

Cell Nuclei Segmentation and classification Using Feed Forward Neural Networks

Riya Paul, K Malathy M.E

Infant Jesus College Of Engineering And Technology

Abstract:

The main objective of this project is cell nuclei segmentation and classification. In pre-processing convert the gray scale and apply the segmentation. In segmentation this project proposes the graph cut algorithm. After segmentation the features are extracts such as texture and etc. In classification this project used the feed forward neural network. The proposed method is very efficient. The feed forward neural network is very efficient for classification.

1. Introduction:

Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. The application of image processing is classification, feature extraction, pattern recognition and etc. Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. More precisely, image segmentation is the process of assigning a label to every pixel

in an image such that pixels with the same label share certain characteristics. Segmentation of the body plan is important for allowing different regions of the body to develop differentially for different uses. While many details will be discussed here, there are other details about the process of establishing such a segmented body pattern in morphogenesis. Medical imaging is the technique and process used to create images of the human body (or parts and function thereof) for clinical purposes (medical procedures seeking to reveal, diagnose, or examine disease) or medical science (including the study of normal anatomy and physiology). Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are not usually referred to as medical imaging, but rather are a part of pathology.

Medical imaging is the technique, process and art of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. Although imaging of removed organs and tissues can be performed for medical reasons, such procedures are usually

considered part of pathology instead of medical imaging.

Digital Pathology is an image-based information environment enabled by computer technology that allows for the management of information generated from a digital slide. Digital pathology is enabled in part by virtual microscopy, which is the practice of converting glass slides into digital slides that can be viewed, managed, and analyzed on a computer monitor. With the advent of Whole-Slide Imaging, the field of digital pathology has exploded and is currently regarded as one of the most promising avenues of diagnostic medicine in order to achieve even better, faster and cheaper diagnosis, prognosis and prediction of cancer and other important diseases.

Nuclei are a mass of nerve cells in the brain or spinal cord in which nerve fibers form connections. Breast cancer classification divides breast cancer into categories according to different schemes, each based on different criteria and serving a different purpose. The major categories are the histopathological type, the grade of the tumor, the stage of the tumor, and the expression of proteins and genes. As knowledge of cancer cell biology develops these classifications are updated.

2. Related Work:

A. D. Belsare [1] This paper reviews computer assisted histopathology image analysis for cancer detection and classification. Histopathology refers to the examination of invasive or less invasive biopsy sample by a pathologist under microscope for locating, analyzing and classifying most of the diseases like cancer. The analysis of histoapthological

image is done manually by the pathologist to detect disease which leads to subjective diagnosis of sample and varies with level of expertise of examiner. The pathologist examine the tissue structure, distribution of cells in tissue, regularities of cell shapes and determine benign and malignancy in image. In this paper[2] describe a new technique for general purpose interactive segmentation of N-dimensional images. The user marks certain pixels as “object” or “background” to provide hard constraints for segmentation. Additional soft constraints incorporate both boundary and region information. Graph cuts are used to find the globally optimal segmentation of the N-dimensional image. The obtained solution gives the best balance of boundary and region properties among all segmentations satisfying the constraints. The topology of our segmentation is unrestricted and both “object” and “background” segments may consist of several isolated parts. Some experimental results are presented in the context of photo/video editing and medical image segmentation. J. P. Thiran [3] This paper presents a new method for automatic recognition of cancerous tissues from a microscopic image. This method provides the physician with non subjective numerical values for four criteria of malignancy. This technique is used to remove the background noise from the image and then to operate a segmentation of the nuclei of the cells and an analysis of their shape, their size and their texture. Xiaofan Zhang [4] In this paper focus on a scalable image retrieval method with high-dimensional features for the analysis of histopathology images. This paper presents a kernelized and supervised hashing method. With a small amount of

supervised information, our method can compress a 10,000-dimensional image feature vector into only tens of binary bits with informative signatures preserved, and these binary codes are then indexed into a hash table that enables real-time retrieval. This paper validate the hashing-based image retrieval framework on several thousands of images of breast microscopic tissues for both image classification (i.e., benign vs. actionable categorization) and retrieval. T. F. Chan [5] In this paper propose a new model for active contours to detect objects in a given image, based on techniques of curve evolution, Mumford–Shah functional for segmentation and level sets. Our model can detect objects whose boundaries are not necessarily defined by gradient. This method automatically detects interior contours starting with only one initial curve. The position of the initial curve can be anywhere in the image, and it does not necessarily surround the objects to be detected.

In existing use many cancer cell segmentation. Breast cancer is one of the most common cancers among woman of the developing countries in the world, and it has also become a major cause of death. For cancer diagnosis and grading, it is essential to examine the tissue specimens of histopathological images. This examination depends on visual interpretation of pathologists. To overcome this problem proposed the cell nuclei segmentatiuon. This project proposes an efficient segmentation of cell nuclei in breast histopathology images and its classification using neural network. The segmentation of cell nuclei is an important step in automatic analysis of digitized microscopic images, hence Graph cut

algorithm is used for segmentation .After segmentation of cell nuclei features are extracted and are given as input to the Feed Forward Neural Network for classification of cell nuclei.

3. Methodology:

3.1 System Architecture:

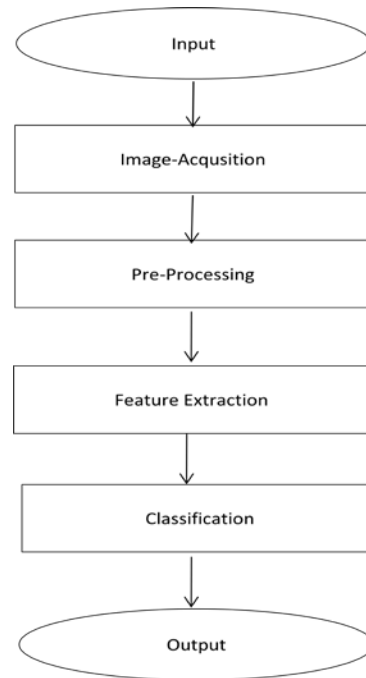


Fig: 1 block diagram

3.2 Modules:

3.2.1 Image Acquisition:

Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. The first stage of any vision system is the image acquisition stage.

After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. Before any video or image processing can commence an image must be captured by a camera and converted into a manageable entity. This is the process known as image acquisition.

3.2.2. Image Pre-Processing:

The main goal of the pre-processing to enhance the visual appearance of images and improve the manipulation of datasets. Pre-processing of image are those operations that are normally required prior to the main data analysis and extraction of information. Image pre-processing, also called image restoration and involves the correction of distortion, degradation, and noise introduced during the imaging process. Image pre-processing can significantly increase the reliability of an optical inspection. Several filter operations which intensify or reduce certain image details enable an easier or faster evaluation.

This project the pre-processing done in 3 ways. Gray scale conversion, denoising and Image Enhancement.

3.2.3 Gray Scale Conversion:

The captured image is stored in RGB color. This RGB color space is converted in to gray scale image. The image acquired is in RGB color. It is converted into gray scale because it carries only the intensity information which is easy to process instead of processing three components R (Red), G(Green), B(Blue). to take the RGB

values for each pixel and make as output a single value reflecting the brightness of that pixel. One such approach is to take the average of the contribution from each channel: $(R+B+C)/3$. However, since the perceived brightness is often dominated by the green component, a different, more "human-oriented", method is to take a weighted average, e.g.: $0.3R + 0.59G + 0.11B$.

3.2.4 Reducing Noise:

Histopathology images are corrupted with different kinds of noise while image acquisition. The noise in the image is reduced by using Median filter. The median filter is normally used to reduce noise in an image. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

The median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the mean of neighboring pixel values, it replaces it with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value.

3.2.5 Image Enhancement:

Image enhancement is the process of improving the quality of a

digitally stored image by manipulating the image. It is quite easy, for example, to make an image lighter or darker, or to increase or decrease contrast. This project using fuzzy enhancement.

In the field of image enhancement, a rule is capable of performing a simple smoothing action as follows: If a pixel is much brighter (darker) than neighboring pixels THEN reduce (increase) its luminance, else leave it unchanged. Application of theory of fuzzy sets to image analysis is to consider images as fuzzy subsets of a plane. The use of fuzzy sets provides a basis for a systematic way for the implementation of vague and imprecise concepts. The manipulation of these concepts leads to theory of approximation using fuzzy systems in image processing. If the observed data are disturbed by random noise then the fuzzification operator should convert the probabilistic data into fuzzy numbers or fuzzy (possibilistic) data, so that computational efficiency is enhanced since fuzzy numbers are much easier to manipulate than random variables.

3.2.6 Segmentation:

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. This project using the graph-cut segmentation.

Graph cut segmentation is an image segmentation method based on combinatorial optimization techniques. The graph cut method produces a binary segmentation, where the boundary between the object and the background is located at strong edges in the image. Given a set of labels L and a set of sites S , the labelling problem is to assign a label $f_p \in L$ to each of the sites $p \in S$. The label set is $L = \{0,1\}$, where 0 corresponds to the background and 1 corresponds to the object. Let $f = \{f_p | f_p \in L\}$ stand for a labeling, i.e. label assignments to all pixels. An energy function is formulated as:

$$E(f) = \sum_{p \in S} D_p(f_p) + \lambda \sum_{\{p,q\} \in N} \omega_{pq} \cdot T(f_p \neq f_q)$$

3.2.7 Feature Extraction:

After segmentation, features are extracted either at the cellular or at the tissue-level to measure morphological characteristics of image for abnormality or to classify the image for different grades of disease. The cellular-level features focuses on quantifying the properties of individual cells without considering spatial dependency between them. For a single cell, the morphological, textural, fractal, and/or intensity-based features can be extracted. The aim of the diagnosis step is (i) to distinguish benignity and malignancy or (ii) to classify different malignancy levels by making use of extracted features.. These can be used for analysis of histology image as 1) normal or abnormal image, 2) for identifying grades of cancer. Gray Scale, Texture, Symmetrical and morphological features are extracted. These extracted features are given as input

to feed forward neural network for classification

3.2.8 Classification:

The Feed Forward neural network consists of neurons, that are arranged into the layers. The first layer is the input layer, the last layer is called the output layer, and the layers between input layer and output layers are hidden layers. This network's information flows only in one direction that is forward, from input towards the output. The input to this Feed Forward neural network is the features extracted from the cell nuclei of the Histopathology image. The Back propagation algorithm is used to train this Feed forward neural network.

1. Calculate weighted sums in the first hidden layer
2. Apply the activation function
3. Calculate the weighted sum
4. Get the results

4. Results

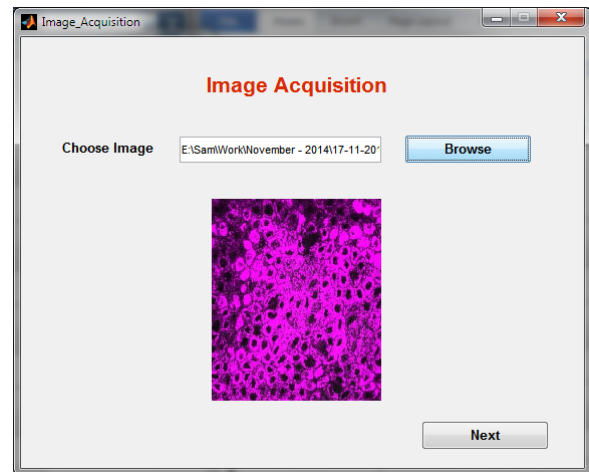


Fig: 4.1 Image Acquisition

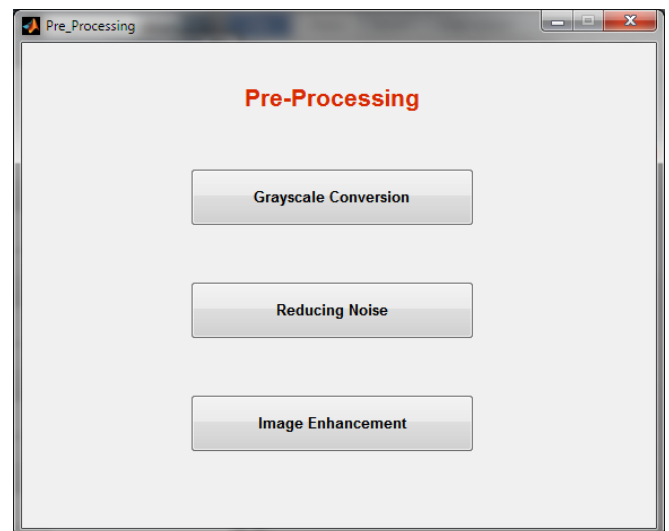


Fig: 4.2 Pre-Processing

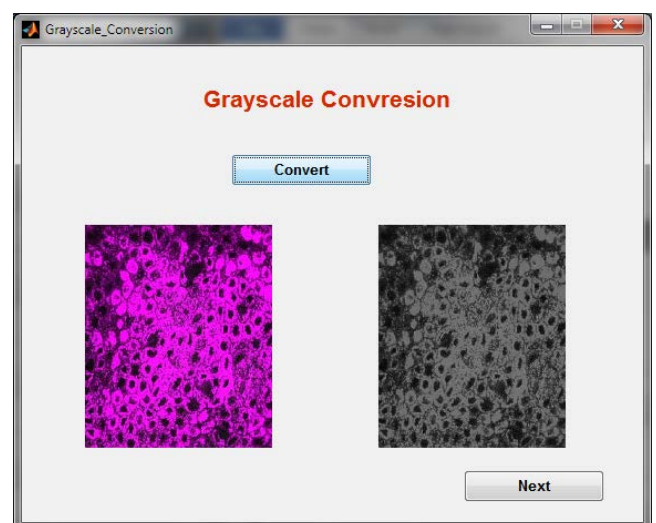


Fig: 4.3 Gray Scale Conversion

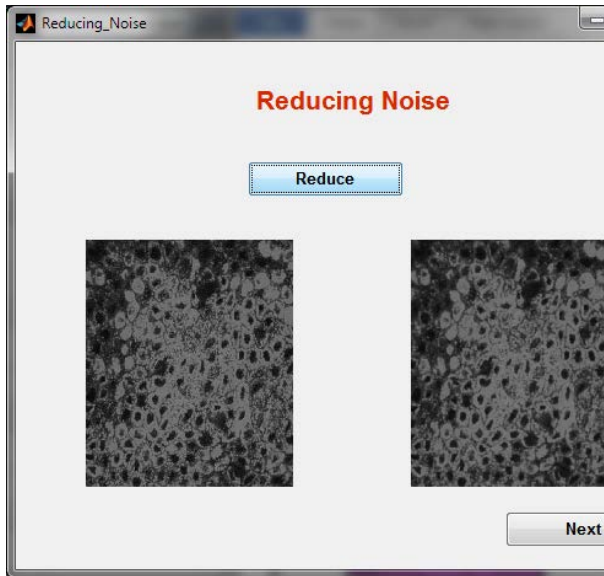


Fig: 4.4 Reduce noise

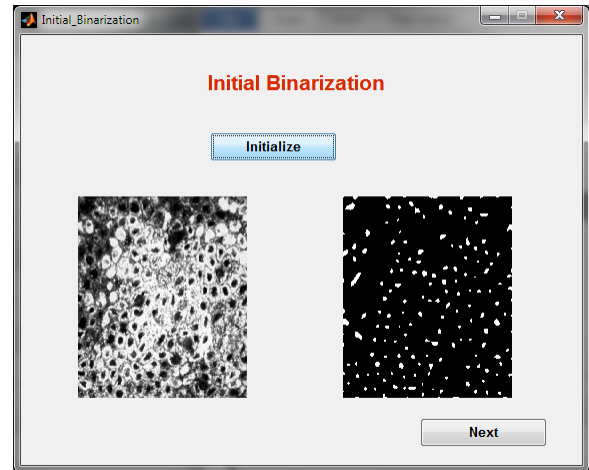


Fig: 4.7 Initial Binarization

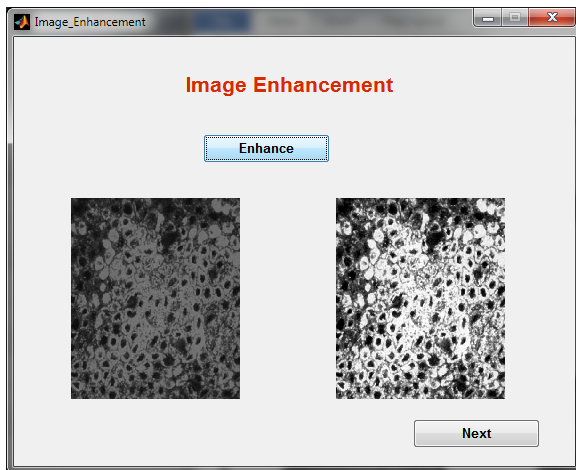


Fig: 4.5 Image Enhancement

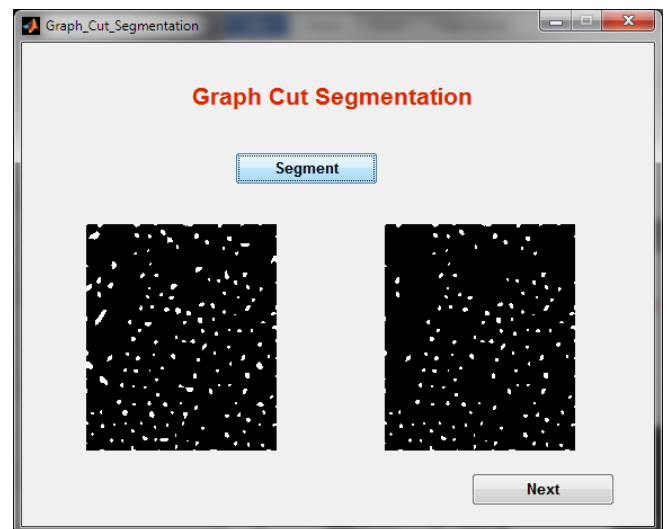


Fig: 4.8 Graphcut Segmentation

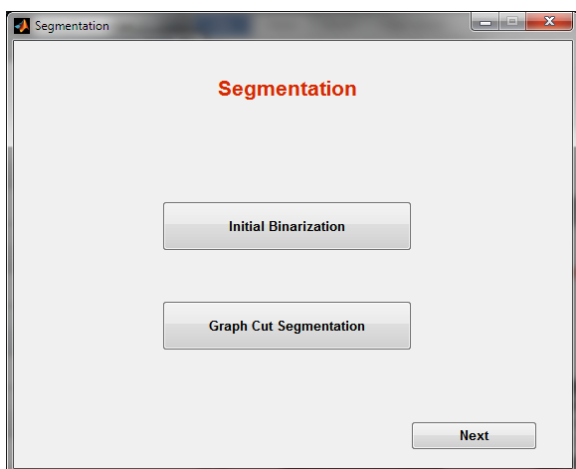


Fig: 4.6 Segmentation

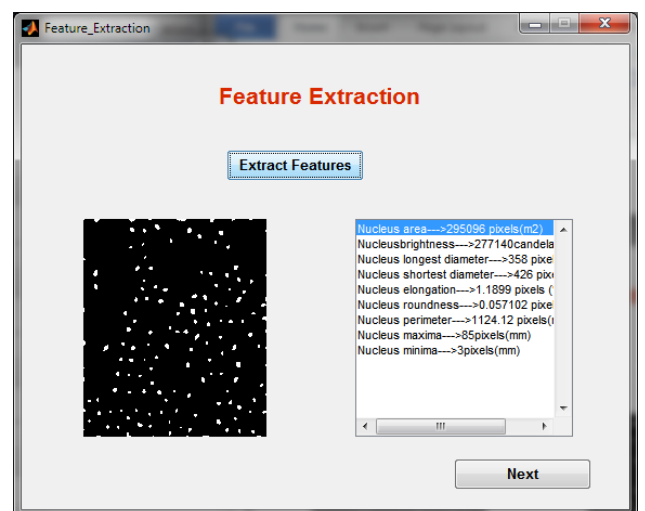


Fig: 4.9 Feature Extraction

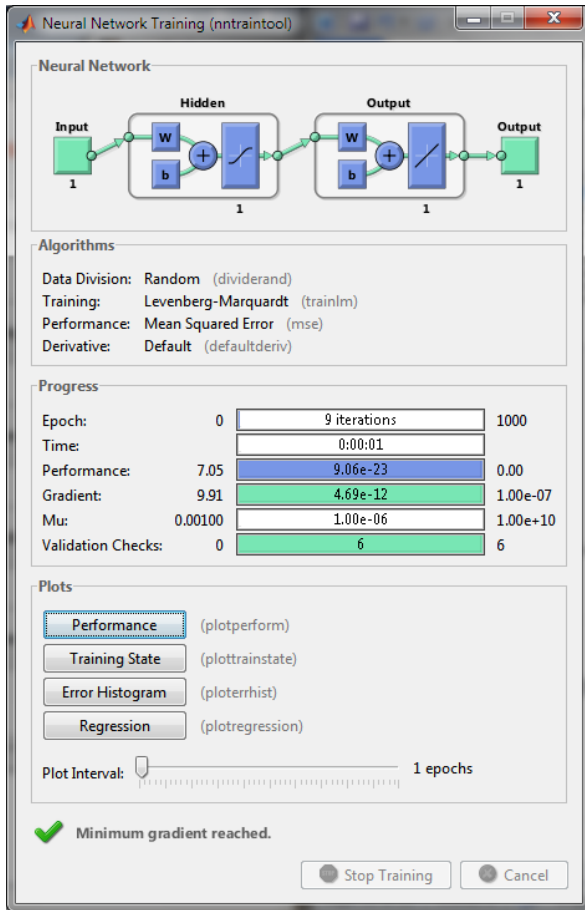


Fig: 4.10 Feed Forward Neural Network

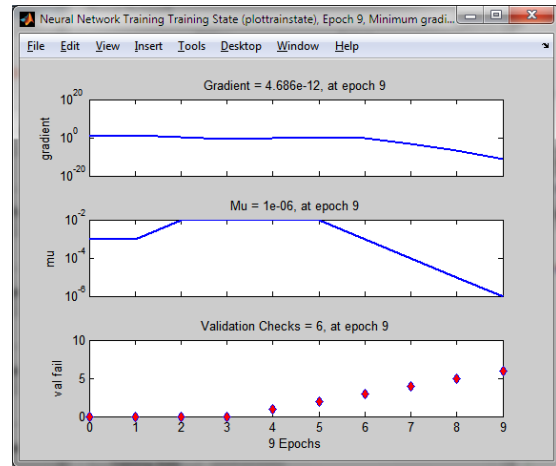


Fig: 4.12 Gradient

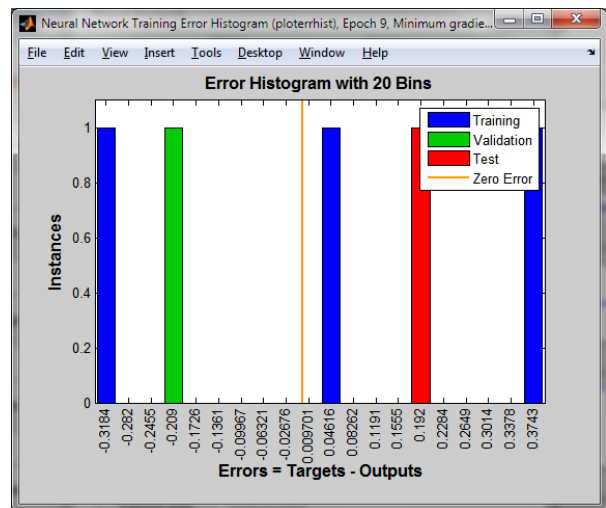


Fig: 4.13 Error Histogram

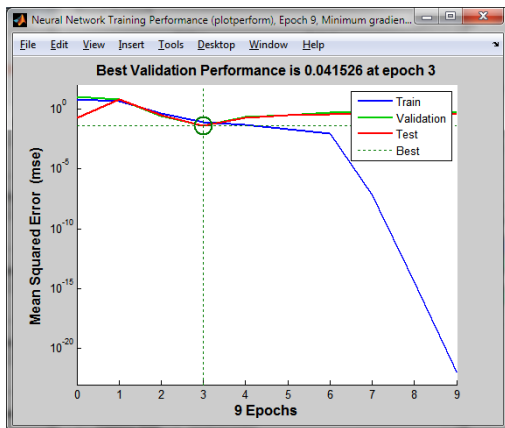


Fig: 4.11 MSE Value

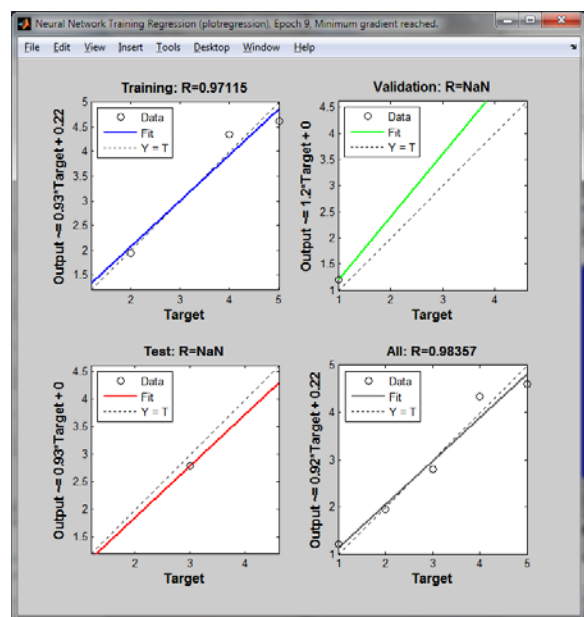


Fig: 4.14 Results

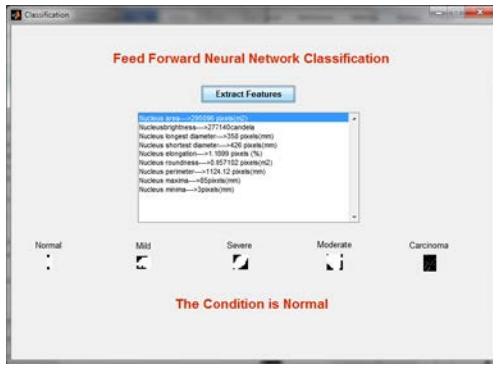
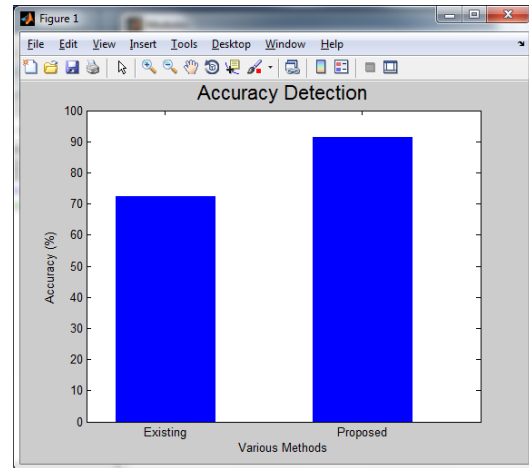


Fig: 4.15 Classification



Experimental Results:

Performance Metrics:

Accuracy:

Accuracy is the measurement system, which measure the degree of closeness of measurement between the original value and the extracted value.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN}$$

Where, TP – True Positive (equivalent with hit)

FN – False Negative (equivalent with miss)

TN – True Negative (equivalent with correct rejection)

FP – False Positive (equivalent with false alarm)

Performance Evaluation

To compare the existing and proposed method with the accuracy. The following graph shows the results.

5. Conclusion:

This project proposed the cell segmentation in breast histopathology. In pre-processing convert the gray scale and apply the segmentation. In segmentation this project proposed the graph cut algorithm. After segmentation the features are extracted such as texture and etc. In classification this project used the feed forward neural network. The proposed method is very efficient. The experimental results show the performance of proposed system.

Reference:

[1] A. D. Belsare1 and M. M. Mushrif “Histopathological Image Analysis Using Image Processing Techniques: An Overview” Signal & Image Processing : An International Journal (SIPIJ) Vol.3, No.4, August 2012

[2] Boykov, Y., Jolly, M. P.: Interactive graph cuts for optimal boundary and

region segmentation. International Conference on Computer Vision, vol. I,(2001).

[3] J. P. Thiran and B. Macq, “Morphological feature extraction for the classification of digital images of cancerous tissues,” *IEEE Trans. Biomed. Eng.*, vol. 43, no. 10, pp. 1011–1020, Oct. 1996.

[4] Xiaofan Zhang, Wei Liu, Shaoting Zhang “Mining Histopathological Images Via Hashing-Based Scalable Image Retrieval” IBM T. J. Watson Research Center, NY, USA

[5] T. F. Chan and L. A. Vese, “Active contours without edges,” *IEEE Trans. Image Process.*, vol. 10, no. 2, pp. 266–277, Feb. 2001.

[6] Hussain Fatakawala, Ajay Basavanahally “Expectation Maximization driven Geodesic Active Contour with Overlap Resolution (EMaGACOR): Application to Lymphocyte Segmentation on Breast Cancer Histopathology” Authorized licensed use limited to: Rutgers University. Downloaded on September 28, 2009 at 16:05 from IEEE Xplore.

[7] O. Lezoray and H. Cardot, “Cooperation of color pixel classification schemes and color watershed: A study for microscopic images,” *IEEE Trans. Image Process.*, vol. 11, no. 7, pp. 783–789, Jul. 2002.