Chapter 8

Conclusions and Future work

8.1 Conclusions

The results of mass segmentation of mammograms with entropic thresholding are found to be better than those due to Otsu's method in this particular application. The background subtraction technique is applied in the beginning so as to make the segmentation a two-class problem by eliminating the variable background in different ROIs. Fuzzy weighted averaging filter is used prior to thresholding as it provides smoothing effect by preserving the edges. The segmentation algorithm is applied to all the samples in the database and the results are satisfactory. Two other semi-automated approaches, viz., level set and a marker controlled watershed are presented for the tumor image segmentation which overcomes the accuracy and sensitivity limitations of the current solutions. Foveal adaptation technique which is based on human visual system is an adaptive thresholding technique which is found to be more effective in segmenting the micro-calcifications. This method is compared with the LoG filtering technique with background subtraction. There is a substantial reduction of false positives and true negatives.

The co-occurrence matrix based texture analysis suits well for mammographic images because it captures the spatial arrangement of pixels. The drawback of this technique is that it gives rise to a large number of features. Malignancy in masses is recognized mainly by its spiculated shape and high contrast or any of these. Certain important shape features like spiculation, relative contrast, circulatory, compactness and radial angle which can categorize the masses are also used for the classifications. In micro-calcification cluster shape is an important feature. Others include the number of calcifications and their contrast. The features used in this work are best suited for classifying the masses and micro-calcifications. False positive (FP) and false negative (FN) cases are considered as errors in these experiments because they degrade the overall performance of the detection techniques. Otsu's method for the classification based on GLCM features shows the best performance as it produces less error than the other segmentation methods.
For classifying the masses from the normal ROIs, co-occurrence matrix based feature selection scheme is developed by using new entropy in place of Shannon's entropy. It shows drastic improvement in the classification of results. SVM when used in combination with the tuned kernel function and the training-test partition performs well for the classification of masses and micro-calcifications. This approach is found to be very effective. The classification system is based on rough set theory and it uses the SVM and neural networks for the classification. The classification accuracy of 80% is achieved using SVM in classifying the masses from normal regions. The classification accuracies of 91.37% and 93.54% are achieved using SVM in classifying the masses and micro-calcifications respectively into their specific classes, i.e. benign and malignant. With neural networks, the classification achieved is 70% only.

The basic objective of CAD is to provide a computer output as a second opinion to assist radiologist's image interpretation by improving the accuracy and consistency of radiological diagnosis by reducing the image reading time. PACS is a computer system or network dedicated to the storage, retrieval, distribution and presentation of images. PACS is designed to streamline the operations through the entire patient-care delivery system that is expected to make a significant difference in terms of throughput and clinical action as well. Currently, CAD and PACS are two separate independent systems with only minimal communications between them. A CAD–PACS design is described as a universal method to integrate CAD results with PACS in its clinical environment.

Three different semi-automated approaches viz., modified gradient magnitude region growing technique; level set and a marker controlled watershed method are presented for the tumor image segmentation that overcomes the accuracy and sensitivity limitations of the current solutions. These methods are illustrated on the brain tumor area using MR imaging modality. Recent attention has been given to semi-automatic segmentation methods in tumor measurements in order to avoid the observer variability and therefore increase the accuracy. In our study of the reliability of brain tumor area measurements, we quantitatively compared the expert manual trace method with semi-automatic segmentation methods. The semi-automatic segmentation techniques require very less time to generate tumor area measurements than manual method. Manual method is highly labor intensive and require more concentration than semi-automatic method. These methods are applied on different types of MRI slices, different tumor type and
shape and better segmentation results are achieved. Also these three methods have been tested extensively and results are validated numerically.

Region growing is shown to segment a tumor successfully provided that the desired parameters are set correctly. There are many input parameters such as value of the standard deviation for the Gaussian filtering, value of threshold to convert the intensity adjusted image into the binary image, initial value of seed point, threshold value for region growing segmentation etc. This method is applied to MRI slices from 2 brain tumor patients’ data sets and satisfactory segmentation results are achieved.

A 3D level-set evolution framework is applied for the automatic segmentation of brain tumors in MRI, using a probability map of tumor versus background to guide the snake propagation. A nonlinear fit of a mixture model to the histogram provides a fuzzy classification map of gadolinium-enhancing voxels and the probability map is used to guide the propagation of the snake. The snake is very stable and converges in 300 iterations without leaking. Preliminary comparisons demonstrate that the semi-automatic segmentation comes close to the manual expert segmentation.

There is no credible evidence to the Environmental Health and Safety Office (EHSO) about the cause of cancer or brain tumors with the use of cell phones. Most studies do not find association between the development of AN and cell phone use, but some studies that followed cases for 10 years or more did show an association. The results indicate that using a cell phone for 10 years approximately doubles the risk of being diagnosed with a brain tumor on the same side of the head as that preferred for cell phone use. People should be very restrictive with using mobile phones as there is a significant body of compelling scientific evidence indicating serious hazards from their usage. Therefore, it is advisable to reduce the usage to very few and brief calls. Moreover, it has been repeatedly confirmed that the radiation from base stations is harmful to health. Continued valid research will eventually resolve the current uncertainties and public policy will be reanalyzed and adjusted accordingly. The precautionary principle clearly applies in this case, since the problem is possible but not certain and low cost ameliorating actions are easily implemented by industry. With over 3 billion people using cell phones and with children among the heaviest users, it is time for governments to mandate precautionary measures to protect their citizens. We conclude that the current standard of exposure to microwave during mobile phone use is not safe for long-term exposure and needs to be revised.
8.2 Contribution of the Thesis

At the end of the Herculean task, we look back with a ray of beaming smile though pointing fingers at our inability to pursue a few more good things, but our efforts are cut short by the game of time. We have a few things to show the strength of our thesis.

The contributions of the thesis are outlined here:

i) Algorithms are developed to extract shape based and texture based features.

ii) The feature selection using rough set based methodology has been developed.

iii) SVM and neural network based classifiers are developed and their results compared.

iv) Various breast cancer mammogram segmentation techniques are developed for masses and micro-calcifications and their segmentation results are compared.

v) A detail study of current CAD-PACS system design and their integration is made.

vi) Various MRI brain tumor segmentation techniques are developed, tested and validated against the expert’s manual radiologist results.

vii) Recently more highlighted risk of brain tumors from wireless phone use and its other adverse effect are focused as another challenge to suggest new avenues of research so that the gaps in current understanding may be clarified. It is opinioned that the current standard of exposure to microwave during mobile phone use is not safe for long-term exposure and needs to be revised. Also, cell phone radiation protection tips are presented as an aid to the human society.

8.3 Useful Aid to the Doctor

Imaging plays a pivotal role in the diagnosis and treatment planning of the brain tumor. Tumor volume is an important diagnostic indicator in the treatment planning and results assessment for the brain tumor. The measurement of brain tumor volume can assist a doctor for an effective treatment. The measurement of tumor volume using manual method is although gold standards approach but tedious, labor intensive and time consuming. It involves tracing the tumor outline and tumor area is derived by summation of total slices area. Whether this process
is done by a radiologist or by a technologist, there is always an important element of subjectivity that results in both intra and inter-operator performance. We have applied various semi-automated approaches for the tumor image segmentation that overcomes the accuracy and sensitivity limitations of the current solutions. Thus, the present application assists the radiologist in performing an in-depth exploration of the breast cancer and brain tumor at considerably reduced time. Hopefully the amalgam of efforts of biomedical researchers and radiologists would be useful in the accurate diagnosis. In the domain of medical image analysis, time-consuming algorithms are synonymous with non-interactive methods and are therefore limited to a very small number of specific applications. Biomedical imaging has seen truly exciting advances in recent years. Computerized segmentation methods are now seeking the help of CADs and the radiotherapy planning. CAD has become a part of clinical work in the detection of breast cancer. CAD tools are a valuable support to the current radiological practice due to the increasing resolution and dimension of the data that a radiologist needs to inspect before providing a diagnosis.

8.4 Future Work

Medical imaging is a vast subject with many problems to be addressed. Computer aided diagnosis helps a doctor to take a second opinion or any crucial decision. Cancer is the most dreadful disease affecting the human society. Curing involves a lot of financial burden for the victims. If correct decisions are taken at early stages only then this burden can be reduced and one can hope for better treatment. Identification of tumors is very important field. In this work, we have addressed the problem of identification and detection of tumors from mammograms for breast cancer and MRI for brain tumor. There are other means of detecting tumors, like PET, SPEC, MRI, fMRI and CT which can also be supported by computer. Out of these CT gives the structural information whereas PET and SPEC give the functional information. There is a need to combine various feature data and make it possible for the doctor to visualize it. These are some of the issues to be addressed in future.

This thesis makes an attempt to develop a complete system for the breast cancer segmentation and classification and also for MRI brain tumors. As it is a very difficult and massive task, we began studying and analyzing the proposals found in literature and found that none of the
proposals has an optimal performance for all the cases of tumors. The diameter of masses in mammograms varies from 5 mm to 5 cm, inspiring many research groups to use multi-scale approaches to detect masses. There are some chances that a substantial number of the tumors can be missed by radiologists in a screening program despite double reading, a CAD system can be recommended as a very useful tool for radiologists. Thus, in future by integrating various modules of this work a reliable CAD tool can be developed to help radiologists to detect breast cancer in mammographic images and brain tumor in MR images.

For the implementation of the proposed algorithms in a clinical set up such as the hospital, the initial step will be the integration of the algorithms in the hospital framework. Moreover, after the implementation of the proposals, we will have a great and large database to clinically test them. The breast density quantification uses not only X-ray information but also magnetic resonance imaging (MRI). It is better to use the segmentation strategy not only in mammographic images but also in MRI.