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Diagnosis of Brain Hemorrhage Using Artificial Neural Network

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Abstract— Brain hemorrhage is a type of stroke which is caused due to bursting of artery in the brain and thus causing bleeding in the surrounding tissues. The major technique which is used for diagnosis of brain hemorrhage is through Computed Tomography (CT) scan. This dissertation investigates the possibility of diagnosing brain hemorrhage using an image segmentation of CT scan images using watershed algorithm and using the inputs extracted from the brain CT image to an artificial neural network for classification. The output generated as the type of brain hemorrhages, can be used to verify diagnosis also as a learning tool for trainee radiologists to minimize errors.

Keywords— Brain hemorrhage, Intracerebral Hemorrhage, Subdural Hemorrhage, Extradural Hemorrhage, Subarachnoid Hemorrhage, Computed Tomography, X-rays

I. INTRODUCTION

Medical imaging is the technique and process of creating visual representations of the interior of a body for medical intervention and clinical analysis. One of the main application of medical imaging is in the detection and diagnosis of brain hemorrhage. The literal meaning of brain hemorrhage is ",blood bursting forth",. A brain hemorrhage is a type of stroke which is caused due to bursting of artery and bleeding in the surrounding brain tissues, which kills brain cells. When blood from this injury irritates brain tissues, it causes swelling. These conditions increases pressure on nearby brain tissues, and thau reduces vital blood flow and kills brain cells. Bleeding can occur inside the brain, between the brain and the membranes that cover it, between the layers of the brain's covering or between the skull and the covering of the brain. The symptoms of brain hemorrhage vary depending on the amount of tissue affected, location of the bleeding, the severity of the bleeding. Some of the symptoms include a sudden severe headache, weakness in an arm or leg, loss of balance, etc. Doctors usually advice Computed Tomography(CT) scan or an Magnetic Resonance Imaging (MRI) for checking internal bleeding or blood accumulation. A CT scanner transmits X-ray beams in an arc form taking many pictures, thus sensing different levels of density and tissues inside a solid organ, and can provide detailed information about the body, including the head, chest, skeletal system, pelvis and hips, etc. An MRI scan uses powerful magnetic fields and radio frequency pulses to produce detailed pictures of internal body structures such as soft tissues, organs & bones. An important factor here is to choose which type of scan is suitable depending on the area of scanning and reason of scanning. Radiologists who specialize in reading these scanned images, opt for CT scan to diagnose a muscle or bone disorder and scan for tumors or a fracture or a blood clot. Bleeding in the brain, especially from an injury, can be seen better on a CT scan than an MRI.

II. TYPES of BRAIN HEMORRHAGE

As per bleeding in the brain, it can be divided into four types:

A. Intracerebral Hemorrhage (ICH)

It is a type of stroke caused by bleeding within the brain tissue itself. A stroke occurs when the brain is deprived of oxygen due to an interruption of its blood supply. An ICH can occur close to the surface or in deep areas of the brain.

B. Subdural hemorrhage (SDH)

It is a collection of blood accumulating in the potential space between the dura and arachnoid mater of the meninges around the brain. The meninges are the connective tissue membranes that line the skull and vertebral canal. They enclose the brain and spinal cord.

C. Extradural Hemorrhage (EDH)

It is bleeding between the inside of the skull and the outer covering of the brain called as ",dura",. It is often caused by a skull fracture during childhood or adolescence. An extradural hemorrhage occurs when there is a rupture of a blood vessel, usually an artery, which then bleeds into the space between the ",dura mater", and the skull.

D. Subarachnoid hemorrhage (SAH)

It is a life-threatening type of stroke caused by bleeding in the space surrounding the brain. A stroke is caused when the brain is deprived of oxygen because of an interruption of its blood supply. Subarachnoid hemorrhage is caused by ruptured aneurysm.

III. LITERATURE SURVEY

R. Ganesan and S. Radhakrishnan (2009) had proposed segmentation of CT brain image using Genetic Algorithm (GA) to segment the image. It is evaluated using receiving operating characteristics (ROC) curve analysis. Liu et al. has presented an automated detection of CT scan slices which contain hemorrhages. The detection method consists of two parts. The first part splits the scan slices into encephalic region and nasal cavity region. The second part focuses on encephalic region and detects abnormal slices. In both parts, the method used is Wavelet and Haralick texture model. Rajesh A. Rajwade uses image enhancement tools and medical filtering to diagnose brain hemorrhages along with geometrical and textural features used as input to neural network and support vector machine. C. Amutha Devi and Dr. S. P. Rajagopalan has proposed a method for classifying the brain MRI images into stroke and non-stroke images. This method extracts features from MRI images of brain using watershed segmentation and Gabor filter. Alyaa Hussein Ali et al. (2015) had proposed the detection and segmentation of hemorrhage stroke from brain CT images using textural analysis. In study, the thresholding segmentation process used to extract stroke region from CT image of brain. The median filter was used to remove noise from image and the statistical feature calculated using first order histogram. The first order histogram represents estimation of probability distribution function (PDF) for selected neighbourhood. The results as mean value represents white color in image. The higher mean gives indication that there is an abnormal part in brain. Mayank Chawla et al. (2009) presented an automated method to detect and classify an abnormality into acute and chronic infarct, and hemorrhage at the slice level of non-contrast CT images. The method consists of three main steps: image enhancement, detection of mid-line symmetry and classification of abnormal slices.

IV. PROPOSED METHDOLOGY

The working of the proposed system can be shown in the flowchart below:

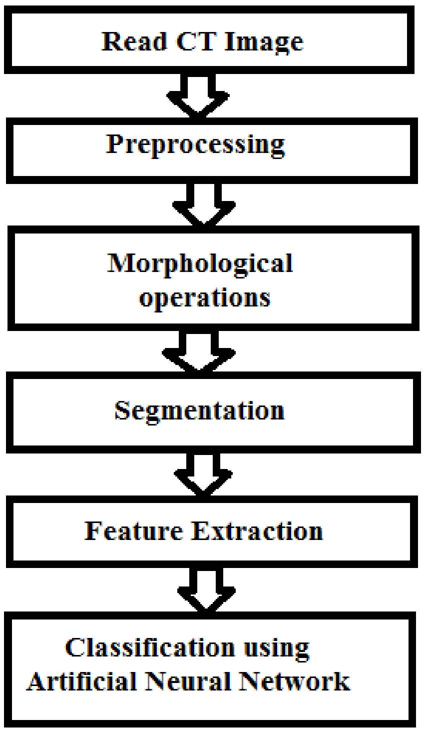

Fig. 1: Flowchart of the proposed system

A. READ CT IMAGE

The initial dataset consist of Computed Tomography (CT) images of the brain. It helps in the diagnosis of haemorrhages by scanning image of bones, soft tissues and blood vessels all at the same time. CT images are read first. Then brain CT image is converted into jpeg format. The jpeg format has many advantages such as high controlled degree of compression. The user can independently select the ratio quality/file size; small file size; format is compatible and it is displayed correctly in any browsers, text and graphics programs, on all computers, tablets and mobile devices & is suitable for full-color realistic images with a lot of color and contrast transitions. The picture quality is high with small degree of compression.This image will be uploaded to the system for pre-processing.

B. PRE-PROCESSING

In this system, pre-processing techniques are developed to remove skull portion surrounding the tissues. The purpose of converting the image to gray is to make the image simpler, and reduce the amount of code you have to write. After conversion of the image, resizing is done so that it fits on system user interface and then convert into two dimensional image e.g., 256x256 pixel size. This is followed by edge detection. It refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene.It basically examines an image and produces a pixel at the boundary of two “,colours”,. The output image contains all of the pixels that were created during the detection.

C. MORPHOLOGICAL OPERATIONS

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. It relies only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest. This technique probes an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels.Some of mathematical morphological operators to be performed are dilation(Expanding the foreground), erosion(Shrinking the foreground), opening(Removing holes in the foreground) and closing(Removing stray foreground pixels in background) .

D. SEGMENTATION

Image segmentation is the process of partitioning a digital image into multiple segments, i.e. sets of pixels, also known as super-pixels.It is typically used to locate objects and boundaries, lines, curves, etc in images. It is a morphological based method of image segmentation. The gradient magnitude of an image is considered as a topographic surface for the watershed transformation. Watershed lines can be found by different ways. The complete division of the image through watershed transformation relies mostly on a good estimation of image gradients. There are different ways to find watershed lines. Different approaches may be employed to use the watershed principle for segmentation. After pre-processing, the image will be segmented to identify required objects in CT scan and to extract values needed as input. The goal of watershed segmentation algorithm is to find the "watershed line", in an image in order to separate the distinct regions.

E. FEATURE EXTRACTION

It is the process by which certain features of interest within an image are detected and represented for further processing. Feature extraction is the method of capturing visual content of an image. The goal of feature extraction is to reduce original datasets by measuring certain features. The extracted features are considered as input to classifier.A statistical method of examining texture that considers the spatial relationship of pixels is the gray-level co-occurrence matrix (GLCM), also known as the gray-level spatial dependence matrix. The GLCM functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a GLCM, and then extracting statistical measures from this matrix. The following parameters will be extracted by using GLCM:

1. Number of Objects: The number of objects shows the type of hemorrhage.
2. Area of Objects: Area of objects shows the intensity of bleeding.
3. Energy: is a measure of unorderedness or information content in an image.
4. Entropy: Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image.
5. Standard Deviation: Angular second moment is called as standard deviation.
6. Coverience
7. Hemorrhage Percentage

F. ARTIFICIAL NEURAL NETWORK

It is used as a classifier.It has originated from the studies on how brains work, hence one has to study brain to understand fundamentals of ANNs.A neuron consists of cell body, axon and dendrites. The dendrites receive signals from other neurons and transmit them to the cell body. Extracted features acts as input to classifier. The brain is an extremely complex, nonlinear and parallel computer.There are several types of architecture of NNs. In a feed forward network, information flows in one direction along connecting pathways, from the input layer via the hidden layers to the final output layer. There is no feedback (loops) i.e., the output of any layer does not affect that same or preceding layer. Feed-forward neural networks, where the data own from input to output units is strictly feed forward.Feed-forward networks are particularly suitable for applications in medical imaging where the inputs and outputs are numerical and pairs of input/output vectors provide a clear basis for training in a supervised manner.

V. CONCLUSION

Detecting the type of haemorrhage is very crucial step in the medical treatment to save life of the patient. The segmentation and the quantification of region are based on the watershed algorithm based segmentation procedure. Before application of the watershed algorithm morphological operations are performed to compute the foreground and background markers. The use of artificial neural network will reduce the error at the output, which will enable us to detect the haemorrhage effectively. Thus we will get an accurate software to diagnose the type of brain hemorrhage. This system will be a highly innovative technique, wherein doctors and radiologists will be able to verify diagnosis with great accuracy. Even non-technical users will find this concept useful after knowing that the user need not be technical to handle the application after the initial set up. Thus this will be a very simple and accurate system to diagnose hemorrhages.

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