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IMAGE PROCESSING AND ITS APPLICATION IN MEDICINE: A CASE STUDY IN NEUROLOGY

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Abstract

OCR or Optical Character Recognition is meant to identify the letters with the help of optical tool and is a branch of signal processing science. OCR includes imaging on paper and extracting its words. This study dealt with investigating and application of image processing method in medical science and had chosen brain tumor patients as a sample for studying and proposing a method for detecting brain tumors using image processing and ultimately tried to evaluate this method and compare it with other available approaches to this issue.

Keywords: Image processing, medical science, brain tumor, OCR.

Introduction

Nowadays, image processing has many applications with growing expansion of various methods such as scanning and digital camera for obtaining discrete information. Obtained images from this information have always had an amount of noise. In some cases there have been problems of blurring boundaries for the samples inside image which reduces input of received image. "Image Processing" could be called an operation set and the methods used to reduce errors and increase the quality of visual image. There are large areas working with image, but generally four areas of focus are as below:

1. Enhancement visual quality
2. Restoration of disturbed images
3. Compression and coding of image
4. Understanding image by machine

Main operations in image processing including:

1. Geometric transformations such as resizing, rotating,

2. Color: like, change the brightness, resolution and color space transformation.

3. Images combination: combining two or more images.

4. Image compression: reduce the image size.

5. Image segmentation: image analysis in areas and parts with meaning.

6. Image differences: Finding the difference of image.

7. Averaging: obtaining an average image from two image.

Application of Image Processing.

Image processing has many applications in various fields. At first briefly introduce image processing applications in various fields, and then in more detail medical application of image processing and diagnosis of brain tumors will be discussed.

- **Print out and manuscripts:**

Recognition of printed or written characters is new applications of images processing. Other applications are including reading automatically zip codes and codes cited bank.

- **Barcode:**

Responsible for checking in most supermarkets have bar codes on merchandise items that are read and interpreted.

The use of barcodes can record samples, samples for biochemical and tissue samples noted in the hospital.

- **Creates chromosomal properties:** Since chromosomal images area simple structure, chromosome pairing and auto-renewal of one of the Latest in medical image is processing applications.

- **Cytology and Histology:**

Automatic interpretation and quantization of microscopic images is of other applications in medical image processing.

Other image processing applications.

1. Industry:

Nowadays in many modern factories, part of the production line is controlled by the intelligent programs of machine vision. Lowerror, high speed, low maintenance, lack of necessity to the presence of an operator 24 hours a day and many other advantages had caused many industries and factories goes to image processing and computer vision. One of the purposes of the application of machine vision is visibility and measurement products that see or measurement of them is not possible with the naked eye. Elements of a machine vision system is visual intelligent software that get

its input from the cameras installed indifferent parts of the production line and in accordance with the received images commands instructions to control industrial machinery.

Urban Development:

Among image processing applications in the field of urban development, the traffic control can be noted that the amount of traffic in every part of the city with taking aerial pictures from the ground is determined. On the other hand, the amount of development and improving of the city is observable with comparing the various images from different years. Before building a city, it can be simulated by computer and showing which two-dimensional views from above and even three-dimensional views is created from different views. Satellite images of the city can be filtered by various filters of image processing and different information can be extracted from it.

5. The military and security sciences:

Image processing in particular machine vision have many applications in the military and security sciences. These are applications that are most significant for the government of all countries. In the military field, it can be pointed out to the missiles that they can detect certain parts of the building and to attack it. In the field of security cameras can be stated that automatically photograph vehicles that do traffic violation.

Medical:

One of the most important applications of image processing is in medical science. It is somewhere all photos need to be taken with the utmost clarity; because, it is necessary to see all the details.

In the following, some of the image processing applications in medical science are provided:

- Detection of breast cancer in mammography images.
- Detection of pulmonary nodule son CT images.
- Automatic detection of brain tumors.
- determine the brain regions in which gray matter density disorders among healthy individuals and patients with Alzheimeris maximum.
- In small operations with a very small opening and viewing the surgical site by tele medicine and surgery by robotic arms with high accuracy

The information was clearly stated the importance of image processing. In this study, an important application of image processing in the medical field and the automatic diagnosis of brain tumors has been investigated. In the following, this area will be discussed.

Brain tumor is one of the main causes of death among children and adults and is considered among fatal diseases.

According to statistic, the annual incidence of primary brain tumors in the United States was seven to nineteen cases at per 100,000 people. Its prevalence at the age of zero to four years was 1/3 at per 100,000 people that in the age of fifteen to 24 decreased and then gradually increased from 65 to 79 getting to the eighteen to nineteen cases per 100,000 people. Brain tumors could be divided into two benign and malignant categories. (attachment comprehensively explained about it) And images play an important role in the diagnosis of these tumors. Tumor images can be extracted with MRI¹, CT SCAN², ultrasound³, ...that MRI method is better than other methods. There are a lot of problems in diagnosis of tumor based on MRI images which among them, extract border from the environment can be mentioned. The purpose of this study is to diagnose brain tumors with minimal error image processing which two following steps for achieving this purpose is used:

- 1) Separating the image of brain tissue from the brain.
- 2) Tumor and remove it from the rest of the portrayal of injury.

A review of methods for automatic detection of brain tumors.

The different methods that are used to automatically diagnose brain tumors include:

The histogram method and neural network techniques and tiny calculation method the summary of histogram method can be described in two step below:

The first step is filtering the images to reduce noise by median filter and then edge detection by CANNY filter the second step-to perform segmentation by categorizing histogram that the image of tumor is divided into quarter and threshold value.

Available methods for diagnosis of brain tumor with neural networks are as follows:

1-input:

tumor tissue is more difficult than normal tissue of brain and therefore it can be seen brighter compared to other tissues in MRI images. Tumors have a heterogeneity tissue.

(2) Pre-processing: Eliminating noise is of high importance in medical images because the accuracy is very important in them. Here, the first steps to remove noise that aims to increase the contrast between normal and abnormal brain tissue. The median filter is used for this purpose. The proposed method in this study and its simulation as what was stated earlier, there are a variety of ways in automatic diagnosis of brain tumors. In this study thresholding, histogram comprehensively will be discussed. To achieve this goal the following steps are implemented:

- 1) Pre-processing: segmentation of brain MRI images using created restraints.
- 2) Diagnosis tumor: analysis method based on histogram thresholding method and finally, some of the results are presented.
- 3) But contents about used idea in this study before starting discussion are presented.

First, it should be noted that the value of each pixel of the image is variable between zero_255 ranges. Thus, a zero represents black and 255 represents white and other colors are located between these ranges.

Studying MRI images of a brain tumor and consult with related doctors, it can be concluded that tumor is in a region of the brain that accumulation of white pixels are more than other areas.

In this study, the same subject is used to find the location of the tumor. The important point in this discussion is that the accumulation of pixels with a value of about 255 in addition to the tumor part are in the region of skull, which lead to reducing the accuracy of tumor diagnosis.

In order to solve this problem, at first skull part is be isolated from brain tissue in the pre-processing stage, and then proceeded to isolate the tumor is in the stage of tumor diagnosis. By performing this process, accuracy is greatly increased and its error is reduced.

How to access the database:

There are three methods in MRI imaging that imaging protocols are different in them.

Proton density _weighted: with great TR and small TE.

T₁ -weighted: that a small TR and small TE.

T₂ -weighted: that a large TR and great TE.

In the below diagram, the difference between these three types has been shown better.

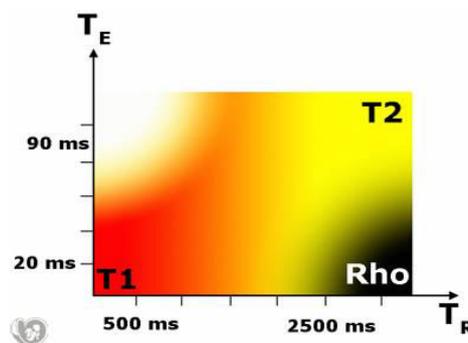


Figure1: Difference diagram between T1, T2.

To access the database, available pictures in cyberspace were have some problems. Some of these images have the different size, intensity, quality and magnetic field. On the other hand, they were prepared by a variety of devices and

also, the images were belonging to people with different ages. All of these factors caused to there were not possibility of preparing acceptable algorithm with a help of such a database. In order to solve this problem, there was a need for a database with the same images and the same characteristics. Images should belong to a specific age group, so in this way it could be programming for them. The database used in this study consisted of 33 MRI image of type T1 from newborn with the age class 39 to 42 weeks.

Seventeen of the 33 MRI image belongs to boys and sixteen to girls. Among these numbers, 31 pictures were taken in Amien's University Hospital at the University of Picardy in France in 2003 and 2006. Two other pictures were from Swede Lund University Hospital. Now, with similarity of brain MRI images, it can be said that there is the possibility of creating an acceptable algorithm to achieve the desired goal. But according to this fact that available pictures are without tumor, the tumor must be added to the original image. The important point in this process is that after performing surgery should be demonstrated that tumor diagnosis in the tumor images created by hand not only is simpler than image of the actual tumor, but even is somewhat more complicated. Photoshop software was used to create a tumor in main images and in this stage, all the available images are modeled based on real images patterns like the one below:

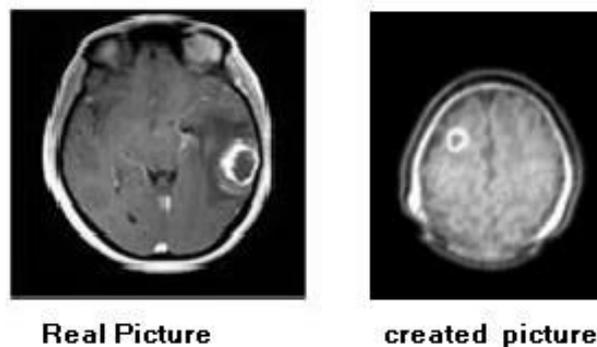


Figure-2.

In creating a tumor by Photoshop software and more closeness to actual images, varying intensity (according to selected model) were used.

In every real and un-real tumor image by Photoshop, it is necessary to compare the distribution of brightness intensity in a tumor part and brain part which tumor is removed from it. In other words, firstly tumor is removed from brain and histograms diagram is obtained. Then brain is removed from tumor and histograms diagram of brain without a tumor is obtained too.

This operations is also performed for images that tumor is added to them by hand.

In this stage, it is proved that overlapping areas in histogram of two images of tumor and brain without tumor by Photoshop is more than real tumor images. In other words, tumor diagnosis in images created with Photoshop is more difficult.

The following is a sample of the images referenced. (To display more clearly, tumor histogram is drawn larger than the brain histogram without tumor.)

Now for achieving the research objectives, the available images were classified into two categories of training and experimental. In this way the process was conducted on the training images and desired values obtained from it, then obtained conclusion are tested on training images.

Here, ten images as training images and 23 images as experimental images are used.

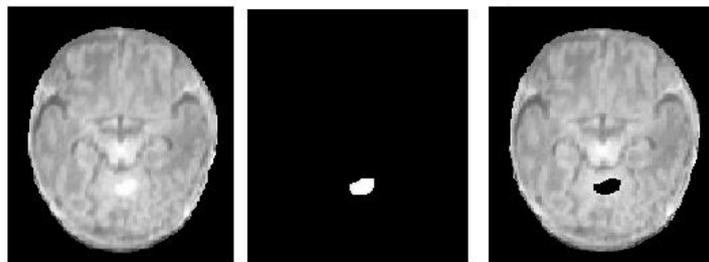


Figure-3. The tumor created in the brain by Photoshop

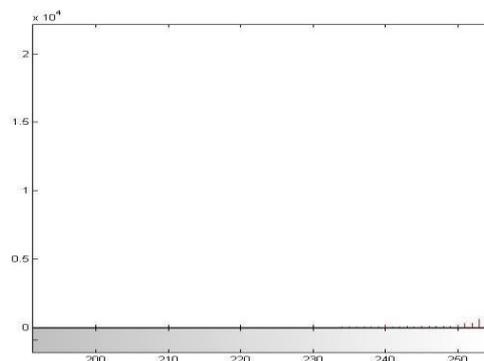


Figure-4.histogram of figure 3

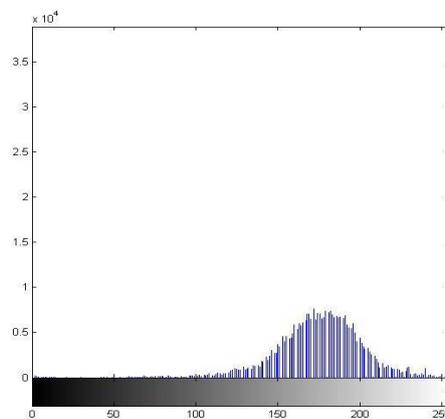


Figure-5.histogram of figure 3

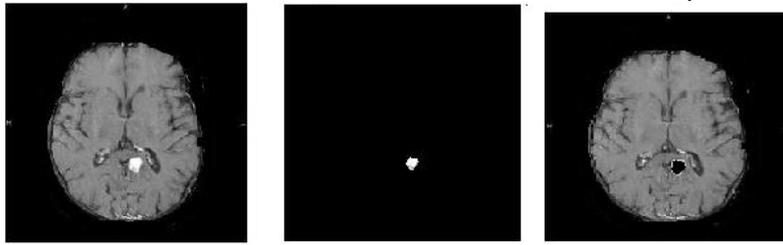


Figure-6.Real tumor

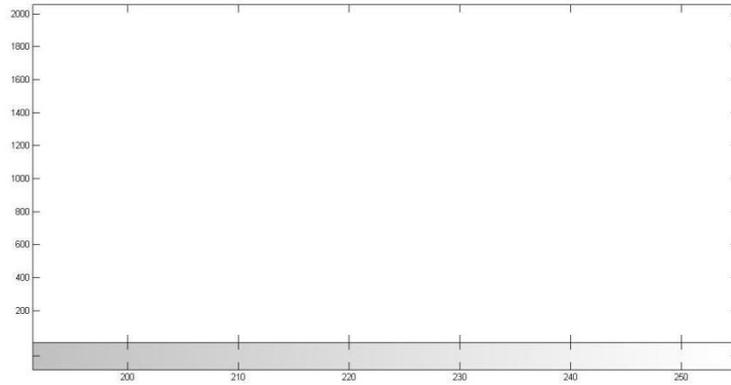


Figure-7.histogram of figure 6

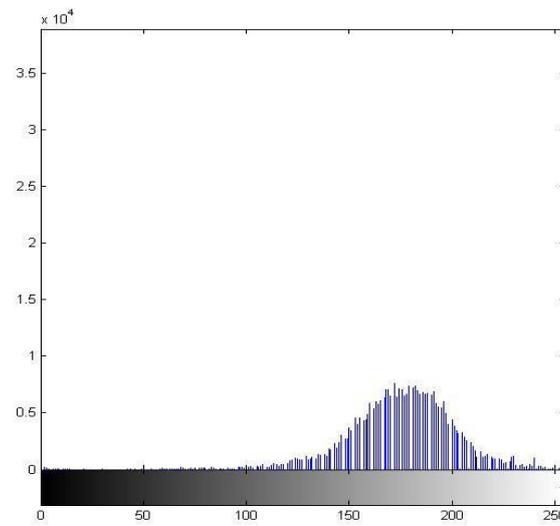


Figure-7.histogram of figure 6

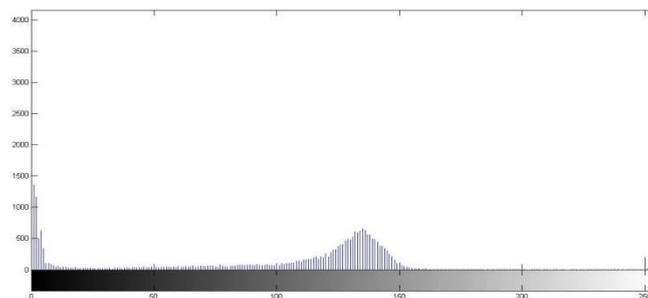


Figure-8.histogram of figure 6

1) Pre-processing:

In MRI images which the tumor is clearly seen, the doctor needs to determine the properties of the tumor. Therefore, the abnormal parts of the brain were zoning and then zoning images could be measured. In zoning image which has a prime importance, the purpose is separating brain tissue of the skull.

There are a variety of algorithms, that some of which have similar problems, and that is often standard algorithms are not enough strong in the presence of severe on-uniformity (location or intensity).

Therefore to solve this problem, an algorithm with higher power should be sought.

The idea: there are many effective algorithms for zoning images that is used for CT layers of the retina based on the graph. Now, we use this technique for zoning brain.

The technique is applicable to the following steps:

1) cuts in polar coordinates have been open.

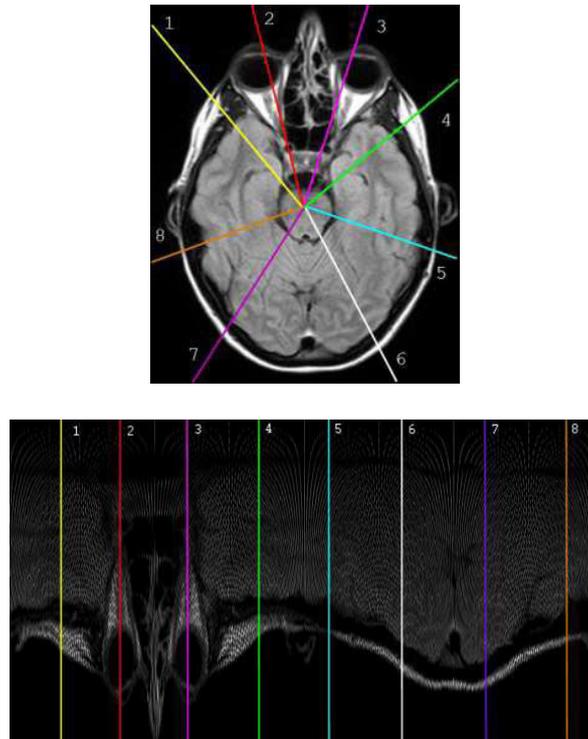


Figure 9

Implementation restrictions

(A) Border line should for all of the picture for all of the columns have to be in a same place where it can be with described the $F(x)$.

(B) there is no cut in the image and is completely continuous.

$$|f(x) - f(x + 1)| \leq 1$$

Probability of F (x) is in finite, but we are looking for the best F (x).

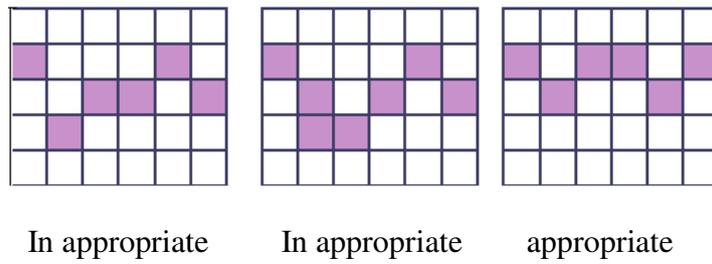
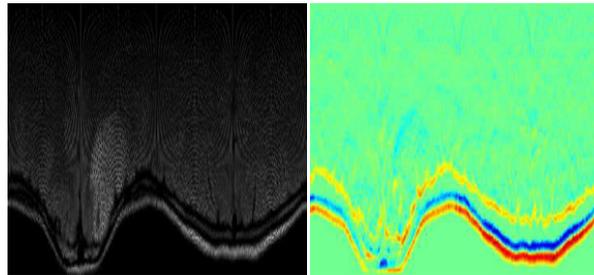


Figure 10

Now to find the best F (x) which comply with these mentioned limitations, it can be said that the best function is that minimize the cost.

At first, the used cost from the vertical gradient image is determined. C (x,y)



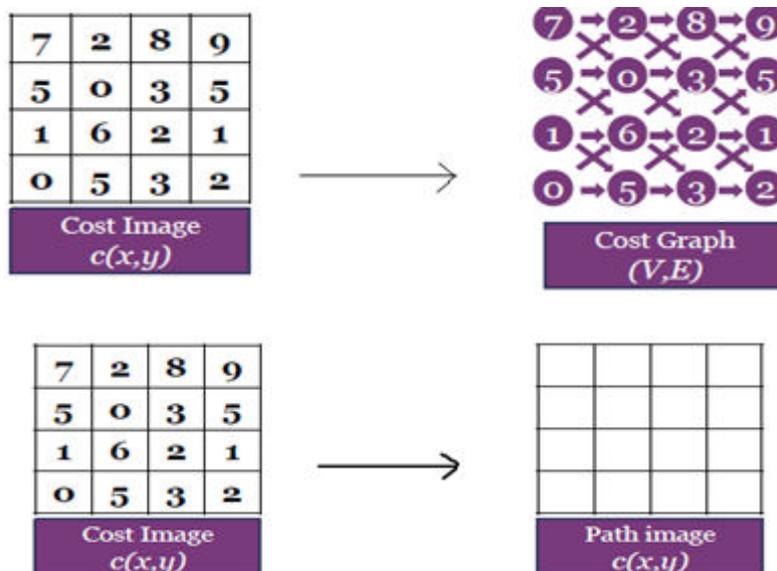
$$B_{\text{cost}} = \sum_{x=1}^N c(x, f(x))$$

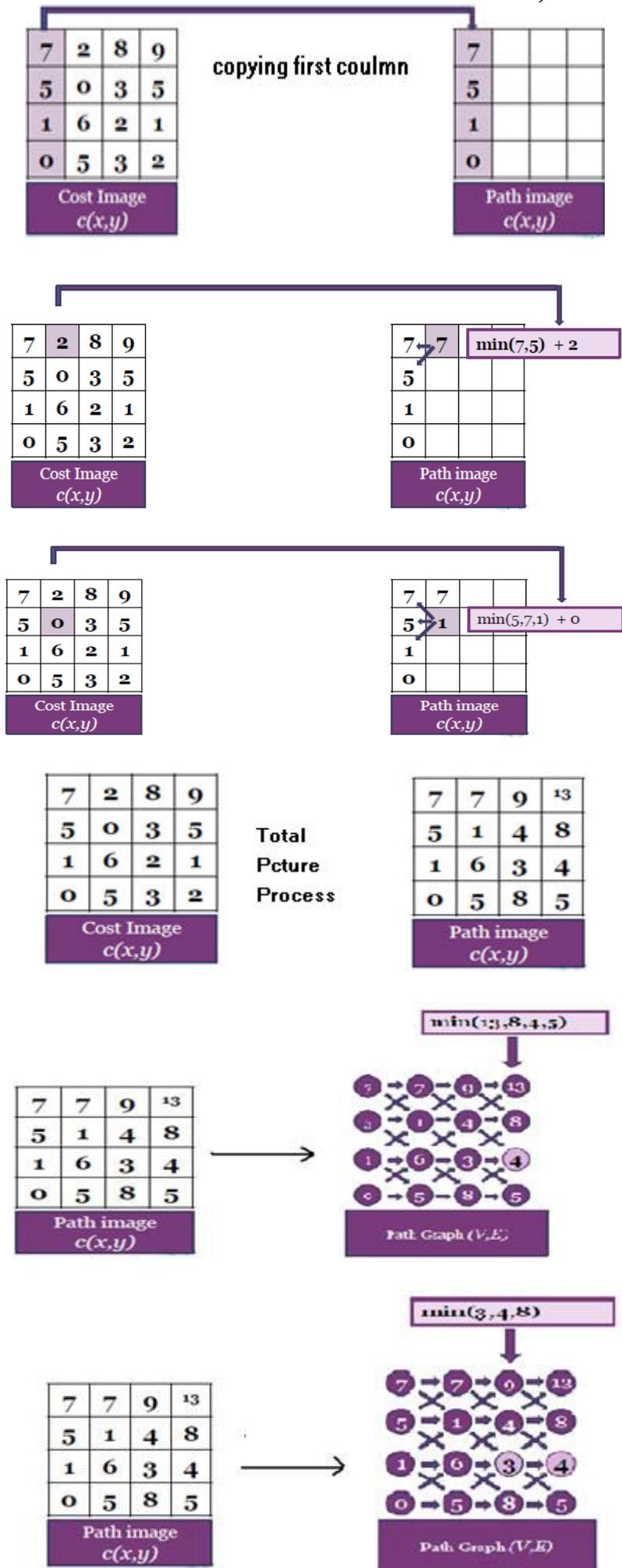
→ the cost of border

Figure 11

Now we use a graph for finding the solution.

In this graph, the pixel value in the cost image is the rate of graph nodes that show graph connections and the amount of limitations to find the boundary line. Minimize restrictions lead to searching for the minimum part in the graph, that can be found using a dynamic programming algorithm. The process described in these images is seen more clearly.





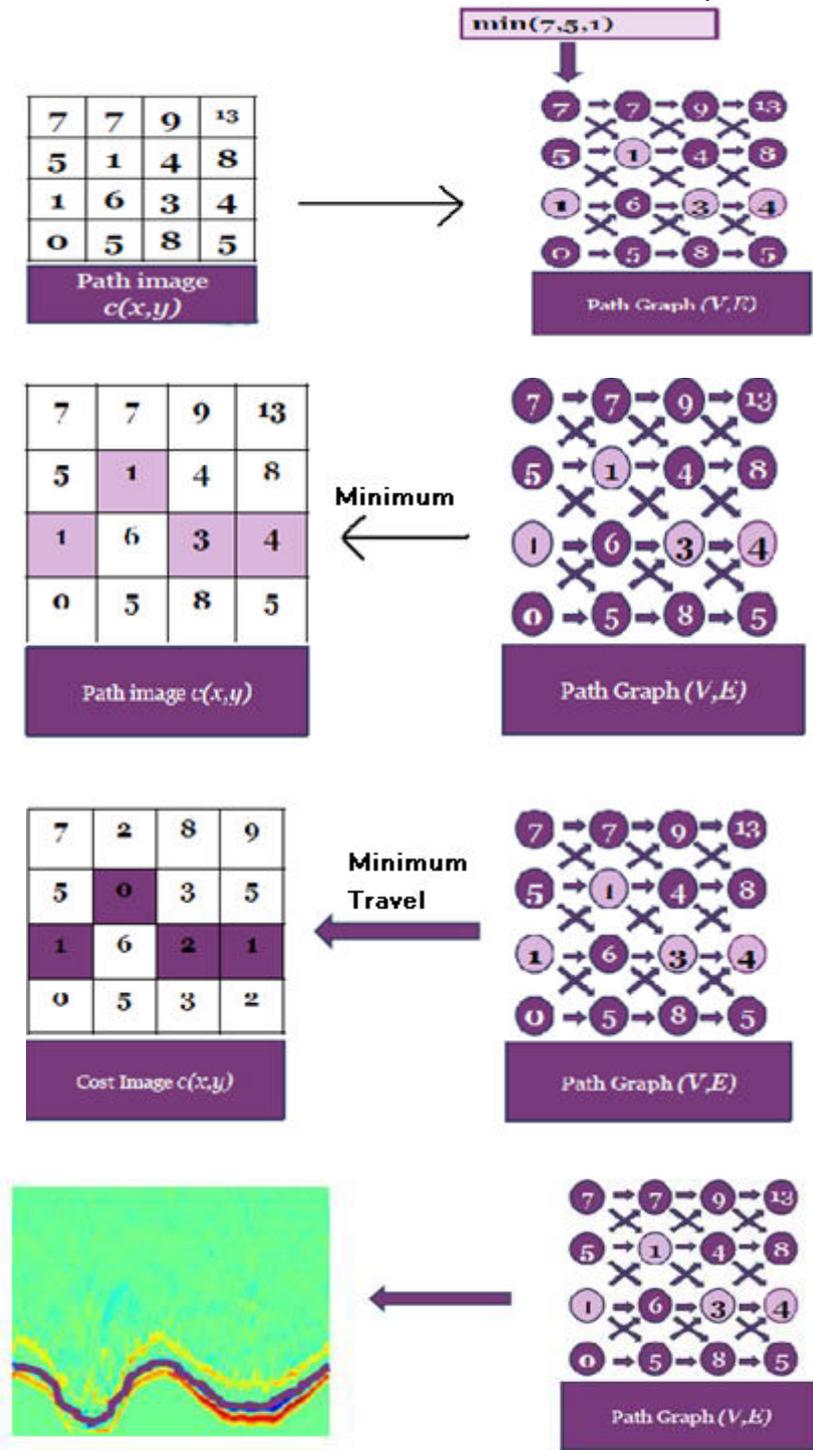


Figure 26

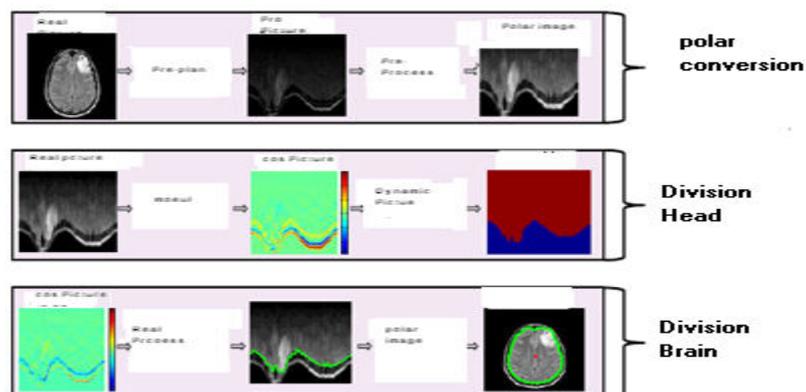


Figure 27

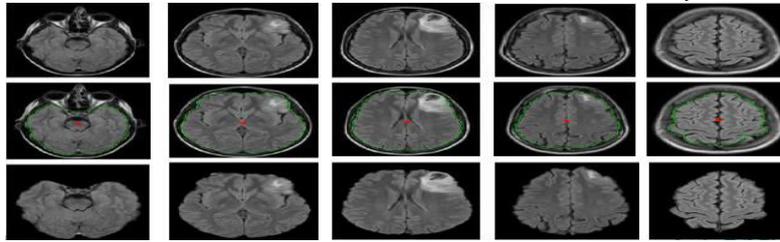
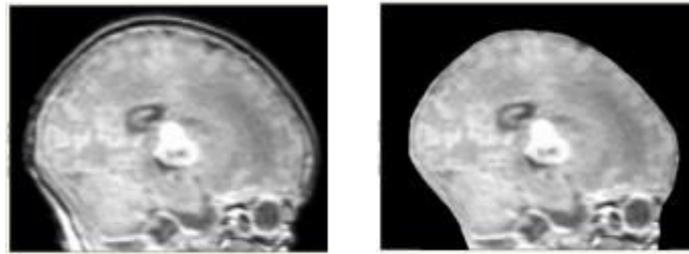


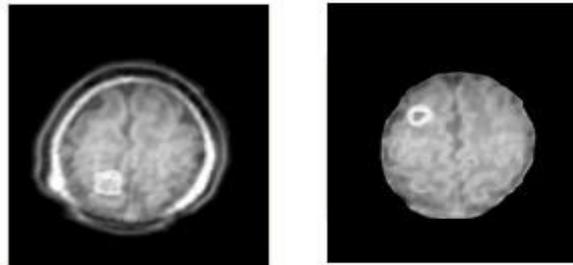
Figure 12

In Figure13, some pre-processing results of this study are shown.



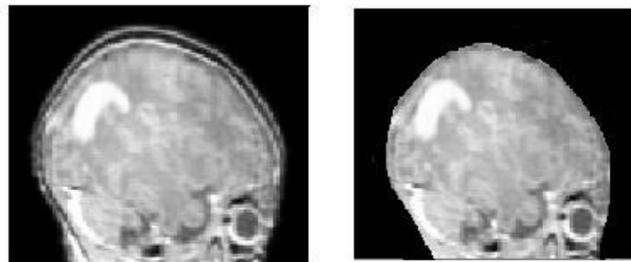
(A)

(B)



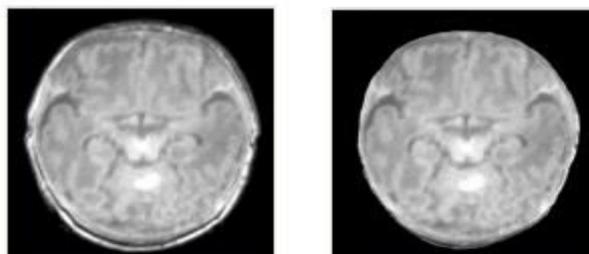
(A)

(B)



(A)

(B)



(A)

(B)

Figure-13: (A) Original image(b) pre-processed image.

2- Diagnosing tumors using histogram thresholding:

Now, after pre-processing stage and achieve the brain image without a skull, we go to diagnosis of tumor. At this point, one of the most important steps is determining level of histogram threshold, which lead to increase the accuracy of diagnosis. According to the contents presented at the beginning of this season, the gathering place of white pixels is the tumor place. Now we are considering this issue to find an algorithm to obtain the optimal threshold level and error detection into a minimum.

Before starting the process of determining the threshold level, a brief explanation is provided on the Histogram graph.

Histogram graph:

Each image is composed of many pixels which each of them has a specific intensity to itself. The intensity is variable between zero-255. Histogram diagram can be described simply in this way, if we count all pixels that the brightness of them is the number "zero", also the number of pixels that the brightness of them is "one, two and..." and drawn them as a bar graph, now we achieved a histogram. In other words, histogram graph is frequency distribution of the pixel's brightness.

In this graph, horizontal range is based on color intensity(contrast)and vertical range is based on the light intensity(intensity). Histogram graph can be used only for two-dimensional images and is none of use in three-dimensional images. In the below, a example of Histogram graph is plotted.

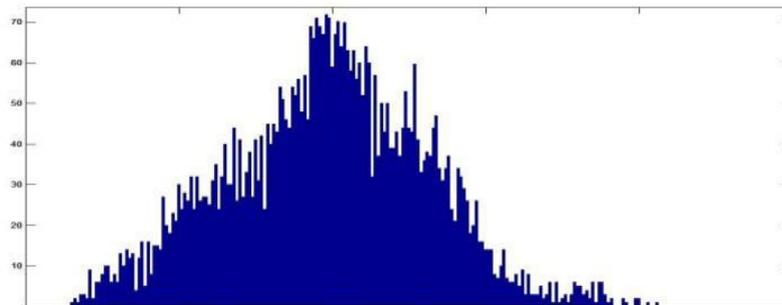


Figure-14.An example of Histogram graph.

How to reach the histogram threshold level:

At this point as a first step, the tumor exactly is distinguished by experts from other areas by red color in the training MRI images. Then Histogram graph of separated area is obtained during a program in Mat lab software which exactly is the place of tumor. In this graph, The change interval in isolated tumor is identified and recorded. This process is done for all training images that the results are as follows:

1. 288_250

2. 224_254
3. 218_250
4. 228_255
5. 220_254
6. 248_255
7. 205_255
8. 220_245
9. 220_238
10. 210_248

Now the above numbers are averaged.

The average of the above results is,223_250 that we consider the threshold level of histogram like these results.

Tumor diagnosis after finding the threshold, the desired number is known as the determinant limit and it is considered as the criterion for the diagnosis of tumor.

Thus, the range more than above mentioned level is diagnosed as a tumor.

It should be noted that in this step, the obtained value to the threshold level is performed on experimental images.

According to the above description, tumor detection algorithm can be briefly stated as follows.

Step 1: Separating the brain tissue from the skull

Step 2: Accurate separation of the tumor place from other areas by the red color manually

Step 3: Extract histogram graph for segregated places

Step 4: Obtain the average from the histogram of database training images

Step 5: Put the resulting interval as the threshold level and then extract the tumor from database training images.

Some results:

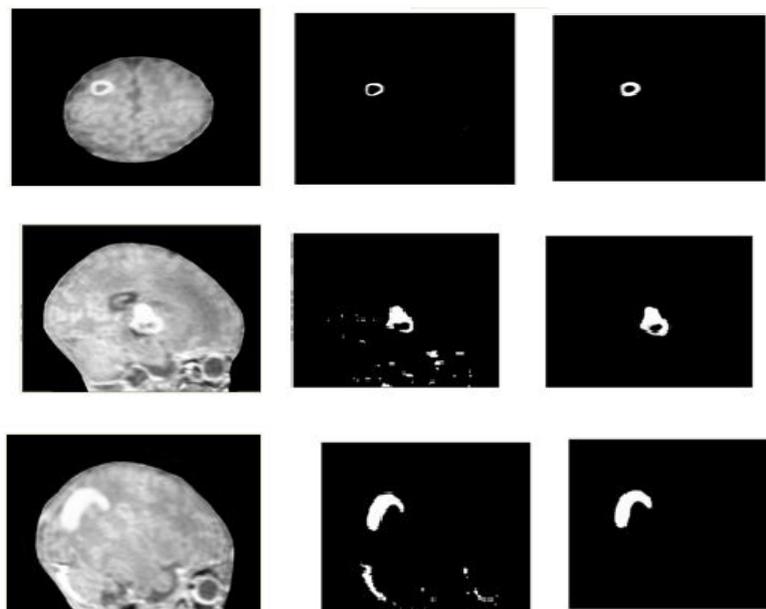


Figure15: The resultsof simulation

Conclusion

In this stage, we assess the accuracy of the process described above. The goal here is achieved comparing tumor diagnosis by a Regional expert that is separated by red color and diagnostic tumors by a computer.

In fact, each pixel of the two images is compared with each other. For example, some pixels which include the tumor area correctly have been diagnosed. Therefore, three situations may occur:

- 1) TP (True Positive) correct positive that represent pixels of tumors that are diagnosed correctly.
- 2) FP (False Positive) incorrect positive that represent pixels of tumors that are diagnosed incorrectly.
- 3) (True Negative) correct negative that represents the pixels of points without tumors that are diagnosed correctly.
- 4) (False Negative) correct negative that represents the pixels of points without tumors that are diagnosed incorrectly.

Now after the above definitions, two below method can be used in to determine the efficiency of the program.

similarity measure Method $SI = 2 * \frac{A \cap B}{A + B}$

The ratio of sharing to the community $R = \frac{A \cup B}{A \cap B}$

In which, A, B represents extracted tumor, one by the expert and the other by computer. In this study, similarity measure of SI was used for evaluating the results that the results of the proposed method are given below.

Table 1-Evaluation of the results		
The percentage of detection	Number of data	Type of data
84%	10	Training data
80.5%	23	The experimental data

References

1. The only hope, Mona. "Independently of each separate letters font type and size".Master's thesis, Department of Electrical Engineering, Sharif University of Technology, 1383.
2. Android app steady, firm. "Guide database Delete 84" (1384).
3. Called able-E. "License plate character recognition" thesis, Department of Electrical Engineering, Sharif University of Technology, 1383.
4. J Beeman. Dave. "Mululti-layer perceptrons (Feed-forward Nets), Gradient Descent, and back Propagation

..University of Colorado, 2011.

<http://ece-www.colorado.edu/ecen4831/lectures/NNet3.html>

5. J Burrow, Peter. "Arabic Handwriting Recognition" .Master of Science Thesis, school of informatics, University of Edinburgh, 2012 '

6. Gonzalez, Rafael C ", Woods, Richard E. Digital Image Processing". Second Edition, New Jersey: Prentice-Hall, 2014.

7. Johnston. Alexander. "Classifying Persian Characters with Artificial Neural Networks and inverted Complex Zernike Moments". 2005.

<http://www.doc.ic.ac.uk/teaching/projects/Distinguished05/Alaxjohnston.pdf>

8. Klassen, Tim. "Towards Neural Network Recognition of Handwritten Arabic Letters".A'project Submitted to the Faculty of Computer Science in Partial Fulfillment of the Requirements for the Degree of Master of Computer Science Dalhousie University, 2011.

9. Math works Inc. * MATLAB Help ".MATLAB Version 11.0 Documentation.

10. Sarlewarren S, 'Archive of Neural Network FAQ'. 2012 <ftp://ftp.sas.com/pub/neural/FAQ.html>

11. Dstat Soft Inc. "Neural Networks'. 2013. <http://www.statsaft.com/textbook/stneunet.html>

12. Philippides, Andy. "Multi-Layer Perceptron (MLP)".Neural Networks Lectures, 2015.