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# A Survey on Neural Network Based Classification & Diagnosis of Brain Hemorrhages

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**ABSTRACT**:

**The fundamental motivation behind this study is to identify the brain hemorrhage prior, so that the death rate because of brain hemorrhage can be diminished. The paper incorporates the structure of the neuron and additionally how the CAD framework is used in diagnosis and classification of the brain hemorrhages. Likewise the general pattern recognition and pattern recognition with the use of CAD system is condensed. The stages to recognize the abnormalities of the brain using Computed Tomography(CT) along with the Region Severance Algorithm is portrayed.**

**Keywords: Neural network, CAD systems, pattern recognition, Computed Tomography, Feature extraction, Image Segmentation**

## I. INTRODUCTION

The human brain is the most complex among all the human organs of the human body. Brain hemorrhage is a type of a stroke which is caused by an artery in the brain bursting and causing bleeding in the surrounded tissues. The known factors of cause of brain hemorrhages are Smoking, High blood pressure, alcohol usage etc, while heredity is also a major factor in causing brain hemorrhage. More than 80% of people are suffering because they born with weak spots in their major brain arteries. Spontaneous brain hemorrhage occurs about 10% of all strokes and is fatal in about 50% of the cases[1][4]. Hypertension occurs for nearly half of these hemorrhages, the remaining are as a result of aneurysms and vascular malformations, tumors, inflammatory etc. In some patients no cause is ever discovered. Hypertensive brain hemorrhage appears in the deep grey nuclei of the hemispheres, the cerebellum, and results in specific clinical syndromes depending on the location[1].

However according to medical specialists earlier diagnosis of the condition and obtaining immediate and relevant treatment may be a lifesaver for those affected patients. The main techniques and tools which are used to diagnose this disease is the human brain Computed Tomography [CT] image obtained from the CT scan and an expert such as an experienced doctor who will be able to pull out the important symptoms of the disease from the image by naked eye[1].

### *A. Image Segmentation*

Image segmentation is an essential method for most medical image analysis tasks. And segmentation is an important process to extract information from complex medical images. Segmentation has wide range application in medical field. By having good segmentations clinicians and patients as they provide vital information for 3-D visualization, surgical planning and early recognition of disease [1].

### *B. Reason to use Neural Networks*

An Artificial Neural Network (ANN) is a mathematical structure which contains interconnected artificial neurons that copies the way a biological neural network or brain works. An ANN has the capability to learn from data and that data can be used in tasks such as regression, classification, clustering and many other. Artificial neural networks (ANN) have been created as generalizations of mathematical models of biological nervous systems. One type of network sees the nodes as 'artificial neurons'. An artificial neuron is a computational model inspired in the natural neurons. Natural neurons get signals through synapses located on the dendrites or membrane of the neuron. And when the signals received are sufficiently strong, the neuron is activated and send out a signal though the axon[1]. This signal might be sent to another synapse, and possibly will activate other neurons.

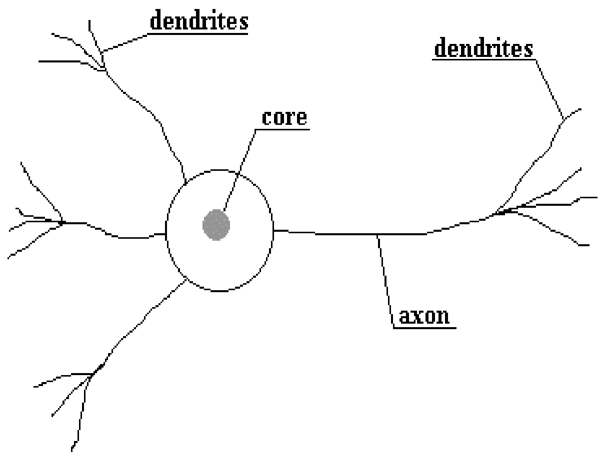


**Figure 1. Structure of Neuron**

## II. CAD SYSTEMS

### *A. Pattern recognition using CAD systems*

Generally radiologists carefully inspect medical images, and diagnose a patient's disease by procuring useful information and interpreting medical images with their experience, knowledge, and wisdom. For the intention of attaining a correct diagnosis, radiologists have to learn and archive a huge number of cases with various types of diseases in their own mind according to their specialty. A good radiologist does not require to have a particularly good eye, but the sensible ability to identify precisely what he or she is looking at when looking at medical images. As CAD systems provide radiologists with a "second opinion" for assisting them in the diagnosis of patients' diseases, it says the CAD system to have similar capabilities as the radiologists in terms of learning and pattern recognition, even though good CAD systems cannot achieve radiologists' high diagnostic capabilities. Consequently, machine learning and pattern recognition techniques are substantially important in developing CAD systems[2]. Pattern recognition is the act of extracting features from some objects in raw data and making a decision based on the classifier output such as classifying each object into one of the possible categories of various patterns [5].

In general, there are two types of CAD systems. One CAD system is for classifying all candidates into abnormal and normal candidates such as intracranial aneurysms or white matter hyper intensities in MR images, like two-class categorization system. The other is a CAD system for classification of unknown cases into several types of abnormalities, which are more than two, *i.e.*, multi-class categorization system. For example, one CAD system would be for the classification of brain tumors into high grade glioma, low grade glioma, malignant lymphoma, metastatic brain tumor, *etc*. Figure 2 and 3 show the difference between a general pattern recognition system and a CAD system.

Basically, both systems involves preprocessing and feature extraction along with classification. Though, there is one difference between these two systems. The CAD systems would advise a "second opinion" to radiologists, not an output "decision," which should be made by the radiologists using the CAD systems. Nevertheless, algorithms of major CAD systems have been developed by using techniques and theories developed in the pattern recognition field, and hence we believe that a computer-aided diagnosis is academically included as one of the pattern recognition fields. The techniques of the CAD systems on preprocessing and feature extraction, and classification are described in the subsequent sections.

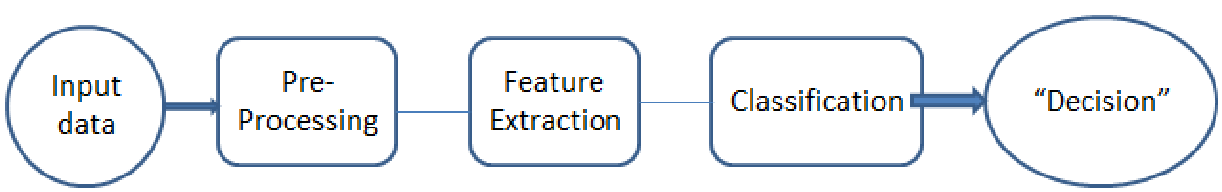


**Figure 2. A general pattern recognition system[2]**

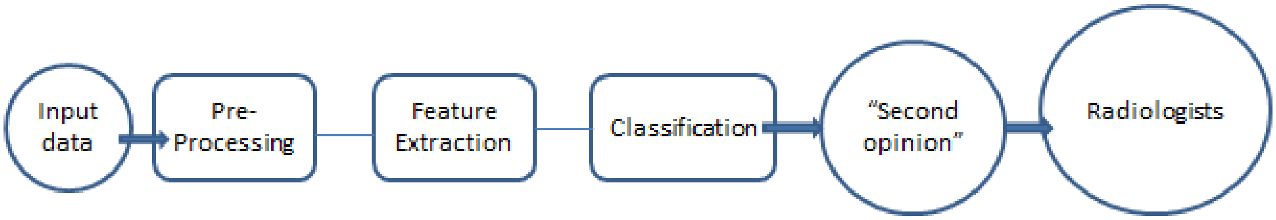


**Figure 3. A computer aided diagnosis system[2]**

*B. Preprocessing in CAD*

Preprocessing of images is essential for reducing the complexity and computation time of the CAD algorithms. Since the image quality of the MR images depends on patients and/or MR imaging sequences, there is much variation in the pixel value range, noise level, and background level. Thus, the normalization of pixel values, some smoothing filters for lowering noise, background correction, *etc.*, should be performed prior to input into the feature extraction. For instance, in accurate segmentation of anatomical regions such as white matter and gray matter regions, the edge preserving smoothing (EPS) filters would be useful for preserving the boundary contrast between anatomical regions as well as for reducing the noise.

As for another important preprocessing, the region of interest (ROI) for searching abnormalities should be segmented for reducing the computation time, considering anatomical regions, where abnormalities could be located. For instance, a search region was determined by dilation of major vessels in a CAD system for detection of aneurysms in MRA [6]. In a CAD system for detection of white matter hyper intensities or MS lesions in MR images, the brain regions were segmented by means of search regions by using basic statistical quantities of tissue peaks in a pixel-value histogram in the original MR images. Also, the spatial position corrections for the head displacement and inclination are important for determination of a reference point or an origin in each patient.

*C. Feature extraction*

The feature extraction is one of the main steps for CAD systems, but there is no "royal road" to extracting features in the CAD field as well as the pattern recognition field. That is because each method for feature extraction depends on each object (lesion) in each medical image. Consequently, a number of feature extraction methods have been developed for specific lesions. Figure 4 shows a scheme of feature extraction in a CAD system.

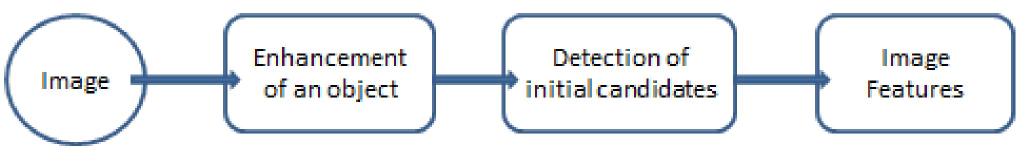


**Figure 4. Feature Extraction**

## II. PROCEDURE TO FOLLOW IN CT SCAN

The present computer based Brain Hemorrhage Diagnostic Tool is built upon a fundamental aspect of 'Automation' in medical diagnostic activity research. A possible consensus reached between the medical diagnostic experts researchers working in the fields of medical diagnosis and the computer professionals, the drive is bound to evolve an automated, time saving economical method of hemorrhage diagnosis , which is free from any risk, further, the process represents a non-invasive diagnostic tool for the detection of brain Hemorrhage. During the processing of automation of CT scan, several procedures are adopted on the essential image, viz., the skull removal, gray matter removal, horns detection, hemorrhage detection etc. Images, the whole gamut of heuristic divisions are divided such that hemorrhage can be easily determined whether hemorrhage occurred and if so, how to locate it. This feature of localization of hemorrhage consists one of the important features which are given as input component of information to the 'perception' process.

An overview of the PC based automated Brain Hemorrhage Diagnostic method presented in block diagram shown in figure 5 gives how the classification of image can be done.

According to the figure 5 set of images are taken and in that vital and outmoded are separated. The vital images are considered and location and shape of hemorrhage is identified, with the shape of hemorrhage we define the type of hemorrhages which was discussed in third phase.

The whole Methodology is divided into three phases.

**Phase1: Fixing the number of required images**

The first phase is image processing which directs to abstract characteristics from the normal or a typical structure. The intention of pre-processing is to mend the eminence of the information through the application of methods which can suppress the noise, and modulate the edges of image structures and distinction. Detection and diagnosis of Brain Hemorrhages, is one of the emerging fields of technologies involving complex strategies through which a classified computer based system is designed. Images collected from multiple configurations are passed to the Systematic analysis. Information from these images is used to detect the abnormalities[3].

**Phase -2 Abnormality Identification**

The second phase is the excavation of the medical images characteristics, in other terms; the step is also the functioning of the quantization of image characteristics. The objective of this step is to quantize the characteristics that have snatched by computer in the first step. Once the features have been drawn out, selection of a split of the toughest feature is crucial, directing at improving classification precision and reducing the whole complexity. The analysis of the indication, such as the volume, compactness or shape of the pathological alters regions, is the most value demonstration in iconography for the doctor conclusions that they have made[3].

A region severance algorithm is introduced here to detect and locate the hemorrhage.
*Region Severance Algorithm (RSA):*

Let **X[m,n**] be input image matrix of **mxn** size.
Let **Y[p,q]** be an estimated image matrix of **pxq** dimensions
Assuming that **m=p, n=q**

**X[i, j] = Y[i,j]** for all **(i, j)>T**
Where T is the threshold value and
i ranges from 1 to m and
j ranges from 1 to n
Source images usually have multi-modal [7] distributions, which are difficult to model for diagnosis. However, the consistency of the estimator **Y[p,q]**, can be obtained using threshold value T as

**Z[i,j] = X[i,j] – Y[i,j]**

Upon repeated (iterative) application of the above steps, unwanted Regions can be eliminated from the resultant image Z. Apply the techniques like Filtering and masking helps to remove Noise from the image. In fact unwanted noise, which can cause difficulty in processing[3].

*Application of Region Severance Algorithm on Brain CT image:*

The CT image consists of regions like skull, gray matter, white matter and abnormal regions like blood clots, accumulated solvents, fats etc. But our main focused is on encephalic region which lies inside the skull. In order to get the encephalic region, skull portion should be excluded [8]. Therefore, our first step is to isolate Skull region from encephalic region in the image.

*Elimination of skull region from the image:*

The skull is in white color, whose threshold is of maximum in a gray scale map. Hence, we simply treat those pixels with maximum intensity as the skull. The interior region refers to the brain content inside the skull. The process of boundary detection is carried out to eliminate the skull region.

Consequently, that the Boundary contains points with maximum intensity, which belongs to the skull. Note that there are two other regions that are also in white color. These two regions belong to the hard machine surfaces of CT scan device.

*Remove grey matter:*

Most of the content inside the skull is gray matter [9]. The hemorrhage part of grey matter should be separated. The resultant image contains horns and the hemorrhage part.

**Phase-3 Classification of brain hemorrhages**

The final step in the diagnosis process is to classify the hemorrhage with the help of a neural network, whose inputs are location and shape. The values of the inputs to the neural network are obtained from the above steps.

If the shape of the hemorrhage is concave and the location of the hemorrhage is near to skull (Fronto parietal region or perieto occipital region) then the hemorrhage is Sub-Dural Hemorrhage[3].If the shape of the hemorrhage is convex or bi-convex and the location of the hemorrhage is near to skull (parietal region) then the hemorrhage is Epi-Dural hemorrhage[3]. If the shape of the hemorrhage is irregular and the location of the hemorrhage is on the ventricles then the hemorrhage is Intra-Ventricular hemorrhage[3]. If the shape of the hemorrhage is homogeneous (not mandatory) and the location of the hemorrhage is in parietal region or in occipital region or temporal or frontal region then the hemorrhage is Intra-Cranial hemorrhage. [3] If the shape of the hemorrhage is concave and the hemorrhage is present in the frontal and parietal regions then the hemorrhage is SubArachanoid hemorrhage[3].

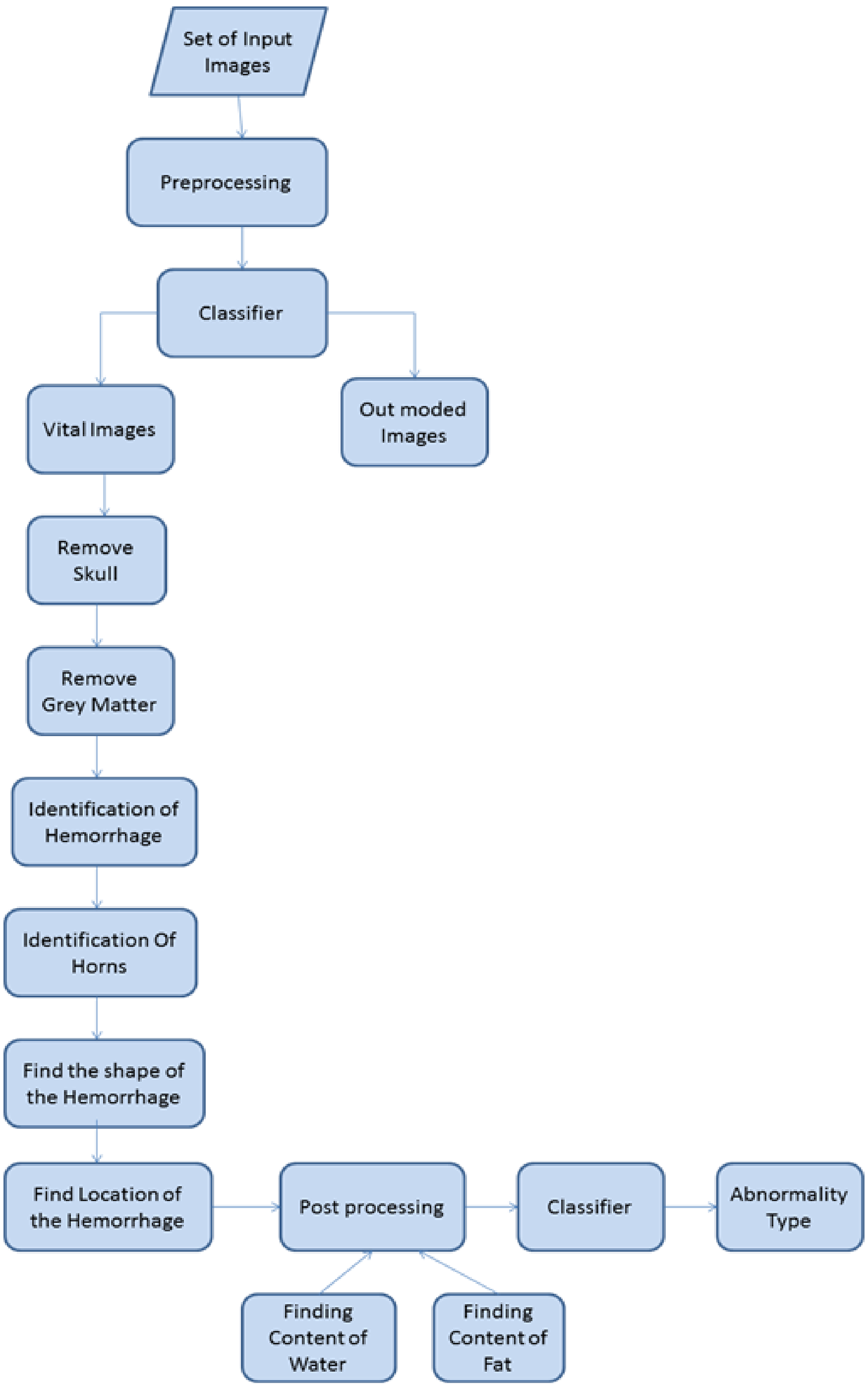


**Figure 5. Block diagram to show how to classify the Images[3]**

## IV CONCLUSIONS

By using CAD method and CT scan the diagnosis and classification of brain hemorrhages can be viably done. So it may help to recognize the hemmorhages prior and will help to lessen death rates because of brain hemmorhages. With the use of RSA, brain abnormalities could be figure out proficiently and it will help additionally to classify the type of hemorrhage. The methodology to follow in CT scan is deliberated for classification.

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