	18.01	16.99	0.1	0.03	0.08	0
I2	18.1	18.3	17.11	17.01	0.06	0.08	0.07	0
I3	19.1	19.2	17.6	16.01	0.02	0.02	0.06	0
I4	18.3	18.5	18.5	16.02	0.11	0.03	0.04	0
I5	17.5	18.7	18.9	17.03	0.23	0.04	0.02	0

Graph plotted for PSNR values



Graph plotted for GCE values



VII. CONCLUSION

The role of segmentation is crucial in most tasks requiring image analysis. This presented approach involves a unique method of image segmentation for further analysis using slope magnitude method. The efficiency of the system is evaluated by the validation measures such as GCE and PSNR applied for different edge detection operators. This work proves that slope magnitude method can be well employed for MRI image analysis.

REFERENCES

1. F.A. Andaló, P.A.V. Miranda, "Shape feature extraction and description based on tensor scale", Elsevier-Pattern Recognition, 1-11.
2. Xiaojun Qi and Hongxing Zheng, "A NEW INTEGRATED METHOD FOR SHAPE BASED IMAGE RETRIEVAL", 1-5.
3. Roshan G. Selkar, Prof. M. N. Thakare, Prof. B. J. Chilke Review on "Detection and segmentation of brain tumor using watershed and thresholding algorithm" IORD Journal of Science & Technology, Volume 1, Issue II (JAN-FEB 2014) PP 11-14.
4. Arpita Mittal, "A Literature Review on Analysis of MRI Images of Rheumatoid Arthritis through Morphological Image Processing Techniques", International Journal of Computer Trends and Technology (IJCTT) - volume 4 Issue 4 - April 2013, 1-3.
5. Rohini Paul Joseph and Senthil Singh, "BRAIN TUMOR MRI IMAGE SEGMENTATION AND DETECTION IN IMAGE PROCESSING", IJRET: International Journal of Research in Engineering and Technology Volume: 03.
6. Cyrus Shahabi-Maytham Safar, "An experimental study of alternative shape-based image retrieval techniques", Multimed Tools Appl, 1-20.

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7. Vinita Dixit, Jyotika Pruthi, "Review of Image Processing Techniques for Automatic Detection of Tumor in Human Liver", International Journal of Computer Science and Mobile Computing, IJCSMC, Vol. 3, Issue. 3.
8. Kekre and Priyadarshini Mukherjee, "Image Retrieval with Shape Features Extracted using Gradient Operators and Slope Magnitude Technique with BTC", International Journal of Computer Applications, Volume 6- No.8.
9. Seyyad mohammad, mohammad saidegh helfroush, "Novel shape and feature extraction for medical x-ray image classification", International journal of innovative computing information.