**NERVE SEGMENTATION IN ULTRASOUND IMAGES**

**SUMMARY**

**ACCORDING TO IEEE:**

Today medical field has provided us enormous facilities that has been never thought before. There has been done many improvements in the field of surgery, medicine, X-Rays and many more. But some areas still want some improvements so that patients don't need to face any type of difficulty or pain. This paper is trying to highlight the difficulties and in the treatments that are based on the ultrasound images. So in paper this our main focus is to improve the treatments based on ultrasound scans which is used widely in medical field due to vast area of application and cost effectiveness. These ultrasound scans are very important to detect any kind of injury of disease in human body because it used to scan the internal tissues of the body. One major disadvantage of these images is that they include huge amount of noise so doctors face difficulty in finding the exact location of the nerve where they have to inject the medicine to operate. These pictures are not clear enough to find the neve at once so they have to inject needle very times. With this application they can find the nerve very easily because it includes the segmentation of these nerves in ultrasound images. This application is further extended to train the system with this data so that it can be used worldwide.

Ultrasound guided regional anesthesia (UGRA) is the Regional Anesthesia (RA) technique of injecting the anesthetic in required amounts depending on the region to be covered using ultrasound images of patients. It is one of the fields which is steadfastly growing in medical imaging, providing advances in ultrasound imaging technology. However, nerve identification continues to remain as one of the most challenging tasks that anesthetists can encounter in the UGRA technique of injection. One of the main reasons of this include the low quality of the ultrasound images which are affected by the introduction of unwanted speckle noise. Since, Regional anesthesia (RA) is one of most frequently undertaken tasks in hospitals throughout the world to reduce or nullify the effect of the persistent pain in patients, any discrepancy in providing anesthesia can lead to severe damage to the respective region of the body or side effects to the rest of the body and also to the life of the patient. This enhances the need for correctly identifying the right nerve region to provide anesthesia. In this paper, we survey the conventional methods [1] used in biomedical image processing. For each stage of the processing, we have performed comparison with the different methodologies and we propose a combination of the methods which gives the best performance.

Ultrasound scans are very important to detect any kind of injury or disease in human body because it used to scan the internal tissues of the body. One major disadvantage of these images is that they include huge amount of noise so doctors face difficulty in finding the exact location of the nerves with in the image. This project aims at identifying the nerves, using canny edge detection. Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection include:

* Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible
* The edge point detected from the operator should accurately localize on the center of the edge.
* A given edge in the image should only be marked once, and where possible, image noise should not create false edges.

Peripheral Nerve Blocking (PNB), is a procedure used for performing regional anaesthesia, that comprises the administration of anaesthetic in the proximity of a nerve. Several techniques have been used with the purpose of locating nerve structures when the PNB procedure is performed: anatomical surface landmarks, elicitation of paraesthesia, nerve stimulation and ultrasound imaging. Among those, ultrasound imaging has gained great attention because it is not invasive and offers an accurate location of the nerve and the structures around it. However, the segmentation of nerve structures in ultrasound images is a difficult task for the specialist, since such images are affected by echo perturbations and speckle noise. The development of systems for the automatic segmentation of nerve structures can aid the specialist for locating nerve structures accurately. In this paper we present a methodology for the automatic segmentation of nerve structures in ultrasound images. An initial step is carried out using Graph Cut segmentation in order to generate regions of interest; we then use machine learning techniques with the aim of segmenting the nerve structure; here, a specific non-linear Wavelet transform is used for the feature extraction stage, and Gaussian processes for the classification step. The methodology performance is measured in terms of accuracy and the dice coefficient. Results show that the implemented methodology can be used for automatically segmenting nerve structures.

This project entitled **“Nerve Segmentation in Ultra Sound Images”** is useful for doctors in identifying the correct location of the nerves. The project is also useful in analyzing the Ultra Sound images, which are difficult to analyze, because of low quality/noise in the image. This project finally leads to the improvement of quality of the patients life.

As of now, the system is currently generating the analysis report, based on 10 symptoms and two test results. The system can be further extended to include all symptoms and test results.

**ACCORDING TO ACM:**

The identification of nerve structures is a crucial issue in the field of anesthesiology. But some areas still want some improvements so that patients don't need to face any type of difficulty or pain. This paper is trying to highlight the difficulties and in the treatments that are based on the ultrasound images. So in paper this our main focus is to improve the treatments based on ultrasound scans which is used widely in medical field due to vast area of application and cost effectiveness. These ultrasound scans are very important to detect any kind of injury of disease in human body because it used to scan the internal tissues of the body.

Recently, ultrasound images have become relevant for performing Peripheral Nerve Blocking (PNB) procedures since it offers a non-invasive visualization of the nerve and the anatomical structures around it. However, the location of nerve structures from ultrasound images is a difficult task for the specialist due to the artifacts, i.e., speckle noise, which affect the intelligibility of a given image. Here, we proposed an automatic nerve structure segmentation approach from ultrasound images based on random under-sampling (RUS) and a support vector machine (SVM) classifier. In particular, we use a Graph Cuts-based technique to define a region of interest (ROI). Then, such an ROI is split into several correlated areas (superpixels) using the well-known Simple Linear Iterative Clustering algorithm. Further, a nonlinear Wavelet transform is applied to extract relevant features. Afterward, we use a classification scheme based on RUS and SVM to predict the label of each parametrized superpixel. Thus, our approach can deal with the imbalance issues when classifying a superpixel as nerve or non-nerve. Attained results on a real-world dataset demonstrate that our method outperforms similar works regarding both the dice segmentation coefficient and the geometric mean-based classification assessment. Digital image processing has become an important part of the medical imaging. With the help of image segmentation we can highlight the important part in any medical image that is useful for the doctors to study. So it is very important to accurately segment the image and provide the useful information that can be used by the doctors without any difficulty for the different medical purposes. Ultrasound scans are very useful and widely used because of their less cost, portability and safety but due to the poor image quality of the ultrasound scans we need some processing that can provide us more information to operate based on the ultrasound scans. So it is very important to provide the good segmentation scheme for these ultrasound scans that can be used in medical field and can benefit people. For segmentation of ultrasound images, they have used a graph based approach in their paper.

This paper concentrates on the segmentation of breast lesions in ultrasound scans. This paper focuses on the robust graph based algorithm for segmentation in ultrasound images. In their method they have first converted these images into a graph, then this robust graph method merges the spatially aligned pixels that are neighbors to each other. So they have build a minimal spanning tree with the help of these pixels and these pixels have the same intensities in this minimal spanning tree which corresponds to the subgraph. So like this images can be grouped into several subgraphs or sub regions. The final segmentation can be achieved by merging these forests of the minimal spanning trees Image preprocessing: In this module we have applied some preprocessing techniques to the ultrasound images. Ultrasound images contains some speckle noise into them due to that it is hard to extract information out of them. So for this purpose we have used some filters for the images so that we can reduce this speckle noise form ultrasound images. Nerve Segmentation: After applying the image preprocessing we get the preprocessed images which do not contain any type of noise. These image can be further used for image segmentation. For image segmentation or to segment the nerve area from the ultrasound images we have used edge detection algorithm or canny operator algorithm in python that can detect the edges very efficiently with the help of the sobel operator. The input images are being converted into 2D arrays. In this we have given input for train and test images and these images are converted into arrays and then saved in the form of arrays. This we have achieved with the help of python numpy array. Now we will give this data as an input to the machine learning algorithm to train the system. For training the system the array of train images will be given to the fit model of machine learning algorithm and the predict model will predict out of learning on the test images. Canny Algorithm: Firstly it will apply the Gaussian filter to remove the noise from the image then it will find the intensity gradient in the image. This gradient is divided into two factors for vertical and horizontal then these factors are merged and final edge gradient with direction will be calculated. Then it will apply an edge thinning technique so that the edges will not get blurred.

Finally it will apply the double threshold to keep the less gradient edges secure with the high gradient edges. Machine learning: In this module we will train the system with the help of the results that we get from the nerve segmentation. All the data that we get as the result of the nerve segmentation will be loaded into the machine learning algorithm. We will use support vector machine learning algorithm to train the system for nerve segmentation in ultrasound images. After this learning the system will be trained and it will be able to predict the nerve area in the new set of ultrasound images. In this module we have applied some preprocessing techniques to the ultrasound images. Ultrasound images contains some speckle noise into them due to that it is hard to extract information out of them. So for this purpose we have used some filters for the images so that we can reduce this speckle noise form ultrasound images.

**ACCORDING TO AIESL:**

There is a great need for providing the anaesthesiology specialists with comprehensive tools tosucceed safer routine local regional anaesthesia (LRA) practice into the operating room. To this goal, during the last decade, high resolution ultrasound images have been used to detect the nerve regions of a so-called “block” and provide the medical anaesthesiologist with the appropriate needle localisation. The goal is to provide the best path for the needle insertion, with respect to each patient’s anatomy, to safely reach the relevant nerve region and distribute the anesthetic. In this context, this paper presents an approach for an automatic detection of the nerves, based on the analysis of high frequency ultrasound images; this will help the specialist to fully identify the required “block” for the local anaesthesia. The problem however is quite difficult: The appearance of nerves may vary depending on the nerve’s size, the depth from the skin surface, the body region, and the probe frequency. Also, the general nerves structure, organised as a honeycomb structure, is very complex in term of ultrasound image analysis, as it is constituted of combined hypo- and hyper- echoic areas. A single segmentation approach is therefore not sufficient to address such kind of images; in this paper two segmentation schemes are proposed to identify and localise the the nerves. Results showing the detected nerve regions in ultrasound image prove the effectiveness of the proposed method.

General anaesthesia is a medical act that eliminates the feeling of pain as well as the motor reflexes of a person in order to perform surgical operations. It is accompanied by a loss of consciousness andmajor functions (e.g. breathing), which often requires the patient to be intubated. Contrary to general anaesthesia, loco-regional anaesthesia (LRA) allows to anaesthetize specific parts of the body to perform minor or intermediate surgical acts. The patient remains conscious and does not lose respiratory functions. It is, therefore, an efficient and less intrusive technique, which offers patients a prompt post-surgical recovery and reduces hospital length of stay.

However, LRA is a complex patient-dependant technique, which requires a long learning process andyears of practice in real operating room. Under the current protocol, the anaesthesiologist uses general anatomical references to decide the best possible puncture point from which he/she will insert the electric stimulated needle to search for the relevant nerve. This high skill protocol is not without risk and may generate nerve or lung puncture (paresthesia, pneumothorax), or anaesthetic injection in arteries.

We aim at providing the anaesthesiology specialists with a comprehensive tool to improve and provide safer routine LRA practice into the operating room [1] [2]. This assisting control will offer a real-time interactive tool to provide the best path for the needle, with respect to each patient’s anatomy, to safely reach near the relevant nerve region and distribute the aesthetic [3] [4]. With the development of new high frequency ultrasound imaging, anaesthetists can now use echography to visualize and identify nerves from other anatomical parts (e.g.: arteries, muscles).

However, the nerve detection ultrasound approach is not widely used yet in the LRA as it is an expert dependant technique; The lack of ultrasound experts makes it difficult to provide dual expertise, ultrasound analysis and anaesthesia, in routine in the pre-operating room.

In this context, this paper presents a preliminary framework for an automatic detection of the nerves based on the analysis of high frequency ultrasound images to assist the anaesthesiologist in its medical act; this will help the specialist to fully identify the required so-called “block” for the localanaesthesia. The nerves shown in ultrasound images and to be detected for LRA, can be described as hypoechoic (black) regions with hyperechoic (bright) perimeter constituting a Honeycomb pattern (many small circles with a hypoechoic centre and hyperechoic perimeter – see Fig 1a). Please notice that depending on the body part, this hoeycomb pattern may contain few (or even just one) hypoechoic.

The goal of this paper is to employ efficient image segmentation algorithms which identify nerves (according tothe respective patterns) in ultrasound scans. This task of locating the nerves regions in ultrasound is a very difficult problem since the appearance of nerves may vary depending on the nerve’s size, the depth from the skin surface, the body region, and the probe frequency. Also, the general nerves structure, organised as a honeycomb structure, is very complex in term of ultrasound image analysis. Althought these difficulties, the proposed approaches have shown a good detection of the nerves regions in agreement with the expert’s ground truthhe real time processing however is still to be improved especially for the GVF method using for instance the parallel programming with GPU. This will be a strong requirement for in vivo future applications. One of the future works is to combine the two proposed methods as a hybrid approach to handle any nerve regions segmentation. These preliminary results demonstrate the relevance of the two segmentation methods; they have to be further explored in various nerves areas and tested in a significant number of patients, before being validated for automatic needle insertion during LRA.