CHAPTER 7

CONCLUSION AND FUTURE WORKS

7.1 CONCLUSION

Tumor in medical terms means unwanted growth which can grow in any part of the body. This may or may not be cancerous. The reasons for this are still unknown. Irrespective of the reason, the classification of tumor is very important. Therefore tumor classification is one of the challenging tasks in the field of medicine. Tumors occurring in the brain may be more challenging for diagnosis. Magnetic resonance images are mainly used for analyzing brain images due to its good accuracy and high applicability. There are many semi-automated and automated methods existing for classification tumors.

In this thesis, a fully automatic method has been proposed for tumor identification in brain MRI. It combines composite operators, grouping and classification for brain MRI. The composite operators considered are orthogonal, orthonormal, Laplacian and Sobel. All the possible combinations of these operators have been proposed for convolution. The resultant convolved operators are combined with grouping and classification for tumor classification in the given image.
The proposed work of the various combinations of operators have been discussed below.

- A novel tumor classification has been proposed using the composite operator, grouping and classification.

  - Comparative study of classification accuracy with various operator sizes for the various proposed convolution approaches with orthogonal operators for brain MRI Database images has been done. Classification accuracy for sizes 3 and 4 was 99.41 whereas for size 5 was 100%.

  - Comparative study of classification accuracy of various operator sizes for the various proposed convolution approaches with orthonormal operators for brain MRI has been done and accuracy for size 4 outperformed with 94.56%.

  - Bin requirements of sizes 3, 4 and 5 of operators for convolution of orthogonal and orthonormal operators with sobel and laplacian operators has been compared and size 5 of both the operators of convolution with sobel has outperformed with less number of bins.

  - A Comparative study of bin requirement for all the sets of each operator size has been made. For all the sets of each size of orthogonal operator has outperformed with less number of bins.
The proposed convolution of orthogonal operator with sobel and the classification using SVM for the sizes 3, 4 and 5 outperformed other proposed convolution of operators.

- A novel tumor classification method has been proposed using the 2D-DWT for preprocessing, grouping and classification.
  - Comparative study of classification performance of combination of 2D-DWT with orthogonal operators of various sizes has been done and orthogonal operator has outperformed for the sizes 3, 4 and 5 with classification accuracy of 100%.
  - Comparative study of classification accuracy for the proposed combination of 2D-DWT with orthogonal operator for all the sets of size 3, size 4 and size 5 using SVM & BPN classifiers respectively for each size has been done. The combination of 2D-DWT with orthogonal operator for all the sets of size 3, size 4 and size 5 outperformed combination of 2D-DWT and orthonormal operators.
  - Comparative study of classification performance against bin requirement of the proposed convolution of orthogonal operators for each sizes 3, 4 and 5 and combination of 2D-DWT with orthogonal operators of respective size 3, 4 and 5 has been done individually. Also a comparative study of classification performance against bin requirement of the proposed convolution of orthonormal operators for each sizes 3, 4 and 5 and combination of 2D-DWT with orthonormal operators of respective size 3, 4 and 5 has been done individually.
• The combination of 2D-DWT with orthogonal operators for all the sizes has outperformed with bin requirement of 6 and percentage of accuracy as 99.41%.

• Comparative study of overall classification performance against bin requirement of the proposed convolution of operators of various sizes and combination of 2D-DWT with orthogonal operators of respective size has been made. The combination of 2D-DWT with orthogonal operators for all the sizes has outperformed convolution orthogonal operators.

• Comparative study of overall classification performance against bin requirement of the proposed convolution of operators of various sizes and combination of 2D-DWT with orthonormal operators of respective size has been made. The combination of 2D-DWT with orthonormal operators for all the sizes has outperformed convolution orthonormal operators.

The proposed combination of 2D-DWT with orthogonal operator using SVM classifier outperformed other proposed methods with the least number of bin requirement.

• Two novel feature descriptors based on the variation of Local Ternary Pattern Operator have been proposed in the third framework. Both approaches have used the concept based on Local Ternary Pattern. The grouping of pattern has been done and classified using SVM.
The proposed Multi-level LTP operator had been developed that handles the similarity among the pixels. This similarity has been measured by varying the threshold values and hence includes the idea of human perception. A new way of classifying the brain MRI had been suggested and grouped. The operator had been able to classify the image well.

The proposed Multi-level LTP operator used squared neighbors and hence no interpolation calculation had been required. Also octets have been framed based on the size of the operators and hence only one mapping table has been sufficient to compute the LTP code. The performance of the proposed MLTP operator was 99.41% with an increase of 7.5% when compared to the existing LTP operator.

The proposed MLTP operator had justified the role of threshold in classification performance by showing the improvement from 91.86% to 99.41% on tumor classification of brain images for the operator size 5x5. The improvement shown for the operator size 7 x 7 was from 91.86% to 100%. The contributions of patterns in tumor images had been found to increase when the threshold value changed from 2 to 20. Computational simplicity is another advantage, since the operator has been evaluated with few comparisons in a local neighborhood.

The performance of MLTP had been tested on different bin sizes and for various threshold values. A threshold
value of 2 and bin size 20 has been found suitable for tumor classification for the MLTP of size 5x5 since it has produced the recognition rate of 98.83%. A threshold value of 2 and bin size 10 has been found suitable for tumor classification for the MLTP of size 7x7 since it has produced the recognition rate of 100%.

- A comparative study of the LTP with the proposed MTLP operators had been made. The tumor classification scheme based on MLTP had outperformed on brain image classification with classification accuracy of 99.41%.

- A comparative study of the classification Performance of MLTP operator sizes 5x5 and 7x7 for different bin sizes and threshold values had been made. MLTP operator of size 7x7 outperformed MLTP of size 5x5 for the same threshold value with lesser bin size. For the bin size 20 considering all the threshold values the average classification accuracy for MLTP operator of size 5x5 was 99.70% and for operator of size 7x7 was 100%.

The proposed MLTP operator of size 7x7 using SVM outperformed the proposed 5x5 operator.

Classification accuracies of all the proposed tumor classification techniques has been done. The combination of 2D-DWT for preprocessing with orthogonal operators outperformed the other proposed approaches for tumor classification with classification average accuracy of 99.41%.
Classification accuracies of all the proposed tumor classification technique of combination of 2D-DWT for preprocessing with orthogonal operator and combination of 2D-DWT for preprocessing with orthonormal operator have been made. The first combination outperformed the second combination with classification average accuracy of 99.41%.

- Comparative study of machine time for various proposed approaches.
  - The tumor classification time for all the images using convolution of operators on brain MR images has been compared and time taken by convolution of operator-orthogonal operator size 5 is 3.95 seconds.
  - The tumor classification time for all the images using combination of 2D-DWT with orthogonal and orthonormal operators on brain MR images has been compared and time taken by combination of 2D-DWT with orthogonal operator size 3 is 0.065 seconds.
  - Comparison of the tumor classification time for all the images using MLTP on brain MR images has been done and MLTP of size 5 x 5 took only 0.997 seconds for the whole process.
  - Machine time for all the images, for all the proposed work has been compared and the combination of 2D-DWT for preprocessing with orthogonal operator outperformed with least time of 0.996 seconds.

- Comparative study of bin requirement for various proposed approaches.
• The bin requirement for classification of the image using convolution of operators on brain MR images has been compared and maximum number of bins required to achieve 100% accuracy varied from 165 to 180 for sizes 3, 4 and 5 respectively. Bin requirement for convolution of operators, both orthogonal and orthonormal operators were the same for sizes 4 and 5.

• The bin requirement for classification of the image using combination of 2D-DWT with orthogonal and orthonormal operators has been compared and maximum number of bins required to achieve 100% accuracy decreased from 13 to 6 for sizes 3, 4 and 5 respectively.

• The bin requirement for classification of the image using MLTP operator sizes has been compared and found to be same for both.

• The bin requirement for classification of the images, for all the proposed approaches has been compared and the combination of 2D-DWT for preprocessing with orthogonal operator outperformed with least number of bin requirement 13.

7.2 SCOPE FOR FUTURE WORKS

The future scope of the work reported in this thesis is as follows:

• The entire classification method can be experimented with image considered for tumor classification in any other MR image or CT image of liver, abdomen or breast.
• The proposed work can be extended by testing against various colour images since only gray scale images has been tested on different classification models.

• The proposed work can be extended by using optimal orthogonal polynomial operator sets.

• The optimal operator set can be extended for different sizes of orthogonal polynomial operators.