CHAPTER 8
CONCLUSIONS

8.1 INTRODUCTION

Medical image classification is an important thing in medicine. It allows for biological structures to be isolated non-invasively. Whether it is for diagnostic purposes or practically applied in image guided surgeries, image classification has many forms and uses. Unfortunately, currently there is no classification strategy that can accommodate all its applications.

The system that has been designed is used for classifying and detecting tumors in brain fMR images. The system involves two major modules, one that performs classification after analysis and the other one that detects the tumors from the images.

BSS is suitable and feasible to be used as supportive tools for medical problems. The combination of both, neural network and BSS model has been tested and evaluated for classification and detection of fMR images.

The classification system is based on paradigm that grasps the learning abilities of ANN to enhance the intelligent system’s performance using a priori Knowledge. Using a given input/output data set, the system constructs an inference system whose function parameters is tuned (adjusted) using either a BSS approach alone, or in combination with a BSS and NN based wavelet packet method.

This allows the systems to learn from the modeled data. The parameters associated with the proposed PDF will change through the learning process. The computation of these parameters (or their adjustment) is facilitated by a gradient vector, which provides a measure of how well the system is modeling the input/output data for a given set of parameters. Once the gradient vector is obtained, any of several optimization routines could be applied to adjust parameters that will reduce some error measure (usually defined by the sum of the squared differences between actual and desired response).

These techniques provide a method for the modeling procedure to learn information about a data set, in order to compute the function parameters that best allow the associated with the proposed inference system to track the given input/output data. This learning method works similarly to that of neural network. To use proposed system in the classification and recognition problem, the following steps need to be performed:

1. Design a sequence based algorithm appropriate to the classification problem.
2. Hands optimize the fMRI images, given actual input classification data.
3. Set up training and testing matrices. The training and testing matrices will be composed of inputs and the desired classification corresponding to those inputs.
4. Run the algorithm on the training data.
5. Test the results using the testing data.

The technique that has been proposed here has shown a very encouraging level of performance for the problem of early tumor classification and detection in brain fMR images. Efforts were made to reduce the amount of a priori knowledge used so as to keep the method as generic as possible. This makes the approach worth serious consideration for further development as an automatic tool for image classification in medicine.

Based on the result in Chapter 5, it can be concluded that this project has achieved the objectives and problem statements as set earlier in Chapter 2. There is a need to apply the classification and detection techniques in many fields especially in the medical field whereby the data is large and time consuming to sort or classify manually. Furthermore, it is very crucial to determine the accuracy and precision of the output of the analysis, especially in the medical problems or field such as lung cancer, breast cancer and etc.

Experimental result indicates that the technique is workable with accuracy greater than 90%. This technique is fast in execution, efficient in classification and easy in implementation. As an overall conclusion, this project is successful as it met the objectives of the project and successfully developed, run and optimized the performance of the classification technique.

8.1 THE SPARSENESS CRITERIA RESULTS

It is strongly recommended not to use a single node in any criterion; this approach gives poor results and is unstable.

The best results were obtained by:

1) The Q(L1,L2) criteria on 25% of the best blocks
2) Choosing the ‘all the blocks’ that appear on the 25% of each criterion.

These two approaches gave the highest results and were the most stable (lowest STD).

Most of the times it turned out that none of the sparse criteria recommended the best nodes/blocks for extraction were really the best results (even when agreeing on 2-3 nodes as there best out of four). When all three or two out of three, sparse criteria, agreed on the same nodes than these nodes are truly sparse.
The fact that nodes which are not considered sparse produced much better results than nodes which are considered as sparse leads to the conclusion that the coefficients in this sparse representation “live” in the same indexes and hence the model described above doesn’t work. It is advised to find another quality factor that simply checks the amount of coefficients that “live” in the same indexes.

8.2 THE SPARSE REPRESENTATION RESULTS
• When comparing the sparse representation for the ICA-NEWTON algorithm, good results are obtained from all algorithms proposed in the thesis. The differences are minor, the Laplacian operator and the WP decomposition attained the best representation.
• The results are more dramatic for the geometric extraction algorithms. For the angular algorithm the first derivative is the best representation, its results are all above the 13dB bar. The WP too looked good except for one failure; however all the other appeared to be unstable and failed a lot in the extraction of one image.

8.3 THE RECONSTRUCTION ALGORITHMS
The ICA based algorithm is:
1. The best of the three after analysis as it has the highest average results and it is stable. A very important feature it has is its independency on the mixing matrix, which can be very crucial for the geometric algorithms.
2. It can handle problem of high dimension.
3. More stable than the geometric algorithms and its average performance usually outperforms the best results given by the geometric.

• The hyper-sphere algorithm doesn’t give good results for systems with more than two sources. The angular on the other hand wasn’t tried but seems to have the same problem.
• The geometric algorithms work nice for problems of two sources and two mixing images, they work fast and for some application there performance may be adequate.

Using ANN approach, the prediction of diagnosis and detection of early brain tumor is comparably accurate than the human being. The efficiency of manual detection of early brain tumor is 85% and the efficiency of the NN based recognition and classification obtained is nearly 97%. This high rate of accuracy can be utilized to support the Doctor’s decision to avoid biopsy.
8.4 FUTURE WORK

To the fields of fMR images classification, this thesis is like an explorer who has just landed on a big tropical island. He is only able to gather just a few items on the island to bring back with him because his ship is not big. There could be many valuable resources on the island, but the explorer is not able to find out about them because his stay on the island is constrained by time. Nevertheless, based on those resources he can see, the explorer has a strong feeling that the island has tremendous development potential.

This thesis has only explored a small territory in using the neuro-based BSS approach in medical image classification. There are many possible directions for future work, which include the following:

In this thesis the number of medical images considered is less. For future work the number of brain medical images should be increased and using the real ones. By increasing the number of image, more training data set can be performed.

Upgrade the system to the application for different size brain medical images slice as shown in Figure 8.1. By doing this, the same region of the tumor but in the different slice of brain medical image can be determined.

![Figure 6.1: Different slice of brain medical image](image)

- Perform the segmentation process to detect a tumor and also its size. The classification would be better performed after the segmentation method and the segmentation results will be used in classification.
- Get the extra information that could be very useful in detecting some patterns in developing a certain disease. In such a system, not only the images are important, but also some patient information.
· Build the complete GUI to interface all the process starting from region of interest to ANN and Fuzzy classification and detection.

· Design a combining multiple classifiers that use different features such as texture features, tumor shape and size features, etc in order to get an accurate classification of the normal and abnormal brain image. A combined feature is more meaningful than the one feature representation alone and can significantly improve the performance. The method can be useful in the diagnostic of diseases if the possibility of a feature is known in the Region of Interest (ROI) of an image, and the images can be classified into category of diseases. Figure 8.2 gives the block diagram of the technique.

![Proposed Block Diagram of the Neuro Fuzzy Approach](image)

Figure 6.2: Proposed Block Diagram of the Neuro Fuzzy Approach