# Detection and Segmentation of Hemorrhage Stroke using Textural Analysis on Brain CT Images

**Alyaa Hussein Ali, Shahad Imad Abdulsalam, Ihssan Subhi Nema**

***Abstract*— The detection of brain strokes from Computed Tomography CT images needs convenient processing techniques starting from image enhancement to qualify the brain image by isolation process, region growing and logical operators (OR and AND). These methods with the help of the simplest segmentation process, which is the thresholding process, are used to extract a stroke region from the CT image of the brain. The median filter is applied to remove the noise from the image. The statistical features calculated using first-order histogram were utilized in the detection of the stroke region.**

***Index Terms*— Hemorrhage stroke; CT scan image; Brain segmentation; statistical features.**

## I. INTRODUCTION

Medical imaging refers to the processes and techniques that are used to produce images of various parts of the human body for clinical purposes. The quality of these images plays an important role in the medical field. The issues of medical imaging are very complicated and important to diagnose correctly for the treatments of diseases in health care systems. Hemorrhage strokes are formed by any blood loss from a vessel, where a pooling of blood outside the vessel is referred to a hematoma. Computed Tomography (CT) images are widely used to diagnose brain strokes due to wider availability, lower cost and sensitivity to early strokes. The success in the diagnosis mainly depends on the accuracy of segmentation algorithm. The used image processing algorithm and methodologies will enable an easy and faultless identification of abnormalities present in the scanned region [1]. Myat Mon Kyaw introduced an automated method for the detection and classification of an abnormality (hemorrhage) or stroke in brain CT images. The image is initially pre-processed to remove film artifacts and skull region. The image is subdivided into four regions to find the region that has the possibility of including abnormal areas. Thus, there is no need to search and segment unnecessary regions [1]. A method for automatic classification of Computed Tomography (CT) brain images of different types of head trauma was presented by Tianxia Gonget. al. This method proposed pre-segmentation steps for the detection of abnormal regions in the brain image. Then, abnormalities can be segmented by grouping homogeneous regions according to the predefined criteria. The images are first segmented to find potential hemorrhage regions using ellipse fitting, background removal and wavelet decomposition technique. For each region, features such as area, major axis length, etc. are extracted, and each extracted feature is classified using machine learning algorithm. The images are then classified based on their component regions' classification [2]. MayankChawlaet. al.. Presented an automated method to detect and classify an abnormality into acute infarct, chronic infarct and hemorrhage at the slice level of non-contrast CT images. The proposed method consists of three main steps: image enhancement, detection of mid-line symmetry and classification of abnormal slices. A windowing operation is performed on the intensity distribution to enhance the region of interest. Domain knowledge about the anatomical structure of the skull and the brain is used to detect abnormalities in a rotation- and translation-invariant manner. A two-level classification scheme is used to detect abnormalities using features derived in the intensity and the wavelet domain [3]. This paper is concerned with brain strokes and investigates proposed image processing techniques to improve the detection of such strokes. The adopted procedure is illustrated in the flow chart shown in figure 1. The following sections explain the various parts of the proposed method of stroke detection.

## II. PREPROCESSING

CT images need preprocessing operations because of unorganized nature of the brain tissue that is why we applying method for the diagnosis of the infraction.

### 2.1 Gray image

The images received from CT scans are usually colored by RGB (red, green and blue) components. However, they are converted into gray-scale images by eliminating brightness information, thus converting the image format from 512×512×3 color RGB to 512×512 gray-image [4] as shown in figure (2-b). This image was obtained from CT scanning of the head of a patient suffering from brain stroke.

### 2.2 Skull removal (Brain Insulation)

The removal of the bony skull surrounding the brain tissue is considered as a challenge to the brain isolation. This process will allow us to extend the segmentation of the stroke. The following methods and mathematical operations are used to perform the skull removal.

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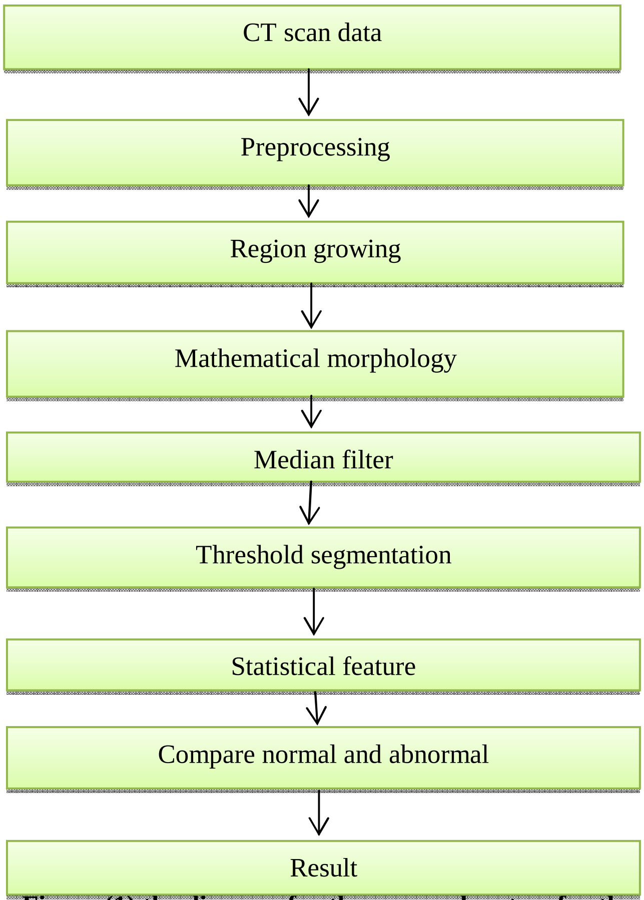


**Figure (1) the diagram for the assumed system for the detection of strokes from CT brain images.**

### 2.2.1 Region Growing

The region growing is a step that groups the pixels or sub-regions into larger regions based on a predefined criteria for growth. A "Region" forms pixels growing with the same intensity level which is used to calculate the area of white mater for the skull as shown in figure (2-c) [5].

### 2.2.2 Image Masking

To remove the cortex, the logical operator (OR) is applied. This makes the region of study black while the background is converted into white as shown in figure (2-e). We have also used the AND operator which transforms the regain of study into white and background into black as shown in figure (2-d). These two operators were used to extract the brain tissue as can be seen in figure (2-f).

### 2.2.3 Filtering

The resulting image needs a filtering operation so a median filter of window [3X3] was applied on the image for three successive times to remove the noise in the CT image. Smother images were obtained as can be clearly seen in figures (2-g, 2-h, and 2-i).

## III. Thresholding

The thresholding technique is the simplest method used in the segmentation process. The process collects all the pixels with a certain threshold and rejects other pixels which have values less than the threshold. After the thresholding procedure is applied the stroke region will be isolated from the brain tissue. The stroke region will be more clearly visible in the output image.

### 3.1 Hemorrhage stroke

To obtain an image showing the hemorrhage stroke the threshold method was applied on the image and the obtained result is shown in Fig. (2-j).

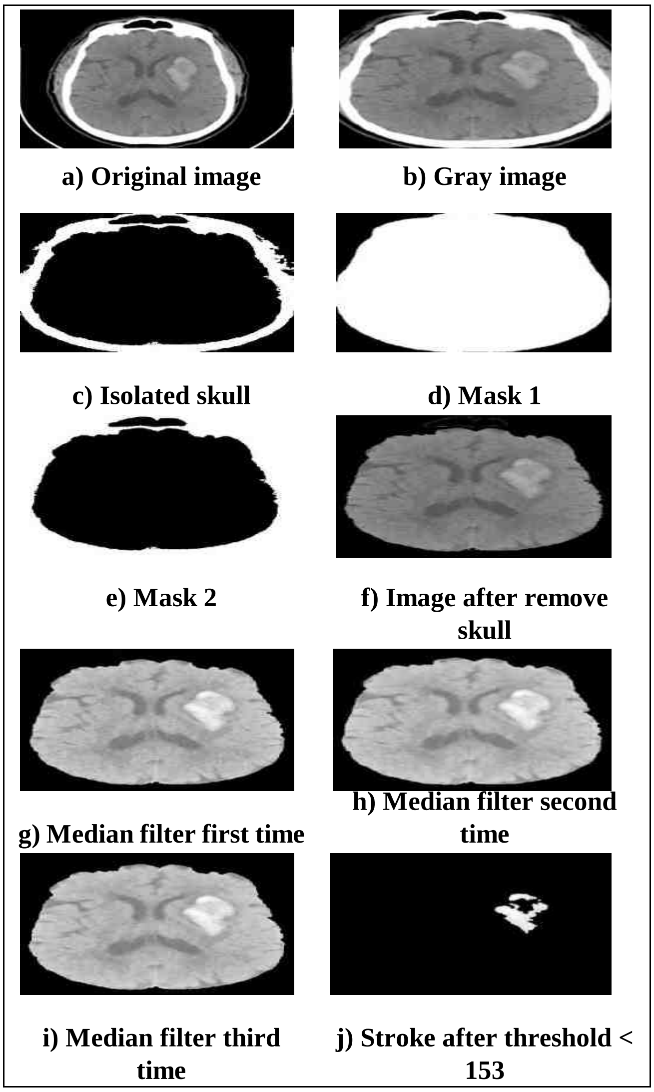


**Figure (2) Images obtained from the preprocessing and thresholding processes**

## IV. Methodology

The brain image has been divided into two equal parts one of these parts includes abnormal area and the other one contains the normal area. The statistical features were then calculated from the first-order histogram. Comparisons were made between the histograms of the two parts to check which part carries the stroke.

### 4.1 First-Order Histogram features

The random variable *i* represents the gray levels of the image region. The first-order histogram p (*i*) is defined as:

$$p(i) = \frac{\text{number of pixels with gray level } i}{\text{total number of pixel in the region}} \qquad (1)$$

P (*i*) = H (*i*)/NM
P (*i*) = is the probability of occurrence of the *i*.
Where *i*=0, 1, 2………G-1



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G= gray level tone of an image (255), N= number of cells in the horizontal domain.
M= number of cells in the vertical domain.

Mean: $\mu = \sum_{i=1}^{G-1} ip(i)$ (2)

Standard deviation: $\sigma = \sqrt{\sum_{i=0}^{G-1} (i-\mu)^2 \, p(i)}$ (3)

Energy: $E = \sum_{i-1}^{G-1} (p(i))^2$ (4)

Entropy: $H = - \sum_{i=1}^{G-1} p(i) log2 \, [p(i)]$ (5)

Variance: $\sigma^2 = \sum_{i=1}^{G-1} (i-\mu)^2 p(i)$ (6)

Skewness: $skew = \sigma^{-3} \sum_{i=1}^{G-1} (i-\mu)^3 \, p(i)$ (7)

Kurtosis: $kurt = \sigma^{-}4 \sum_{i-1}^{G-1} (i-\mu)^4 \, p(i)$ (8)

The first order histogram represents the estimation of the probability density function (PDF) for the selected neighborhood [6]. The result as the mean value which represents the white color in the image. The higher mean gives indication that there is an abnormal part in the brain. So we can see the mean value is higher for the abnormal part compared with normal part. The energy gives an indication about the number of gray-level in the image. When its value is low this mean that there is a defect in our study area i.e. there is a low number of gray levels and the study area is not homogenous. Since the entropy is inversely proportional to the energy, then its value behaves in opposite way, the higher the entropy means un-homogenous texture i.e. there is a defect in the texture. The skewness represents the symmetry of a texture around the mean so the abnormal part its value has more symmetry than normal part. The kurtosis is the parameter that depicts the shape of histogram. The variance and standard deviation are higher for abnormal parts because indication of intensity variance and variation respectively around the mean as shown in table (1) and figure (3).

**Table (1) texture features for the normal and abnormal parts**

| Image | Normal | Abnormal |
|---|---|---|
| mean | 113.0861 | 119.9361 |
| Energy | 0.1092 | 0.1000 |
| Entropy | 0.4455 | 0.4787 |
| Variance | 9.8694e+003 | 1.0579e+004 |
| Standard deviation | 99.34485 | 102.85426 |
| skewness | 1.3225e-006 | 1.1687e-006 |
| kurtosis | 1.3400e-01 | 1.1048e-01 |

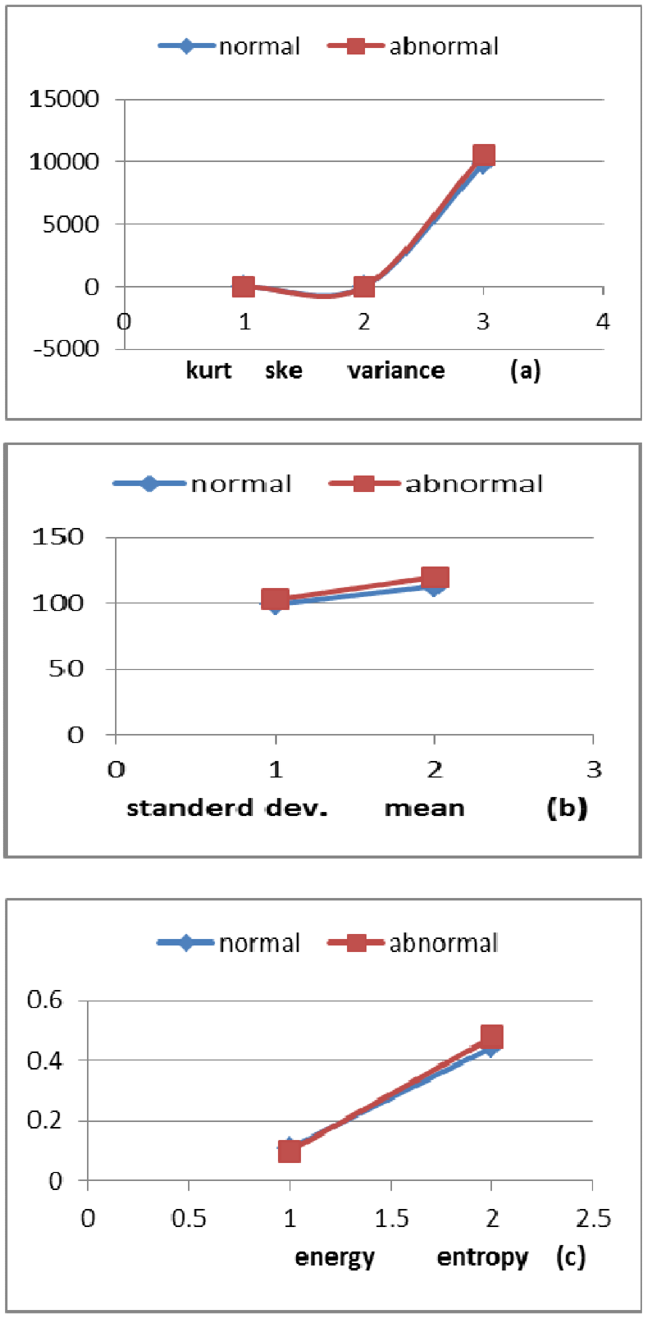


**Figure (4) the graphs of the statistical features (a, b, c)**

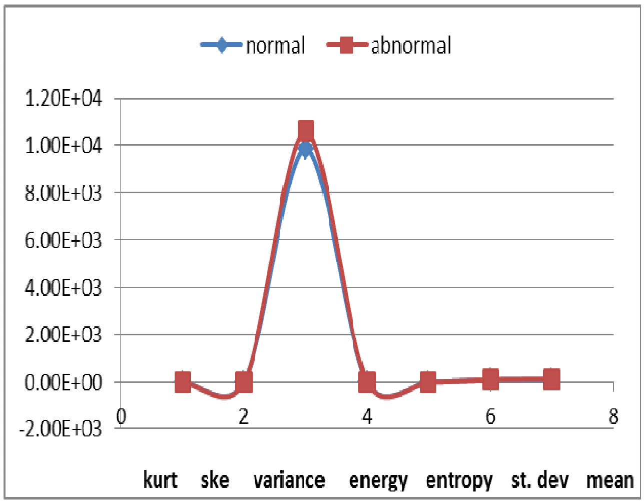


**Figure (5) the statistical features for normal and abnormal parts**



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## V. CONCLUSION

The pre-processing methods are important to make the segmentation easier and faster than the familiar process. Features are used to compare between the normal and abnormal parts of the brain. Different pre-processing methods have been used to improve the abnormal part in the statistical features which were obtained from the first-order histogram gave information about the two image halves. From figure (4) and table (1) the statistical features show higher value for the entropy. Since it represented the randomness in the image and it is inversely proportional to the energy so the energy value for the abnormal part is lower than that of the normal part this means that the number of gray-level value is higher than the normal part, because appearance of stroke in this part. Skewness and kurtosis show a higher value for the normal part. The mean value are higher for abnormal part since the stroke appears more white than the normal brain tissue and the mean represented the brightness part in the image. This method gives good result about the detection and segmentation of brain stroke with the help of the statistical features.

## REFERENCES


[1] M. M. Kyaw, "Computer-Aided Detection system for Hemorrhage contained region", International Journal of Computational Science and Information Technology, Vol. 1, February 2013, No. 1, PP. 11-16.

[2] T. Gong, "Classification of CT Brain Images of Head Trauma", Springer-Verlag Berlin Heidelberg, 2007, PP. 401-408,.

[3] M. Chawla, "A method for automatic detection and classification of stroke from brain CT images", 31st Annual International Conference of the IEEE EMBS, Minneapolis, Minnesota, USA, September 2009.

[4] V. Nagalkar and S. Agrawal, "Ischemic Stroke Detection Using Digital Image Processing by Fuzzy Methods", International Journal of Latest Research in Science and Technology, Vol. 1, November-December 2012, PP. 345-347,

[5] O.E. Ramos and B. Rezaei, "Scene Segmentation and Interpretation Image Segmentation using Region Growing", MSc, Thesis, Computer Vision and Robotics, Universitat de Girona, 2010.

[6] N. Aggarwal and R.K. Agrawal ," First and Second Order Statistics Features for Classification of Magnetic Resonance Brain Images", Journal of Signal and Information Processing, Vol. 3, 2012, PP. 146-153.



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