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Zigbee Based Device for Predicting Strokes in Carotid Atherosclerosis Using Ultrasound Image Analysis.

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ABSTRACT

This article documents the serious and frequent cerebrovascular disease. The most common cause of stroke according to a specific diagnostic algorithm can be prevented by treating carotid atherosclerosis. This algorithm is insufficient and poses a significant research challenge to study in detail to discover a solution. Earlier solutions illustrate on this matter the potential of carotid ultrasound picture analysis with a high cost and innovative imaging on plaque composition & stability. This paper illustrates the potential of carotid ultrasound picture analysis towards this direction with ultrasound imaging being a low cost picture based features revealing the information on plaque composition and stability. Systematic applications are used to diagnose & find results & orient future research. A bright respective for clinical scenario is diagnosed for atherosclerotic patients in low cost. The general project developed in MATLAB platform. Finally validation of results shows both in hardware and application, the information of vulnerability or non-vulnerability of plaque is displayed.

Keywords: Ultrasound image, atherosclerosis, cerebrovascular, Carotid artery, Plaque.

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INTRODUCTION

Stroke is a worldwide health issue. It is the second commonest cause of death & fourth leading cause of disability worldwide. About twenty million people each year will suffer from stroke and of these five million won't survive. In developed countries, stroke is the first leading cause for disability, second leading cause of dementia & third leading cause of death. Strokes can be classified in to major categories: ischemic & hemorrhagic. Ischemic strokes are those that are caused by interruption of the blood supply, while hemorrhagic strokes are the ones which result from rupture of a blood vessel or an abnormal vascular structure. About 87% of strokes are caused by ischemia & the remainder by hemorrhage. Some hemorrhages create inside areas of ischemia. Ischemic strokes caused by artery stenosis, account for about 75% of all strokes. Stroke is & a predisposing factor for epilepsy, falls & depression in developed countries & is a leading cause of functional impairments, with 20% of survivors requiring institutional care after three months & 15% - 30% being permanently disabled. Stroke is no longer a disease of the developed world: Low and middle-income countries account for 85.5% of total stroke deaths worldwide and the number of disability adjusted life years in these countries was about seven times that in high income countries.

Stroke is a major health issue in this country. 500,000 people in the United States have a stroke each year, and a third of these people die in the work of the first few months after their stroke, Of those who survive, about ten percent can return to their earlier level of activity, about 50 percent regain function to return home and carryover on with only limited assistance, and about 40 percent stay institutionalized or need significant assistance in caring for themselves.The Indian National Commission on Macro-economic and Health estimated that the number of strokes will increase from 1,081,480 in 2000 to 1,667,372 in 2015, The Global Burden of Disease Study projects that total deaths from stroke in India will surpass established market economies by year 2020.

Computer aided diagnosis (CAD) of carotid atherosclerosis in to symptomatic or asymptomatic is useful in the analysis of cardiac health. In the existing technique only plaque characterization in carotid ultrasound scan was analyzed. [1-5] In the proposed technique they are going to analyses the blood clot in the carotid artery as well as going to measure the variations in the length and breadth of the carotid artery. In the existing method only experienced physicians or vascular ultrasonographers can analyses the plaque. But in the proposed method all can identify the signs.

EXPERIMENTAL

Methodology

Ultrasound input picture is collected and imaged is preprocessed , algorithms are used for feature extraction, neutral network is used for training about twenty images using back propagation process and images are classified in to normal and abnormal images. The following block diagram describes the procedure of finding the solution given below fig.1.

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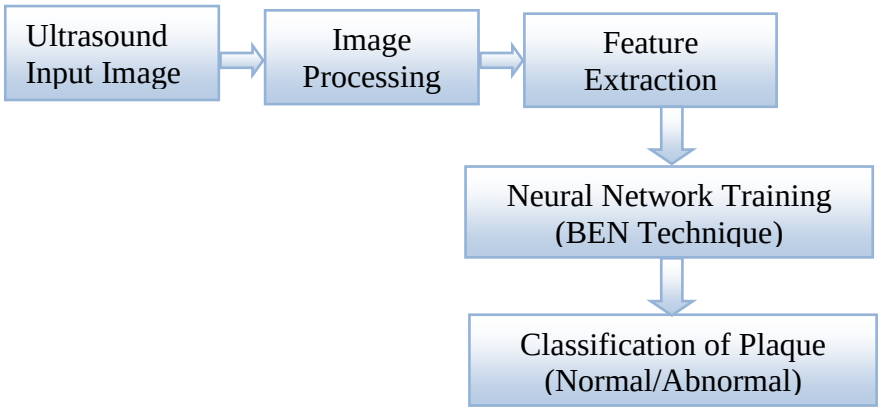

Figure 1: Block Diagram for procedure finding solution

Ultrasound imaging holds a prominent position in the diagnosis of carotid atherosclerosis. It's a considerable number of benefits including non invasiveness, widespread availability short examination times, lack of radiation exposure and low cost. This helps in visualizing and quantifying atherosclerotic lesions using a repeatable procedure that has proved to be a powerful indicator of heart issues.[6]

RESULTS AND DISCUSSION

Image Pre Processing

Pre-processing operations also known filtration is use a small neighbourhood of a pixel in an input picture to get a value in the output picture. Preprocessing is a set of techniques whose objective is improving the input picture to make it simpler to method by the segmentation step. The blocked carotid artery area is zoomed and cropped. The nature of the disease is focused on the vessel wall that specifically changes the morphology of the lumena intima interface from slow gradual lipid formation and maturing in to hard plaque or loose island of hemorrhage. [6-9] The young and elderly plaques are all focused toward the vessel disease which yields the information in the type of echogenicity in the ultrasound picture. The picture describes the output of finding the solution shown in fig. 5-9.

Discrete Wavelet Transform

Wavelets are extract information from plenty of different kinds of information including audio and images. The transform generates sub band LL, LH, HL, HH each with forth. Most of the energy is concentrated in HH, which represents the high-resolution version of the original picture. A DWT is any wavelet transform for which the wavelets are discretely sampled. For 2-D signals, the 2-D DWT can be used focuses on wavelet packets (WPs) for images. These images are represented as an m x n grey scale matrix where each element of the matrix represents the intensity of one pixel. All non-border pixels in I [i, j], where $i \in \{0,m\}$ and $j \in \{0, n\}$, have eight immediate neighbouring pixels. These eight neighbours can be used to traverse through the matrix. However, changing the direction with which the matrix is traversed inverts the sequence of pixels, & the 2-D DWT coefficients are the same.[10]

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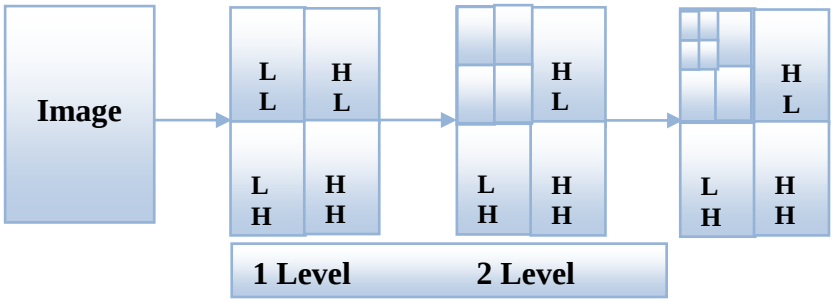

Figure 2: Discrete wavelet transforms (2D-DWT) operation

The four possible directions, which are known as decomposition corresponding to 0◦ (horizontal, *Dh*), 90◦ (vertical, *Dv*) and 45◦ or 135◦ (diagonal, *Dd*) orientations. The first-level 2-D-DWT yields four result matrices, namely Dh_1, Dv_1, Dd_1 and A_1, whose elements are intensity values. The frequency bands that are not very prominent in the original signal will have very low amplitudes, and that part of the DWT signal can be discarded without any major loss of information, allowing information reduction. This decomposition halves the time resolution since only half the number of samples now characterizes the whole signal. However, this operation doubles the frequency resolution, since the frequency band of the signal now spans only half the earlier frequency band, effectively reducing the uncertainty in the frequency by half. The sub band coding can be repeated for further decomposition.

At every level, the filtering and sub sampling will lead to half the number of samples , hence half the time resolution and half the frequency band spanned.

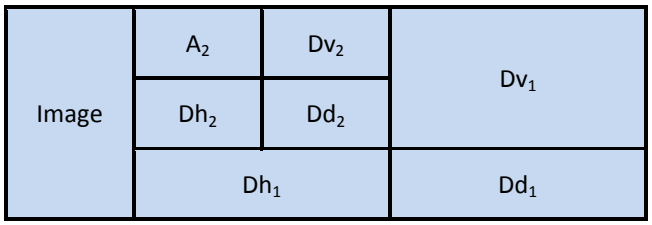

Figure 3: DWT based image decomposition

DWT employs sets of functions, called scaling functions and wavelet functions, which are associated with low pass and high pass filters, respectively. The decomposition of the signal in to different frequency bands is basically obtained by successive high pass and low pass filtering of the time domain signal.

The original signal x[n] is first passed through a half band high pass filter g[n] and a low pass filter h[n]. After the filtering, half of the samples can be eliminated according to the Nyquist's rule, since the signal now has a highest frequency of $\frac{\pi}{2}$ radians in lieu of π. The signal can therefore be sub sampled by two, basically by discarding every other sample. They are various types of wavelet transform: Haar wavelet, Daubechies wavelet, Symlet wavelet, Biorthogonal wavelet.

Haar Wavelet

Discrete Haar functions may be defined as functions determined by sampling the Haar functions at 2n points. These functions can be conveniently represented by means of matrix form. The Haar matrices H(n) are thought about in the natural & sequence ordering which differ in the ordering of rows. Each row of the matrix H(n) includes the discrete Haar sequence haar(w, t) (or otherwise the discrete Haar function). In this notation, index w identifies the number of the Haar function & index t the discrete point of the function determination interval. The following picture describes the output picture of finding the solution fig.6.

Daubechies Wavelet

Belgian mathematician Ingrid Daubechies formulated the most often used set of discrete wavelet transforms in 1988. This formulation is based on the use of recurrence relations to generate progressively finer discrete samplings of an implicit sister wavelet function; each resolution is two times that of the earlier scale. The following picture describes the output picture of finding the solution fig.7

Symlet Wavelet

The symlets are symmetrical, orthogonal and biorthogonal wavelets proposed by Daubechies as modifications to the db relatives. Symlet wavelets used in practice are also selected even number of wavelets as Daubechies. Symlets when applied to signal performs better and SNR of reconstructed or denoised signal is improved. The following picture describes the output picture of finding the solution fig.8

Biorthogonal Wavelet

A biorthogonal wavelet is a wavelet where the associated wavelet transform is invertible. Designing biorthogonal wavelets allows more degrees of freedom than orthogonal wavelets. additional degree of freedom is the chance to construct symmetric wavelet functions. sets of wavelets generate subspaces respectively. The basis is orthogonal; the MRAs are said to be biorthogonal to each other. The biorthogonal wavelet method designed shows improvement common- used least square technique in output picture quality.

The above technique of discrete wavelet transform is used to decompose the preprocessed picture. By comparing the output picture of techniques it is found that biorthoganal gives high resolution and correct picture which is given as the input picture to neural network classifier. The following picture describes the output picture of finding the solution fig.9.

Feature Extraction

Feature extraction is a special kind of dimensionality reduction. The input knowledge to an algorithm is suspected to be notoriously redundant, & then the input knowledge will

be transformed in to a reduced representation set of features. Feature extraction transforms the input knowledge in to the set of features. The features set will extract the relevant information from the input knowledge in order to perform the desired task using this reduced representation.

Feature extraction simplifies a giant set of knowledge exactly of the major issues stems from the number of variables involved. Feature extraction is a general term for methods of constructing combinations of the variables to get around these issues while still describing the knowledge with sufficient accuracy.

Feature extraction methodologies analyze objects & pics to extract the most prominent features that are representative of the various classes of objects. Features are used as inputs to classifiers that assign them to the class that they represent. Feature extraction involves simplifying the amount of resources necessary to report a giant set of knowledge exactly. When performing analysis of complex knowledge of the major issues stems from the number of variables involved. Feature extraction is a general term for methods of constructing combinations of the variables to get around these issues while still describing the knowledge with sufficient accuracy.

The following features were extracted in decomposed picture: Average, Energy, Entropy, Covariance, Standard deviation.

Neural Network Training (BPN Process)

Neural networks have emerged as an important tool for classification & promising alternative to various conventional classification methods. The advantage of neural networks lies in the following theoretical aspects. First, neural networks are knowledge driven self-adaptive methods the knowledge without any explicit specification of functional or distributional form for the underlying model. Second, they are universal functional approximates in that neural networks can approximate any function with arbitrary accuracy. Since any classification procedure seeks a functional relationship between the group membership & the attributes of the object, correct identification of this underlying function is doubtlessly important. Third, neural networks are nonlinear models, which makes them flexible in modeling actual world complex relationships. Finally, neural networks can estimate the posterior probability, which provides the basis for establishing classification rule & performing statistical analysis.

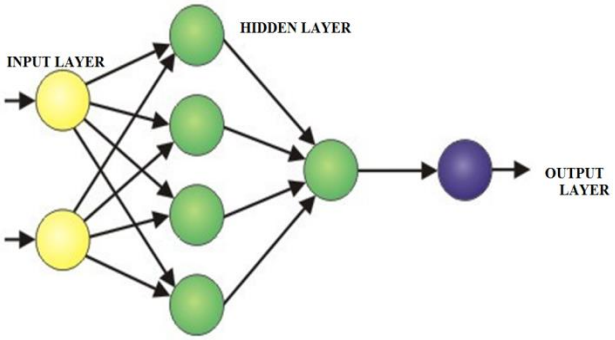

Figure 4: Neural network analysis

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The internal weights of the neural network are adjusted according to the transactions used in the learning method. The neural network receives in addition the expected output in each transaction. This allows the manipulation of the weights. The trained neural network is used to classify new images. Neural network classifier is used to compare the trained picture & input picture based on score value. If the classifier output is one.it will be the normal picture, else it will be the abnormal picture which indicates the presence of signs.

Kernel configurations of neural network in classification results can be compared with neural network classifier. Neural classifier performed better than other classifiers.

Classification of Plaque (Normal/Abnormal)

The features present in the date are analyzed using the input knowledge & an correct description is analyzed in classification of plaque. Unknown class descriptions are classified using this model. Unclassified cases are assigned a class label in classification. Processing techniques apply to the values in a digital yield or remotely sensed scene to group pixels with similar digital number values in to feature classes or categories. Classification is of the most active research & application areas of neural networks.

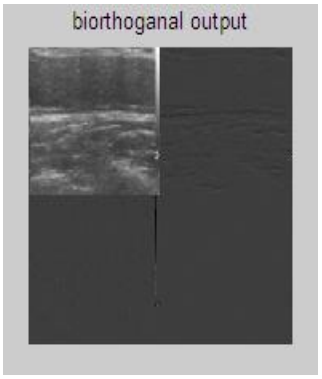

Figure 5: output image of biorhtogonal

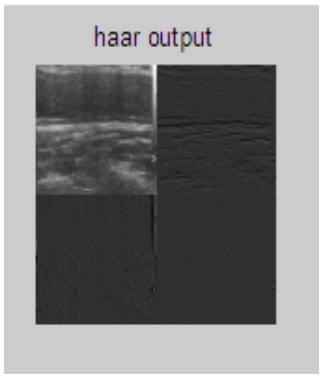

Figure 6: Output image of haar

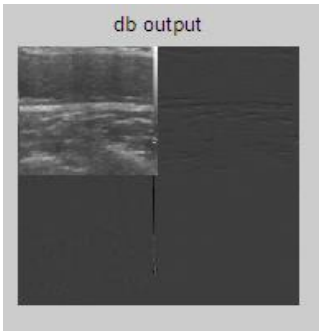

Figure 7: Output image of db

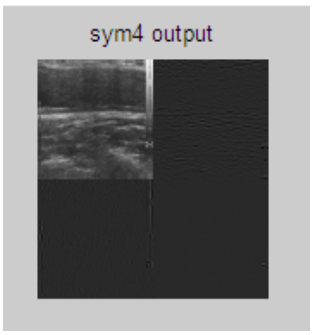

Figure 8: Output image of symlet

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Figure 9: Preprocessing output image

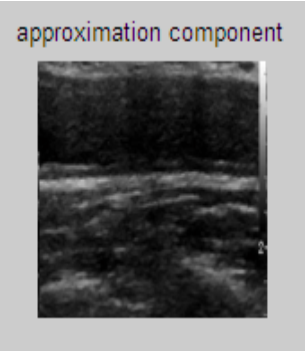

Figure 10: Approximation Component image.

Hardware Description

Matlab application is used to find the results and the results are transferred to RS-232. RS-232 is a standard for serial binary knowledge interconnection between a DTE and a DCE. Electrical signal characteristics such as voltage levels, signaling rate, timing and slew-rate of signals, voltage with stand level, short-circuit behavior, maximum stray capacitance and cable length. Interface mechanical characteristics, pluggable connectors and pin identification. Functions of each circuit in the interface connector. Standard subsets of interface circuits for selected telecom applications. Lots of modern devices can exceed this speed (38,400 and 57,600 bits being common, and 115,200 and 230,400 bit/s making occasional appearances) while still using RS-232 compatible signal levels is suitable. A typical serial port includes specialized driver and receiver integrated circuits to convert between internal logic levels and RS-232 compatible signal are sent to ZigBee transmitter and from there the signals are received in ZigBee receiver. The microcontroller that has been used for this project is from PIC series.LCD is display the result. The hardware tool consists of PC output unit, microcontroller unit and ZigBee transmitter and receiver unit, LCD display, driver, alarm. The Fig.11 shows the block diagram of the tool.

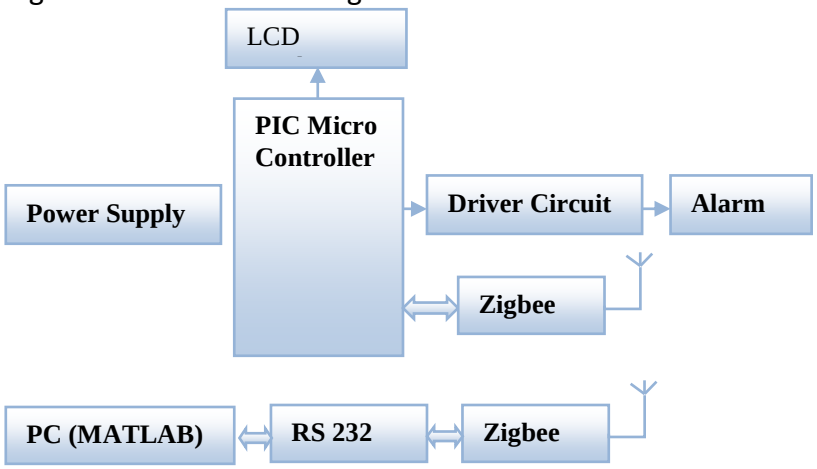

Figure 11: Overview of hardware block diagram

Zigbee Transmision and Reception

The CC2500 is a low cost two.4 GHz transceiver designed for low-power applications. The circuit is intended for the 2400-2483.5 MHz ISM (Industrial, Scientific and Medical) &

SRD (Short Range Gizmo) frequency band.The RF transceiver is integrated with a highly configurable baseband modem. The modem supports various, modulations formats and as a configurable knowledge rate upto 500 kBaud.The CC2500 provides extensive hardware support for packet handling, knowledge buffering, bust transmissions, clear channel assessment, link quality indication & wake-on-radio. ACTIVE Low-power, Low-cost two.4. GHz RF Transceiver Designed for Low-power, Wireless applications in the 2.4 GHz ISM B .The main operating parameters and the 64 byte transmit/receive FIFOs of CC2500 can be controlled by an SPI interface. In a typical process the CC2500 will be used together with a microcontroller & a few additional passive parts.

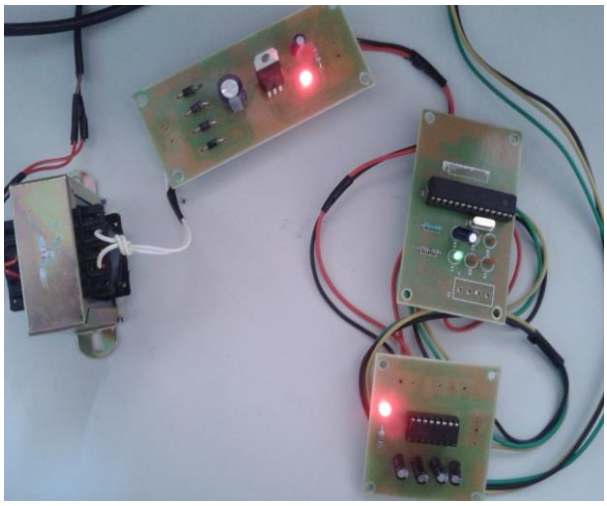

Figure 12: ZigBee Transmitter

Micro Controller

The microcontroller used for this project is PIC series that makes use of separate bus for instruction & knowledge allowing simultaneous access of program & knowledge memory. The main advantage of CMOS & RISC combination is low power consumption leading to a small chip size with a small pin count. The main advantage of CMOS is that it's immunity to noise than other fabrication techniques which is necessary by the project. Expertise that is used in pic16F877 is flash expertise, so that knowledge is retained even when the power is switched off. Simple Programming & Erasing are the other features of PIC 16F877. The PIC start and development process from microchip expertise provides as with a highly flexible low cost microcontroller design gizmo set for operating microchip PIC microcontroller in this project. The PIC start and development process includes PIC start and development programmer & MPLAB IDE. The PIC start and programmer is to program user application in to microcontroller. The PIC start and application jogging under MPLAB provider for full interactive control over the programmer. The above mentioned benefits made us to select this controller for this project. In this project PIC 16F877A is 40 pin package is used & it's input & output ports namely A,B,C,D, & E port connection of microcontroller for this project is as follows.19,20,21,22,27,28,29,30 pins of port C are interconnected with LCD.25 th pins of port D are interconnected with transmitter & 26th pins of port D are interconnected with receiver. 40th pin of port C is interconnected with driver circuit used for alarm.pin 13, 14 are used for providing crystal clock input & output pins 12,31 are used for providing ground reference for input & output pins. Pins 32, 11 used

for providing positive supply to input & output pins.

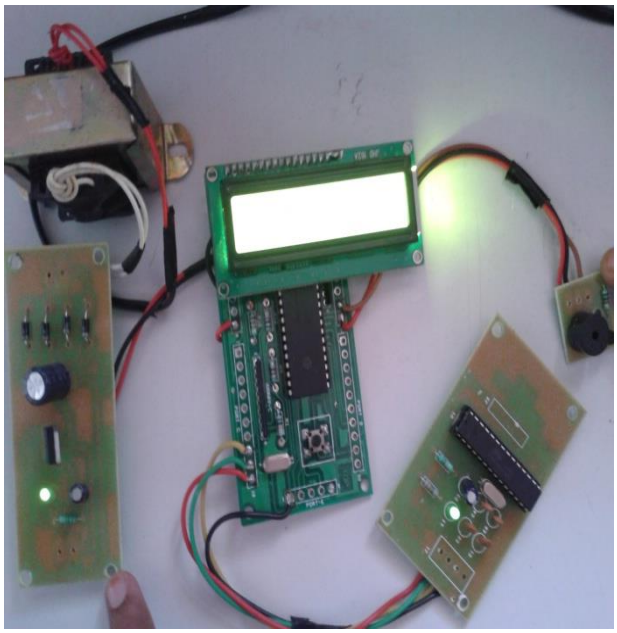

Figure 13: ZigBee Receiver

LCD Display and Alarm

Liquid crystal displays (LCDs) have materials which merge the properties of both liquids and crystals An LCD consists of glass panels, with the liquid crystal material sand witched in between them each polarizer are pasted outside the glass panels.

This polarizer would rotate the light rays passing through them to a sure angle, in a specific direction. The LCD display used in this project is a 16X2 LCD which is interfaced with PIC16F877A. LCD display can be used to get the important details necessary as soon as the driver circuit is used.

The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications. Finally validation of results shows in LCD connector , the information of vulnerability or non vulnerability of plaque is displayed. The LCD has 16 pins which include three controls pins 8 pins and power pins 4 as shown in fig.13

Figure 14: LCD Display Result

A buzzer or beeper is a signaling device, usually electronic, usually used to give an alarm if a button was pushed or a preset time has lapsed, and usually illuminates a light on

the appropriate button or control panel, and sounds a warning in the kind of a continuous or intermittent buzzing or beeping sound which is 5v.

CONCLUSION

Plaque & Blood clot identification from ultrasound images is low cost & can be used by all kind of patients. Physicians or vascular ultrasonographers detect these differences in the coursework of ultrasound scans. The proposed CAD method overcomes a number of the issues faced by the physicians. It can be used as a diagnostic device in modern clinical practice since it can provide decision support with regard to carotid plaque treatment. The method can diagnose the types of plaque & blood clot formations automatically. The CAD method makes use of DWT for feature extraction & can diagnose the classes automatically with an accuracy, sensitivity, & specificity.

The Neural network algorithm is used to classify symptomatic & asymptomatic plaques & blood clot. This accuracy is comparatively higher than those recorded in similar studies in the literature. The proposed method is an effective picture mining method which can serve as an efficient adjunct device for the vascular surgeons in selecting patients for dicy stenosis treatments. The accuracy of the proposed method can be improved further to be incorporated in to method clinical work flow. More research is necessary to improve the classification results.

The future work includes studying more feature extraction techniques in order to improve the accuracy & usage. A number of the areas where future work is necessary: Diagnosing different types of arterial wall disorders by motion and texture analysis, Findings ways for the motion of carotid artery using arterial elasticity and measures for modification of carotid artery in the presence of atherosclerosis.

Finding solution for Blood pressure which induces compressive stress in radial directions and tensile stress.

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