A Proposed model for the Implementation of Cloud based Decision Support System for Diagnosis of Breast Cancer using Digital Mammograms

Veeresh Mulimani
Department of Computer Science and Engineering
MMEC, Belgaum, Karnataka, India

D.A. Kulkarni
Department of Computer Science and Engineering
GIT, Belgaum, Karnataka, India

Abstract- In this paper, we propose the recent development and application of Cloud computing in diagnosis of breast cancer. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications. Currently, the most common method for breast cancer is the X-ray mammography due to its simplicity, portability and cost effectiveness. The main application of this proposed work is focused in developing a cloud based decision support system for screening breast cancer using digital mammograms. The system can be deployed in a private cloud as software / infrastructure as a service. The combination of image enhancement techniques, feature extraction techniques, feature selection techniques, ensemble of neural networks for classification, results verification process and deployment in the private cloud are added advantages for effective performance of the system.

Keywords – Breast cancer, Digital Mammograms, Neural Networks, Feature extraction, Feature selection, Cloud computing.

I. INTRODUCTION

Cancer detection has become a significant area of research in pattern recognition community. Breast cancer is one of the leading causes of cancer mortality among women in the United States [2]. Although breast cancer is a potentially fatal condition, early diagnosis of disease can lead to successful treatment. Early diagnosis needs a precise and reliable diagnostic procedure that allows physicians to distinguish between benign breast tumors and malignant ones [4]. In the last two decades, breast cancer has been the second leading cause of cancer deaths among in the United States of America, following lung cancer. According to an estimated 232,340 new cases of invasive breast cancer were expected to occur among women in the United States of America during 2013; about 2,240 new cases are expected in men [5]. Out of the 232,240 cases, 39,620 breast cancer deaths were expected. Every year 27% of the new cancer cases in women are breast cancers and the leading cause of death of women between the ages of 35 and 54 are due to breast cancer. Mammography using low energy X-ray of human breast called mammograms are the first step in screening and detecting breast tumors [4]. Digital mammography is a specialized form of mammography that uses digital receptors and computers instead of x-ray film to help examine breast tissue of breast cancer [3]. Digital mammograms are better at detecting early stage breast cancer. However the sensitivity of mammography varies with an increase in breast density. Independent double reading by two radiologists has been shown to improve the sensitivity, but it also increased the cost of the screening process. Sometimes the radiologists for second opinion may be unavailable. Hence there is need for automated systems for decision making.

Clinical decision support systems (CDSS) assist physicians in the decision of diseases thus reducing errors in diagnosis. There are two types of CDSS, namely those using knowledge base and inference engine and those using machine learning algorithm [1]. Machine learning algorithms based systems is fast and effective for a single disease. They can give a second opinion to the physician to aid in selecting the treatment strategies without human intervention. Some of the limitations of these image processing systems are standalone systems, need lots of storage

and processing powers and increased cost of maintenance. These cloud boundaries can be prevailed by providing a CDSS in the cloud. In this we develop a breast cancer decision support system (BCDSS) to diagnose breast cancer from digital mammograms using the cloud [1]. The system is projected to guide radiologists and physician in the breast cancer decision making process.

II. PROPOSED MODEL

The system is intended to support the end users were they can get the results easily. It also assists physicians and radiologists without human intervention thus saving expert human resources. It helps in early detection of mammogram cancer cells. The system is deployed in a private cloud computing environment and implemented as software / infrastructure as a service to ensure data security and to support both novice and expert users. The system uses image enhancement techniques to improve the quality of mammograms. Image enhancement techniques, feature extraction and selection techniques, validation metrics together with ensemble of classifiers yield a high accuracy, performance and cost effective system. The neural networks is used in order to detect the cancer cells and diagnose them which is a reliable and precise diagnostic procedure. Only authenticated users can have access to the BCDSS system. Figure 1 shows the architecture of the BCDSS system.

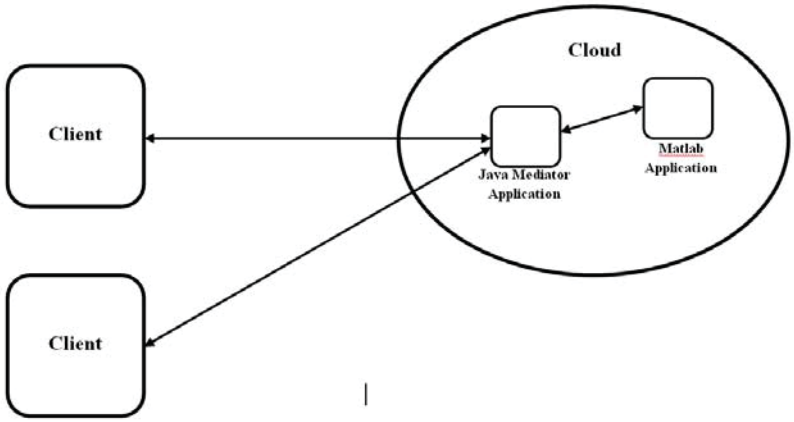

Figure 1: Architecture of the proposed system

III. ROLE OF CLINICAL DECISION SUPPORT SYSTEMS

The cloud offers hardware and software services as virtualization of resources on the internet managed by third parties. These services include advanced software applications and high end networks and servers. These services are offered to the end user without the necessity of knowledge of the systems utilized by them. CDSS for screening breast cancer using digital mammograms need high performance image processing systems, expertise persons for operation and maintenance. They are also stand alone and expensive systems. When CDSS are offered in the cloud end users are benefited with reduced cost, increased storage, flexibility, portability, scalability, maintenance etc. Additionally as the data is stored in the cloud the data is not lost during the shifting of hospitals, hardware errors, earthquake etc.

IV. ROLE OF BREAST CANCER DECISION SUPPORT SYSTEM

Breast cancer decision support system BCDSS is deployed in a private cloud as software as a service for a particular platform i.e. health care in the breast cancer domain. Private clouds offer a higher level of security and regulatory compliance than most public cloud implementations. This enables high security and control over the data. The end users have no worry about the updating, upgrading or maintenance of the system. BCDSS is an image processing system processes digital mammograms. The hospitals/testing centers registered in the cloud can store the digital mammography images in the virtual storage area. These images can be processed either in individual or batch mode. If batch mode is selected the loop will continue processing until no mammograms remain for processing. Figure 2 shows the stages in BCDSS.

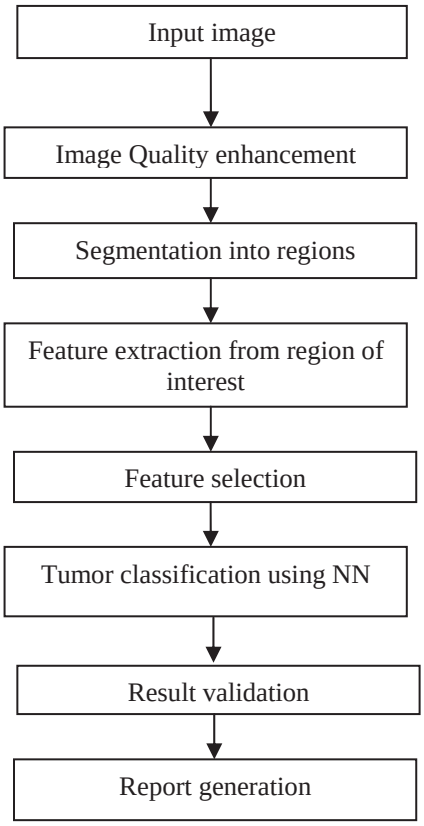

Figure 2: Stages in BCDSS

The sequence of steps in BCDSS is as follows:
Step 1: Image preprocessing techniques like smoothing, sharping, pectoral muscles removal are used to improve the quality of the mammograms.
Step 2: The resultant image is segmented into different regions.
Step 3: Features are extracted from the region of interest.
Step 4: From the extracted features using feature selection techniques a subset of the best features are selected for further processing.
Step 5: Classification of selected features using Ada boost with neural networks as base classifier.
Step 6: The classification results are validated using performance metrics
Step 7: Reports are generated for the processed mammograms.

The generated reports are stored in the data center of the server which can be viewed/printed by the hospitals [1]. As each hospital's data and reports are stored in separate files the hospitals who own the data only can access them after authentication. Therefore data and reports will be secured from unauthorized access. High accuracy of the system will be maintained by cross validation of the results. Only the best features from the region of interest are used for classification to enable faster performance. Artificial neural networks (ANN) are used as the base classifier. The benefits of neural networks namely easy implementation, ability to learn and generalize the patterns similar to humans, adaptability in learning, distribution of knowledge in the entire network, effective learning even features in high dimensional space and ability to predict correctly even with noisy irrelevant features have made us to choose ANN as a base classifier for the system. In addition, the Ada boost technique of ensemble approach is used to improve the predictive accuracy of the ANN. Ada boost algorithm, first introduced by Freund & Schapire improves the performance of any given classifier.

V. IMAGE ENHANCEMENT

Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing `better' input for other automated image processing techniques. The principal objective of image enhancement is to modify attributes of an image to make it more suitable for a given task and a specific observer. During this process, one or more attributes of the image are modified. The choice of attributes and the way they are modified are specific to a given task. Moreover, observer-specific factors, such as the human visual system

and the observer's experience, will introduce a great deal of subjectivity into the choice of image enhancement methods. There exist many techniques that can enhance a digital image without spoiling it.
The enhancement methods can broadly be divided in to the following two categories, Spatial Domain Methods and Frequency Domain Methods, figure 3 shows the techniques of enhancement of image. In spatial domain techniques [7], we directly deal with the image pixels. The pixel values are manipulated to achieve desired enhancement. In frequency domain methods, the image is first transferred in to frequency domain. It means that, the Fourier Transform of the image is computed first. All the enhancement operations are performed on the Fourier transform of the image and then the Inverse Fourier transform is performed to get the resultant image. These enhancement operations are performed in order to modify the image brightness, contrast or the distribution of the grey levels.
As a consequence the pixel value (intensities) of the output image will be modified according to the transformation function applied on the input values. Image enhancement is applied in every field where images are ought to be understood and analyzed. For example, medical image analysis, analysis of images from satellites etc.

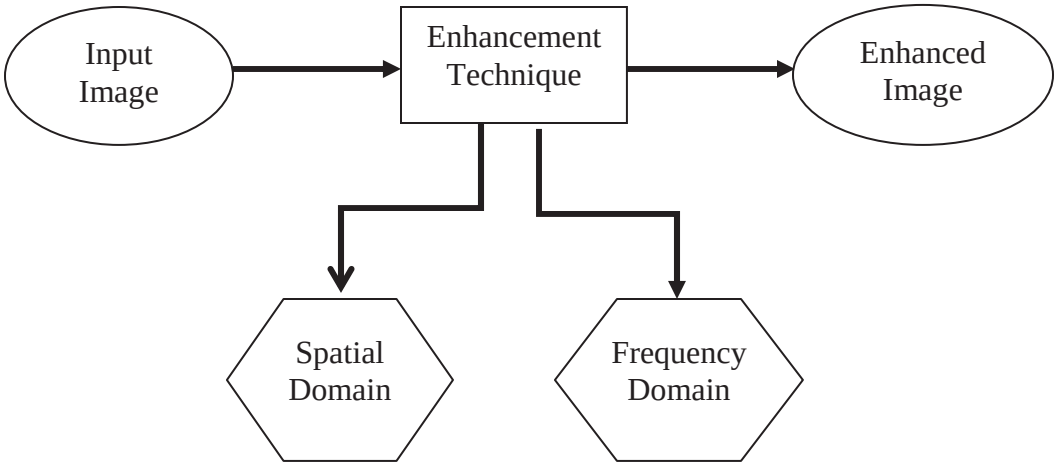

Figure 3: Image Enhancement Techniques

In digital image processing some general image intensification method like average value filter, the low pass filtering, the edge enhancement and so on mainly aim in the image the stochastic noise, but in the fuzzy image's grain line flaw belongs to the constitutive noise, therefore is not ideal to the image's enhancement effect. The essential procedure is to the primitive gradation image after the lowpass filtering, the histogram transformation and so on general image intensification method carries on processing, carries on the binaryzation and refinement processing. This way's basic flaw will be the binaryzation and refinement processing will not only lose the useful pictorial information. Also has some algorithms is carries on the image enhancement on the primitive gradation image. The people proposed uses has the direction and the frequency selection characteristic band pass filter carries on image enhancement processing the thought. Figure 4 shows the basic diagnosis Process.

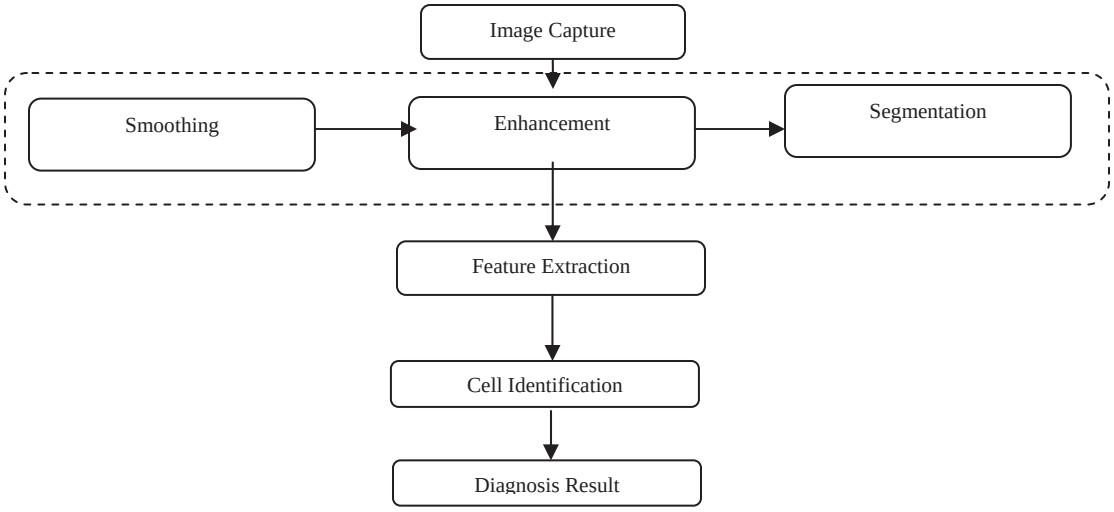

Figure 4: Diagnosis Process

VI. PROBLEMS FACED

The main challenge in the proposed system is to implement the system on the private cloud computing environment and implement as software / infrastructure as a service to ensure data security and to support both novice and expert users.

1. To understand the medical background for disease, its types, risks, symptoms, tests and treatments.
2. To recognize the importance of Image enhancement stage by applying several techniques on given images to get better level of quality and clearness.
3. To work on image segmentation algorithms which are playing an effective rule in image processing stages.
4. To obtain the general features from enhanced segmented image which give indicators of normality or abnormality of images.

VII. BENEFITS OF THE PROPOSED MODEL

- The system can be used either in single or batch processing mode
- The system is deployed in a private cloud computing environment as Software / infrastructure as a service.
- Due to the deployment in the private cloud high security for the patients' data.
- Only authenticated users can have access to the BCDSS system.
- Image enhancement techniques, feature extraction and selection techniques, validation metrics together with ensemble classifiers yield a high accuracy, performance and cost effective system.
- As the system is available in the cloud, BCDSS ensure portability, scalability and flexibility.
- No special maintenance / need for expert personnel for the system
- The system reduces the workload for physicians and radiologists.

VIII. CONCLUSION

Breast malignancy is one of the most common cancer among women. Early detection of the disease can improve the long time survival rate and selecting appropriate treatment methodologies for the disease. Digital mammograms are found to be effective for screening and diagnosing breast cancer. By using the cloud based Breast cancer decision support system (BCDSS) helps for diagnosing breast cancer using digital mammograms. The system is deployed in a private cloud computing environment and implemented as software as a service to ensure data security and to support both novice and expert users.

The system uses image enhancement techniques to improve the quality of mammograms. Then mammograms are segmented into regions and features are extracted from the region of interest. From the extracted features a feature subset of the best features is selected using feature selection techniques. The selected features are used for classification using ensemble neural networks. The results are validated and reports are generated. The system is intended to assist physicians and radiologists without human intervention thus saving expert human resources. Future work will be concentrated in evaluation of the system which will help in further improving of the system.

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