CHAPTER 7

CONCLUSION

This thesis mainly focuses on 3 works 1) retrieval of similar images from brain MR images corresponding to a query image 2) level identification of the query image based on the similar and dissimilar images retrieved 3) classification of the query image as normal or abnormal based on its comparison with same level images. Retrieval of images with similar anatomical structures has got many advantages with respect to research and diagnostic point of view. At the same time, achieving high accuracy of the retrieval is a challenging problem due to intensity related issues and geometrical misalignments. The intensity value is non standard in brain MRI, but it is locally smooth, and hence local measure plays a good role in handling intensity related issues.

In our work, since MOD_LBP is calculated locally, it is invariant to monotonic gray level change. Since it is computed by considering information from every pixel in the local neighborhood, it is invariant to rotation and translation with respect to the that neighborhood. But it is not invariant to global misalignments due to patient movements during the acquisition time. The invariant against global misalignments is achieved by extracting the features with respect to the reference line (line with respect to which 2D brain image exhibits maximum symmetry). The features are represented spatially and non-spatially using histogram and moment features of MOD_LBP. The spatial representation is done by dividing the image into different angularly partitioned grids. The performance of the system is evaluated using the measures like average rank, accuracy, precision-recall etc. In order to attain user's level of satisfaction, a relevance feedback mechanism has been applied in the form of reweighting the moment features extracted from MOD_LBP.
It is observed that the histogram of MOD_LBP on 18 angular regions is a good descriptor for retrieving relevant images. The spatial histogram of MOD_LBP (8, 1) with 18 angular regions shows an average rank (accuracy) of 4.13 (97.42%) for level 1 (L1) images, 6.14 (94.74%) for level 2 (L2) images, 6.25 (95.13%) for level 3 (L3) images, 6.85 (94%) for level 4 (L4) images and 5.84 (95.32%) for images from all levels together. The reweighting the moment features 5 times defined at 18 angularly partitioned grids improves the average rank to 2.72 for level 1, 5.72 for level 2, 3.36 for level 3, and to 3.65 for level 4 images. A comparison has been made among different local measures like $LBP_{8,1}^{ri}$, $LBP_{8,1}^{riu2}$, $LBP_{16,2}^{ri}$, $LBP_{16,2}^{riu2}$, $LGS(8,1)$ etc. In order to make a better discriminant descriptor which is less sensitive to noise near uniform regions, the binary encoding is replaced by ternary encoding based on a global as well as local threshold. The MOD_LBP with ternary encoding based on global or local threshold is termed as Modified Local Ternary Pattern (MOD_LTP). It is observed that the SNR of MOD_LTP (20db) is more than that of MOD_LBP (5.6db) in the presence of 1% noise. The time taken for different local measures is also computed. The results reveal that as window size increases, the time computation for MOD_LBP/MOD_LTP increases linearly only. The descriptor MOD_LBP and MOD_LTP are used to retrieve similar images across different classes, i.e. retrieval of T1 weighted images from T2 weighted images and vice versa. Based on the most similar and dissimilar images retrieved, the level of the query images is determined. It is very useful for the comparison of the query image with similar anatomical structure images. It has been attained a 100% accuracy for level 1 and level 2 images and 98% for level 3 and level 4 images in identifying the level of the images. Once the level of the images is identified, same anatomical structure images are used for normal vs abnormal classification. The results reveal that the comparison with similar anatomical structure images improves the accuracy of the classification. The classification
accuracy is improved from 84.51% to 96.49% when comparisons with similar anatomical structure images are used instead of not using the same.

In this work, only four levels are used for the image retrieval and classification. The classification is more challenging and useful when the number of levels is increased by decreasing the thickness of the slice. Also, this work addresses the anomaly detection in general. It is quite useful, if it can be extended for the diagnosis of certain structure-specific diseases, such as hippocampus or basal ganglia disorders. The method is being applied to the early detection of Alzheimer's using imaging. The method will perform equally well for other cross-sectional images of MR like sagittal or coronal.
Hu (1962) proposed Moment Invariants (MI) for two dimensional pattern recognition applications. For a digital image $f(x, y)$, the two dimensional moment of order $(p + q)$ is defined as

$$m_{pq} = \sum_p \sum_q x^p y^q f(x, y)$$  \hspace{1cm} (1)$$

where $p, q = 0, 1, 2...$. Translation invariance can be achieved by using central moment defined as follows.

$$\mu_{pq} = \sum_p \sum_q (x - \bar{x})^p (y - \bar{y})^q f(x, y)$$ \hspace{1cm} (2)$$

where $\bar{x} = \frac{m_{10}}{m_{00}}$, $\bar{y} = \frac{m_{01}}{m_{00}}$. The scaling invariant may be obtained by further normalizing $\mu_{pq}$ as

$$\eta_{pq} = \frac{\mu_{pq}}{\frac{p \cdot q \cdot \bar{x} \cdot \bar{y}}{p, q, \bar{x}, \bar{y}}}$$ \hspace{1cm} (3)$$

Using this, a set of seven Rotational, Scaling & Translational (RST) invariant features is derived by Schalkoff (1989). The relative difference in magnitude of the Eigenvalues is thus an indication of the eccentricity of the image, or how it is elongated. The eccentricity is

$$e = \sqrt{1 - \frac{\lambda_2}{\lambda_1}}$$ \hspace{1cm} (4)$$

where $\lambda_1, \lambda_2$ are the Eigenvalue of the co-variance matrix, $\begin{pmatrix} \mu_{20}' & \mu_{11}' \\ \mu_{11}' & \mu_{02}' \end{pmatrix}$

$$\mu_{20}' = \frac{\mu_{20}}{\mu_{00}} , \mu_{02}' = \frac{\mu_{02}}{\mu_{00}} , \mu_{11}' = \frac{\mu_{11}}{\mu_{00}} .$$