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Characterization of Hemorrhagic Stroke in CT Image using Texture Analysis Technique

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Abstract:

Clinical images, such as CT images, are still assessed manually. This is to ensure that as few mistakes as possible are made, because any mistake could have serious consequences for the patient, if the image is taken as an aid to treatment or therapy.The aim of this study was to characterize and identify Hemorrhagic Stroke using classification technique depending on the disparity of grey level in CT image.

The study consisted of 100 patients with Hemorrhagic stroke; CT brain examination was performed with multidetector helical CT system. the image were read by IDL in TIFF format and the user clicks on areas represents the grey matter, white matter, CSF and hemorrhagic stroke area in case of test group; in these areas a window 3×3 pixel were generated and textural feature for the classes center were generated. These textural features include First order statistics; (coefficient of variation, stander deviation, variance, signal, energy, and entropy).These features were assigned as classification center using the Euclidian distances to classify the whole image.The result of the study showed that classification Map that created using linear discriminant analysis functions where the three different tissue classes of brain gray and white matter, CSF and hemorrhagic area were clearly separated according to calculated texture at $P<0.05$, and CL=95%.The result also showed that the result of the classification of the hemorrhagic tissues were verydifferent from result of the tissues with classification accuracy of 97.2 %, sensitivity 99.1 % and specificity 96.3 %.

Texture analysis depending on the relative attenuation coefficient of tissues i.e. the CT No in HU could serves the diagnostic field and overcoming the visual diagnosis that comes with different interpretation and also would have promising future to avoid invasive technique if the base line for individual tissues being determined and algorithmic aided computer have been applied.

Keywords:*CT, Hemorrhagic stroke, Texture analysis*

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I. Introduction

Medical images, such as CT images, are still assessedmanually. This is to ensure that as few mistakes aspossible are made, because any mistake could haveserious consequences for the patient, if the image istaken as an aid to treatment or therapy(Cheikh et al.). Computer Aided Diagnosis (CAD) would be of great help to radiologistsand medical doctors, as they have very many imagesto assess each day. However, results of this automatedanalysis are not yet adequate for clinical use.Relatively little effort has been expended in imageanalysis of medical images(Esgiar et al., 1999). Some initial studies on asmall number of images have been carried out. Thiswork has been preceded by some other researchusing texture analysis to classify sets of medicalimages into either healthy or abnormal regions(Freeborough and Fox, 1998, Herlidou et al., 2001).

Computed tomography (CT) of the brain is an established imaging technique that combines x-rays with computer technology. X-ray beams from a variety of angles are used to create a series of detailed cross-sectional images of the brain. Hypertension, aneurysm and vascular malformations account for 80% of intracerebral hemorrhages. All cerebral hematomas, whatever the cause, have a similar resolution pattern on CT. The rate of resolution depends on the size of the hematoma, usually within one to six weeks, and resorbs from outside towards the center. Perihematoma low density (edema) appears in 24-48 hours(Bozzao et al., 1991). Computed Tomography images can be distinguished for different tissues according to their different gray levels. Theimages, if processed appropriately can offer a wealth of information which is significant to assist doctors in medicaldiagnosis. A lot of research efforts have been directed towards the field of medical image analysis with the aim to assist in diagnosis and clinical studies (Duncan and Ayache). Pathologies are clearly identified using automated CAD system (Tourassi, 1999). It also helps the radiologist in analyzing the digital images to bring out the possible outcomes of the diseases.Advantages of using CT include good detection of calcification, hemorrhage and bony detail plus lower cost, short imaging times and widespread availability. The situations include patient who are too large for MRI scanner, claustrophobic patients, patients with metallic or electrical implant and patients unable to remain motionless for the duration of the examination due to age, pain or medical condition(Padma and Sukanesh, 2011).

Texture analysis utilizes effective classification algorithms to qualify and extract the information not normally detected by the human eye. Different valuable parameters have been considered for accurate qualitative characterization of Hemorrhagic Stroke such as: texture features, grey scale, fractal dimension estimators or shape descriptors, combined with a classifier. Therefore the main objective of this study was to characterize and identify Hemorrhagic Stroke using classification technique depending on the disparity of grey level in CT image.

II. Materials And Method:

The study consisted of 100 patients with Hemorrhagic stroke; CT brain examination was performed with multidetector helical CT system to carry out the required images and the data as intensities in Hounsfield Unit (HU) for the Hemorrhagic zone. CT imageswere stored in computer disk and viewed by DICOM viewer to select the axial images that suit the criteria of research population, then uploaded into the computer based software Interactive Data Language (IDL) where the DICOMimage converted to TIFFformat to suit IDL platform. Then the image were read by IDL in TIFF format and the user clicks on areas represents the grey matter, white matter, CSF and hemorrhagic stroke area in case of test group; in these areas a window 3×3 pixel were generated and textural feature for the classes center were generated. These textural features include First order statistics; (coefficient of variation, stander deviation, variance, signal, energy, and entropy).These features were assigned as classification center using the Euclidian distances to classify the whole image. The algorithm scans the whole image using a window; 3×3 pixels and computes the above mentioned textural features and then computes the distance (the Euclidean distance) between the calculated features during the scanning and the class's centers and assigns the window to the class with the lowest distance. Then the window interlaced one pixel and the same processes started over again till the entire image were classified and classification maps were generated. After all images were classified the data concerning the brain tissues (CSF, grey, and white matter)and hemorrhage entered into SPSS with its classes to generate a classification score using stepwise linear discriminate analysis; to select the most discriminate features that can be used in the classification ofbrain tissues in CT images. Where scatter plot using discriminate function were generated as well as classification accuracy and linear discriminate function equations to classify thebrain tissuesinto the previous classes without segmentation process for unseen images in routine work. The delineation of brain stroke area done by furthers processing of the classification using region label function to segment the brain stroke from the other classes and convert the segmented brain stroke from classification map with pseudo-color to binary image to extract (segment) the brain stroke area from the whole original image. Then by applying Sobel function the outline of the binary image was generated and the spatial location of the pixels was used to delineate the brain stroke on the original image using read line.

III. Results

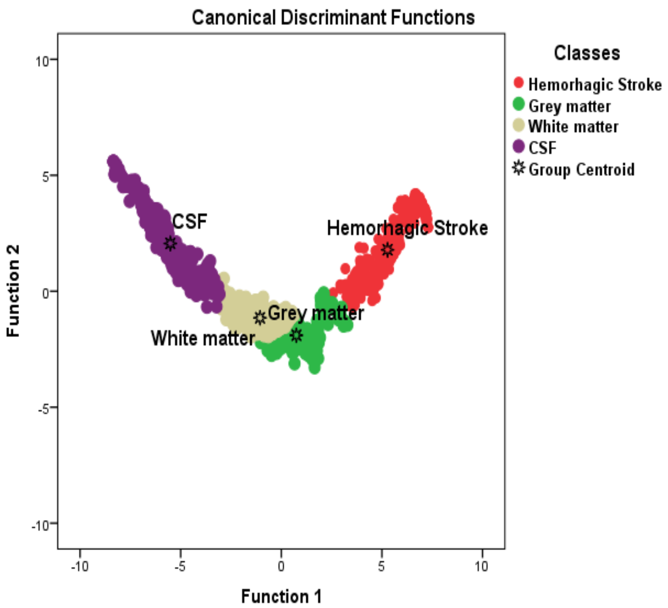

Figure 1: classification Map that created using linear discriminant analysis function.

Table 1: Cross-tabulation table show the classification results tissues using linear discriminate analysis on CT images.

Classes		Predicted Group Membership				Total
		Hemorrhagic Stroke	Grey matter	White matter	CSF	
original group %	Hemorrhagic Stroke	**99.1**	0.9	0.0	0.0	100.0
	Grey matter	0.0	**95.8**	4.2	0.0	100.0
	White matter	0.0	0.9	**99.1**	0.0	100.0
	CSF	0.0	0.0	6.0	**94.0**	100.0

- 97.2% of original grouped cases correctly classified.
- Accuracy = 97.2%, sensitivity = 99.1% and specificity = 96.3%

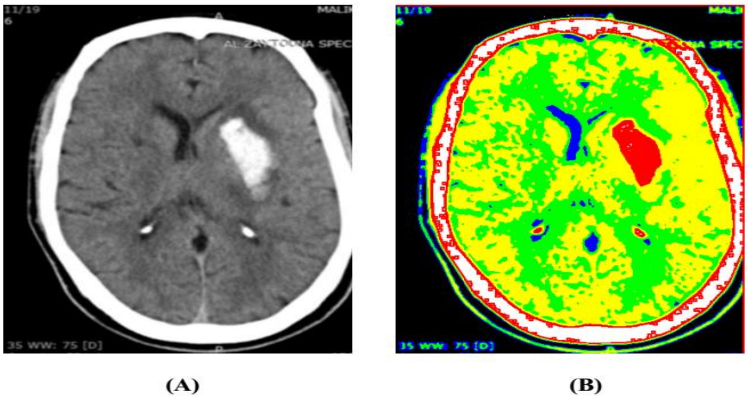

Figure 2: (A) The original CT image with hemorrhagic stroke, (B) Classification map based on intensity of brain tissue

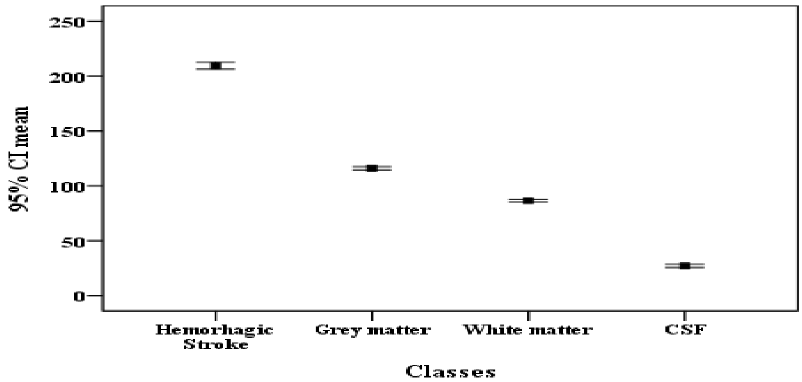

Figure 3 Error bar plot show the discriminate power of the mean textural feature distribution for the selected classes on CT images.

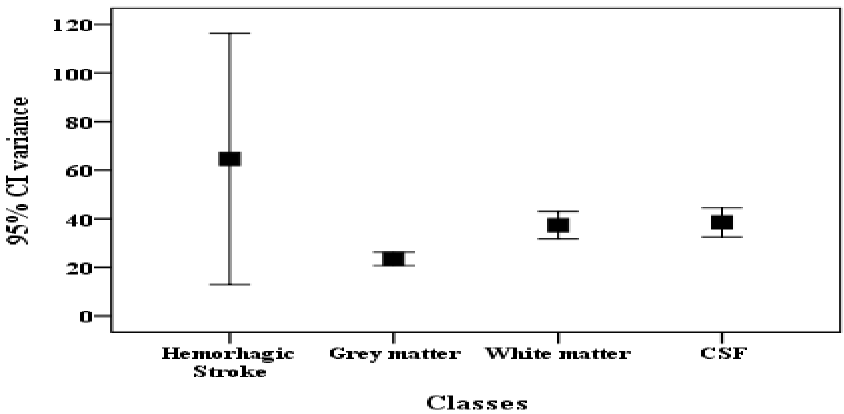

Figure 4 Simple error bar graph showed the classification based on variance from the first order statistics.

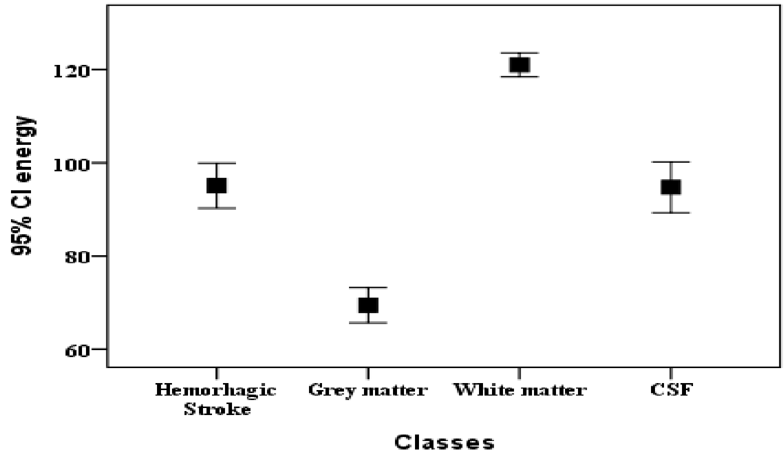

Figure 5 Simple error bar graph showed the classification based on energy from the first order statistics.

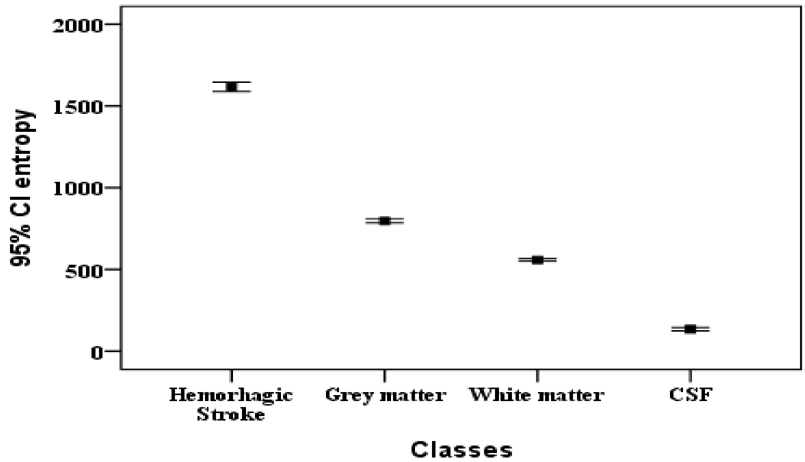

Figure 6 Simple error bar graph showed the classification based on entropy from the first order statistics.

IV. Discussion

CT scan obtained from imaging sequences which aim to differentiate between different brain tissues according to its intensities, this study was conducted using axial CT image to characterize the hemorrhagic area. As shown in Figure 1, the classification Map that created using linear discriminant analysis functions where the three different tissue classes of brain gray and white matter, CSF and hemorrhagic area were clearly separated according to calculated texture at P<0.05, and CL=95%.Table (1): Showed the classification accuracy result using linear discriminant function, in which 97.2% of original grouped cases correctly classified for 3x3 window generated using step-wise technique to select the most significant features that can be used for purpose of hemorrhage characterization which are: mean, variance, energy and entropy from first order statistics.The result also showed that the result of the classification of the hemorrhagic tissues were verydifferent from result of the tissues with classification accuracy of 97.2 %, sensitivity 99.1 % and specificity 96.3 %. Although by definition, visual analysis of the CT image appears with hemorrhagic changes, the texture parameter maps shown in figure 2 validate the fact that there are indeed subtle differences, but that these differences surface only upon numerical processing of the images. These maps were obtained by selecting a small neighborhood around each image pixel, computing the texture parameter for that neighborhood, and then attributing the value of this parameter to the pixel. This was done for all brain pixels and not just in the region of interest. Nevertheless, these maps give an idea about the texture variation in the brain, and they “visually” show that there are, indeed, texture differences of the hemorrhagic change and extension over the brain tissue. In respect to the applied features the mean, SD, energy and entropy on CTimages can differentiate between hemorrhagic and rest of the tissue successfully and the best feature isthe mean followed by entropy then SD and the least isenergy.Texture analysis depending on the relative attenuation coefficient of tissues i.e. the CT No in HU could serves the diagnostic field and overcoming the visual diagnosis that comes with different interpretation and also would havepromising future to avoid invasive technique if the base linefor individual tissues being determined and algorithmic aidedcomputer have been applied.

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