Artificial Neural Networks Approach in Diagnosis of Brain Hemorrhages

R. Kavitha M.E., (Ph.D),
HOD of CSE Dept,
PITS.

T. Kavya
Dept of CSE,
PITS.

Abstract:- **The classification and diagnosis of brain hemorrhages has work out into a great importance in early detection of hemorrhages which reduce the death rates. This paper has introduced one automatic brain hemorrhages detection method to increase the accuracy and yield and decrease the diagnosis time. The appropriate inputs extracted from the brain CT image are feed to an artificial neural network (ANN) for classification. This paper attempts to spot on consider and talk about Computer Based Diagnosis (CBD) that chiefly necessitated in clinical diagnosis without human act. The output generated as the type of brain hemorrhages, can be used to verify expert diagnosis and also as learning tool for trainee radiologists to minimize errors in current methods. The algorithm which we use here is BPN. Back-propagation is well suited to pattern recognition problems. In this paper we considered a perceptron based feed forward neural network for early detection of hemorrhages.**

Key words : Artificial Neural Network, CBD, XML, Nerual XML, BPN.

1. INTRODUCTION

A brain hemorrhage is a very serious and potentially life threatening condition. The cause of a brain hemorrhage is when an artery in the brain begins to swell and then it bursts [1]. The bleeding can result in brain cells being killed. A spontaneous brain hemorrhages are often due to weakened or damaged blood vessels rupturing and bleeding within or around the brain. There is no room for a large amount of blood within the confines of the skull, so any bleeding causes serious damage to brain tissue by increasing pressure within the skull and disrupting the normal blood supply to the brain.

When bleeding occurs deep within the brain, it causes sudden loss of neurological function in a part of the body and collapse.

Any brain hemorrhage can potentially be life-threatening. The location and severity of a hemorrhage are two important factors dictating survival and complications.

The brain requires a constant blood supply to sustain life. A lack of blood flow into the brain tissue, and consequently oxygen, can result in an infarct, an area of dead tissue. A number of blood vessels of varying sizes feed the brain, keeping both it and the body it controls alive. Because of the brain's important role, it is protected within the cranium, a confining cavity of limited space. As long as the brain does not swell or the cavity accumulates additional fluid, the brain is cushioned and safe within this space.

The brain tissue is surrounded by thin tissue. Meninges are the membranes of the central nervous system, including those of the brain. These layers of tissue separate the brain tissue from the skull bone. The space between the inner membrane and the brain where cerebrospinal fluid circulates is the subarachnoid space. The outer membrane is called the dura mater. Anything between the dura mater and bone is epidural; between the dura mater and inner membranes is subdural.

When a blood vessel feeding the brain and its tissues ruptures, it hemorrhages into the surrounding tissue [2]. The four types of brain hemorrhage are divided based on the affected tissue: intracerebal (inside the brain), subarachnoid (between the brain and meninges), subdural (between the meninges), and epidural (between the dura mater and skull).

Intracerebral hemorrhages are usually caused by hypertension, which wears away and damages susceptible blood vessels in various tissues, including the brain, over time.

Subarachnoid hemorrhages (also called as Intra Ventricular hemorrhages) are usually caused by aneurysms. This term refers to the phenomenon of bleeding into the cerebrospinal fluid (CSF). This results in bloody CSF and intense meningeal irritation. The blood accumulation can increase pressure in the brain cavity, resulting in seizures and motor loss.

A subdural hemorrhage causes an accumulation of blood between the membranes around the brain. This type of bleed is usually caused by a head injury that breaks or stretches the veins on the brain surface. The bleeding occurs quickly, compressing the brain tissue.

An epidural hemorrhage typically occurs when a skull fracture damages an underlying blood vessel. These bleeds do not always increase the pressure in the brain, but if left untreated they can lead to more serious complications. This is the least common type of brain hemorrhage.

As with all things in medical, the symptoms can vary, be mixed up, or may not always present itself with typical features. Occasionally, dilated blood vessels with weak walls are in-born, but often the underlying problem is damage caused by smoking, high blood pressure and clogging of the arteries.

2. ARTIFICIAL NEURAL NETWORK

One type of network sees the nodes as 'artificial neurons'. These are called artificial neural networks (ANNs). An artificial neuron is a computational model inspired in the natural neurons [3]. Natural neurons receive signals through *synapses* located on the dendrites or membrane of

Special Issue - 2019

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

the neuron. When the signals received are strong enough, the neuron is *activated* and emits a signal though the *axon*. This signal might be sent to another synapse, and might activate other neurons. An artificial neural network is a system based on the operation of biological neural networks. Although computing these days is truly advanced, there are certain tasks that a program made for a common microprocessor is unable to perform. Artificial neural networks (ANN) are among the newest signal-processing technologies in the engineer's toolbox. An Artificial Neural Network is an adaptive, most often nonlinear system that learns to perform a function (an input/output map) from data. An artificial neural network consists of a pool of simple processing units which communicate by sending signals to each other over a large number of weighted connections. Neural networks provide significant benefits in medical research. They are actively being used for such applications as locating previously undetected patterns in mountains of research data, controlling medical devices based on biofeedback, and detecting characteristics in medical imagery.

3. ARCHITECTURE OF ARTIFICIAL NEURAL NETWORKS

The basic architecture consists of three types of neuron layers: input, hidden, and output layers. In feed-forward networks, the signal flow is from input to output units, strictly in a feed-forward direction, which is shown in figure 1. The data processing can extend over multiple (layers of) units, but no feedback connections are present. Recurrent networks contain feedback connections. Contrary to feed-forward networks, the dynamical properties of the network are important [3][4]. There are several other neural network architectures (Elman network, adaptive resonance theory maps, competitive networks, etc.), depending on the properties and requirement of the application. A neural network has to be configured such that the application of a set of inputs produces the desired set of outputs. Various methods to set the strengths of the connections exist. One way is to set the weights explicitly, using a priori knowledge. Another way is to train the neural network by feeding it teaching patterns and letting it change its weights according to some learning rule. The learning situations in neural networks may be classified into three distinct sorts. These are supervised learning, unsupervised learning, and reinforcement learning. Supervised learning is used in this system. In supervised learning, an input vector is presented at the inputs together with a set of desired responses, one for each node, at the output layer. A forward pass is done, and the errors or discrepancies between the desired and actual response for each node in the output layer are found. These are then used to determine weight changes in the net according to the prevailing learning rule. These input-output pairs can be provided by an external teacher, or by the system which contains the neural network (self-supervised). The best-known examples of this technique occur in the back propagation algorithm All neurons from one layer are connected to all neurons in the next layer.
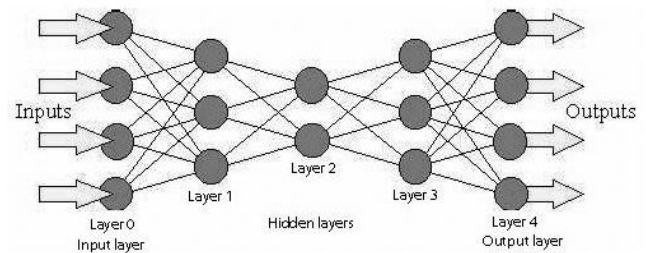

Figure 1. Feed – Forward Network

4. BPN TRAINING ALGORITHM

The following description tends to assume a pattern classification problem, since that is where the BP network has its greatest strength. However back-propagation algorithm may be used for many other problems as well, including compression, prediction and digital signal processing [5]. When a network is not providing the expected output, then modify some connection weights. Since the network weights are initially random, it is likely that the initial output value will be very far from the desired output. To improve the behavior of the network, it is necessary to identify which connection weights must be modified, and by how much, to achieve the objective? This can be achieved by using an algorithm which efficiently modifies the different connection weights to minimize the errors at the output. This is a common problem in engineering; it is known as optimization. The neural network is a more generic system and requires a more complex algorithm to adjust the many network parameters.

One algorithm which has hugely contributed to neural network fame is the back-propagation algorithm. The principal advantages of back-propagation are simplicity and reasonable speed. Back-propagation is well suited to pattern recognition problems.

The training algorithm for a BPN consists of the following steps:

- Selection and Preparation of Training Data
- Repetition
- Running
- Hazards

4.1 Selection and Preparation of Training Data

A neural network is useless if it only sees one example of a matching input/output pair. The best training procedure is to compile a wide range of examples which exhibit all the different characteristics which are interested in. It is important to select examples which are common to input data anyway. If possible, prior to training, add some noise or other randomness to examples. This helps to account for noise and natural variability in real data, and tends to produce a more reliable network. Once again, it cannot be overemphasized: a neural network is only as good as the training data! Poor training data inevitably leads to an unreliable and unpredictable network. Having selected an example, then present it to the network and generate an output.

Special Issue - 2019

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

4.2 Repetition

The above procedure must be repeated many times until the network is performing satisfactorily, and this training session for this particular example has been completed. Once this occurs, randomly select another example, and repeat the procedure. Continue until all of the examples are used many times (`many' may be anywhere between twenty or less and ten thousand or more, depending on the particular application, complexity of data and other parameters).

4.3 Running

Finally, the network should be ready for testing. It is possible to test it with the data which have been used for training. Instead, get some real data which the network has never seen and present it at the input. Hopefully it should correctly classify, compress, or otherwise process the data in a satisfactory way.

4.4 Hazards

A consequence of the back-propagation algorithm is that there are situations where it can get `stuck'. In the event that this happens, resize the network (add extra hidden-layer nodes or even remove some) or try a different starting point (i.e. randomize the network again). Some enhancements to the BP algorithm have been developed to get around this type of problem. Other approaches may use alternatives to the Mean Squared Error as a measure of how well the network is performing.

5. COMPUTER BASED DIAGNOSIS

The main objective is to develop a Computer Based Diagnosis system. It is used to detect and classify the type of hemorrhage. It is not possible for the expert radiologists to be readily available to provide the required crucial image interpretation. It is therefore believed that compute based diagnosis is well suited for this situation. The workload of radiologists has been drastically reduced. The input image which is needed for this system can be obtained with the help of Computed Tomography.

Computed Tomography (CT) is a non invasive technique to give CT images of each part of the human being body. CT scan can show the actual structure of the brain, blood vessels, and other tissues within skull [6]. CT is the most preferable imaging system since it can work over unconscious patients in the emergency room. Because of the unstable vital signs, Magnetic resonance imaging (MRI) is not possible in majority of unconscious patients.

The CT scan of a brain image contains little information which requires more computations in retrieving the region of interest. CT images are digital images, in which each pixel is expressed by its corresponding gray value.

6. METHODOLOGY

The computer based diagnosis tool is build upon the fundamental aspect of automation in medical diagnostic activity research. It is time saving economical method of hemorrhage diagnosis. During the processing of automation of CT scan, several procedures are adopted on the essential image.

6.1 Image acquisition and preprocessing

The image which is obtained from CT scan has to be preprocessed.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 [7]. 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 systematic analysis. Information from these images is used to detect the abnormalities.

The preprocessing of the obtained CT image includes resizing so that the image can fit in the user interface [8]. If the image is color, then is converted in to grey scale image.

6.2 Segmentation

Edge-base segmentation generally indicates the segmentation method based on the edge in an image. The simple methods apply some edge detection methods before segmentation [9]. Edge detection of an image reduces significantly the amount of data and filters out information that may be regarded as less relevant, preserving the important structural properties of an image.

Edge detection is a fundamental tool in image processing and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities. In this paper, canny edge detector is utilized in different aspect to identify the edges of the image and also improve the learning process of neural network [10][11]. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research.

The canny edge detection algorithm runs in five separate steps:

1. *Smoothing*: Blurring of the image to remove noise.
2. *Finding gradients*: The edges should be marked where the gradients of the image has large magnitudes.
3. *Non-maximum suppression*: Only local maxima should be marked as edges.
4. *Double thresholding*: Potential edges are determined by thresholding.
5. *Edge tracking by hysteresis*: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

6.3 Filtering

The segmented image is filtered for further process, which is used for extracting the features from the image. Elimination of noise is one of the major works to be done in computer vision and image processing, as noise leads to the error in the image. Presence of noise is manifested by undesirable information, which is not at all related to the image under study, but in turn disturbs the information present in the image. Noise elimination is a main concern in computer vision and image processing [12]. A digital filter is used to remove noise from the degraded image. As any noise in the image can be result in serious errors. Noise

Special Issue - 2019

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

is an unwanted signal, which is manifested by undesirable information. Thus the image, which gets contaminated by the noise, is the degraded image and using different filters can filter this noise. Thus filter is an important subsystem of any signal processing system.

In this paper Histogram Adaptive Fuzzy filter, based on Neural Network is used. Neural networks exploit their frameworks with many theorems and efficient training algorithms. They embed several input-output mappings on a black-box web of connection weights. However, we cannot directly encode the simple rule of a spatial windowing operation, such as: "If most of the pixels in an input window are BRIGHT, then assign the output pixel intensity as BRIGHT." On the other hand, fuzzy systems can directly encode structured knowledge. Fuzzy systems may invariably store banks of common-sense rules linguistically articulated by an expert or may adaptively infer and modify their fuzzy rules using representative symbols (e.g., DARK, BRIGHT) as well as numerical samples. The combination of fuzzy systems and neural networks produces an adaptive system in that the neural networks are embedded in an overall fuzzy architecture, where fuzzy rules from training data are generated and refined.

6.4 Neural Network creation and training

The principal importance of a neural network is not only the way a neuron is implemented but also how their interconnections (more commonly called topology) are made.

Neural Network can be created using NXML tool. NXML can specify which network to load, what operation to perform on the network, etc.

To create a network, it is necessary to determine

- The number of neurons in input layer.
- The number of neurons in hidden layer and the number of hidden layers
- The number of neurons in output layer.

A neural network has to be configured such that the application of a set of inputs produces the desired set of outputs. Various methods to set the strengths of the connections exist. One way is to set the weights explicitly, using a priori knowledge. Another way is to 'train' the neural network by feeding it teaching patterns and letting it change its weights according to some learning rule.

For training the neural network, create an nxml file, train.n.xml [13]. All images are in the samples folder, relative to the folder where train.n.xml resides. The 'Network' tag is used to load an xml file from disk.

It has the following attributes.

- *LoadPath* - The path of the xml file which holds our network.
- *SaveOnFinish* - Specify whether the network should be saved after a DataBlock operation is performed
- *SavePath* - Save the network to a new file path.

A DataBlock tag specifies which operation we are going to perform.

It has the following attributes.

- *Type* - The type of operation to perform. It can be either Train or Run.
- *TrainCount* - The number of times the operation should be performed. It is not required if Type attribute is Run.

6.5 Classification of brain hemorrhages and providing diagnosis

The final step in the diagnosis process is to classify the hemorrhage with the help of a neural network. 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 then the hemorrhage is Sub-Dural hemorrhage [14].

If the shape of the hemorrhage is convex or bi-convex and the location of the hemorrhage is near to skull then the hemorrhage is Epi-Dural hemorrhage.

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-Cerebral hemorrhage.

If the shape of the hemorrhage is concave and the hemorrhage is present in the frontal and parietal regions then the hemorrhage is Subarachnoid hemorrhage.

We take pixel intensity as the main supporting evidence for the diagnosis process. As image is represented by matrix consisting different values which represent pixel intensities. Therefore, considering pixel intensity as the main supporting evidence generates exact results.
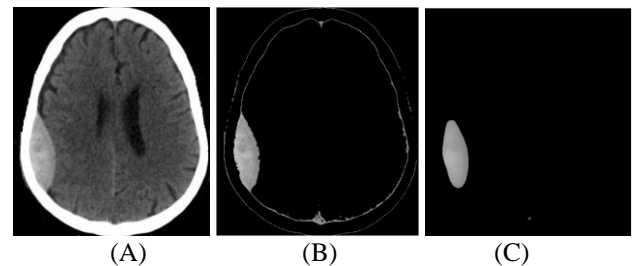

(A) (B) (C)

Figure 2. EDH image
(A) Input image (B) Result after segmentation and filtering (C) Output of the extracted hemorrhage

7. CONCLUSION

The methodology implemented here is based on neural network and the results obtained is useful for radiologists, medical students as well as doctors to feed the CT image of the brain and to diagnosis whether there is a hemorrhage and specify the type based on the classification. The system can be improved to detect other important brain related issues like brain cancer and brain tumor. The application of data mining techniques such as clustering can be implemented as future enhancement to the system.

8. REFERENCE

[1] Joon K. Leea, Tao Chanb, Brent J. Liua, H.K. Huanga - 'Evaluation of a computer-aided detection algorithm for timely diagnosis of small acute intracranial hemorrhage on computed tomography in a critical care environment'.

Special Issue - 2019

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
CONFCALL - 2019 Conference Proceedings

[2]   K.V.Ramana M.Tech & Raghu.B.Korrapati Ph.D – 'Neural Network Based Classification and Diagnosis of Brain Hemorrhages'.

[3]   Ajith Abraham, Handbook of Measuring System Design-Artificial Neural Networks

[4]   Man-Wai Mak,Irwin King Advances in Machine Learning and Neural Networks, International Journal of Computational Intelligence Research.(2007)

[5]   Sarawat Anam - Face Recognition Using Genetic Algorithm and Back Propagation Neural Network, Proceedings of the International MultiConference of Engineers and Computer Scientists 2009.

[6]   E. D. Seletchi, O. G. Duliu, Image processing and data analysis in computed tomography, Rom. Journ. Phys., Vol. 52.

[7]   Pavani Davuluri,1 Jie Wu,2 Yang Tang,3 Charles H. Cockrell,3 Kevin R. Ward,4, 5 Kayvan Najarian,2, 5 and Rosalyn H. Hargraves1 – 'Hemorrhage Detection and Segmentation in Traumatic Pelvic Injuries'.

[8]   Mohr et al. Hemorrhagic Stroke – The Dana Guide. The Dana Foundation. 2007 March.

[9]   Ganesan, R., Radhakrishnan, S. [2009]. Segmentation of Computed Tomography Brain Images Using Genetic Algorithm. International Journal of Soft Computing.

[10] Mohamed, R. [2006]. Comparative Study of Edge Detection Algorithms Applying on the Grayscale Noisy Image Using Morphological Filter. GVIP Journal.

[11] Shriram K V et. al. / International Journal of Engineering Science and Technology 'Automotive image processing technique using canny's edge detector', 2010.

[12] Charu Khare and Kapil Kumar Nagwanshi - 'Image Restoration Technique with Non Linear Filter, international journal of Advanced Science and Technology', February 2012.

[13] Extensible Markup Language (XML) 1.0. W3C Recommendation. http://www.w3.org/TR/1998/REC-xml-19980210.

[14] Levien de Braal et.al, Analyzing and Predicting Images Through a Neural Network Approach, Proceedings of the 4th International Conference on Visualization in Biomedical Computing,