ABSTRACT

Image enhancement is one of the important image processing techniques. It can be treated as transforming one image to another so that the image quality can be improved for machine analysis or visual perception of human beings. The major goal of this research work is to enhance the finer details of the digital colour images for better perception using Undecimated Wavelet Transform (UWT), K-Means Clustering (KMC) with Histogram Equalization (HE). The proposed system is designed by building four sequential modules: colour space transformation module, frequency domain analysis, clustering analysis, and enhancement module.

The proposed system starts with colour space transformation module where the given RGB image is transformed into HSI (Hue Saturation and Intensity) colour space. Only the intensity component is taken for further processing due to its better human perception. The second computational module is employed with frequency domain analysis. In order to achieve better edge enhanced image, UWT is applied on the intensity component. It separates the frequency component of the given input image into their low frequency and high frequency components. As the low frequency component contains finer information than the high frequency or detail components, the finer details are chosen for further enhancement process. Also, the edge features are preserved as it is in the high frequency components.
KMC approach is adopted in third stage for clustering analysis, whereas the given data is partitioned into number of disjoint clusters. However, it is very difficult to find the number of clusters or number of different clusters available in the given input colour image. To overcome this issue, hill climbing algorithm is adopted. Based on the number of peaks detected by the hill climbing approach, the given input image is clustered by KMC. The final module of the proposed approach is enhancement unit, whereas HE is applied for each cluster separately to enhance the details as well as contrast in each cluster. After enhancement, inverse UWT is applied to reconstruct the frequency components into their spatial parts. Finally, HSI to RGB conversion is applied to get the enhanced image with edge preservation.

The performance of the proposed colour image enhancement system is evaluated by subjective and objective assessments. The two benchmark databases; MICT and IRCCYN are used in the analysis. The following quantitative measures; Peak Signal to Noise ratio (PSNR), Structural Similarity (SSIM) index, Universal Quality Index (UQI), and Entropy are measured for evaluating the proposed system. The results show that the proposed colour image enhancement system using UWT, KMC, and HE achieves satisfactory and reliable performance in both subjective and objective evaluations.

**Keywords:** Image enhancement, undecimated wavelet transform, k-means clustering, histogram equalization, hill climbing algorithm.