Abstract

Presently, the world is encountering an enormous increase in number of digital images, for example, millions of biomedical images are generated in various hospitals and medical diagnostic centres, plenty of remote sensing (RS) images are generated due to their crucial applications in weather prediction, geological analysis etc. The proper use of such image information by manual annotation is a difficult job, thereby triggering a terrible requirement for some effective search scheme i.e., content based image retrieval (CBIR). The most crucial step in CBIR is feature extraction, which relies upon the scheme used for capturing image features. Although there are plenty of feature extraction schemes, the extraction of discriminative features without increase in feature dimensions is still challenging.

This thesis mainly focuses upon development of non-subsampled shearlet transform (NSST) based image feature descriptors for improved retrieval of RS and biomedical images. Unlike many existing image transforms, the NSST is thoroughly localized, yields high directional sensitivity, and is translational invariant.

The thesis first takes up the investigation of an appropriate statistical model that best obeys the statistics of image NSST detail subband coefficients. Using log histogram plots and Kolmogorov-Smirnov (KS) test statistics, we demonstrate that the symmetric normal inverse Gaussian (SNIG) provides good fit to the heavy tails of highly non-Gaussian empirical distribution. An effective remote sensing image retrieval (RSIR) scheme is developed using this distribution in the first part of the thesis. We further investigated the performance of a 2-state Laplacian mixture (LM) distribution in modelling the statistics of NSST detail subband coefficients. The LM distribution is shown to be more effective than SNIG and many other non-Gaussian distributions.

A local-global feature fusion scheme for improved RSIR is introduced where the global features are extracted from 2-state LM distribution parameters and the local features are captured from a novel 3D local ternary pattern (LTP) based scheme. The experimental results indicate significant performance improvement over the similar relevant approaches including the local and global descriptors alone.

Unlike many local pattern based feature descriptors such as local binary pattern (LBP), the spatial bit-plane based image feature descriptors are well known for their ability to capture very fine to highly coarse image details. In the second part of the thesis, the problem of extension of bit-plane decomposition and encoding concept in NSST domain is considered. Due to the sensitivity of image NSST coefficients with respect to the local changes, such spatial schemes cannot be applied directly on these coefficients. We have introduced novel bit-plane decomposition and encoding schemes in NSST domain for improved retrieval of biomedical images. These proposed frameworks are shown to have outperformed all the existing bit-plane based schemes along with many other well-known recent feature descriptors.

The third part of this thesis focuses on the development of NSST based multiple feature set i.e., the blend of Zernike moments (ZM) based global shape features and effective NSST based texture features, for improved retrieval of biomedical images. It is seen that any two distinct types of features when combined can efficiently suppress the respective drawbacks of each other. One of the method here exploits the powerful edge magnitude based features in NSST subbands in order to extract effective texture features. An another method here models the singular values of image NSST coefficients using Weibull distribution in order to achieve low dimensional features. The experimental results exhibit the superior strength of these techniques in achieving improved retrieval results with low to moderate dimensions.

Keywords:Content based image retrieval, Remote sensing, Biomedical, Statistical model, Texture, Shape