# 5
# Conclusions and Future Works

## 5.1 CONCLUSIONS

This chapter summarizes the observations and results in the thesis and also discuss some possible extension for future work. Within this thesis, first a multi-level saliency enabled compression method for CCIs is proposed under JPEG framework. The proposed method uses the goodness-of-segmentation (GOS) as a parameter in order to adaptively identify the number of classes in the image. After the optimal number of classes are identified, we proposed to rank them using their within-class variances. For implementing this in the JPEG framework, the coefficients of the quantization table used in JPEG are adaptively changed as a function of the rank of the ROI. This judicious quantization resulted in significant improvement in the JPEG's framework.

For performance evaluation, the proposed method was applied on 397 test images and it was observed to achieve an average of 2.88% improved quality at the most salient region, compared to JPEG baseline. Moreover, the most salient region was observed to contain an average of 31.1% area, and due to the improvement in these regions, the overall perceptual quality of the reconstructed image is better than JPEG. The experimental results also proved that the proposed method outperforms the recently published similar methods with respect to the perceptual quality of the reconstructed images at the same bitrate. Instead of ranking every pixel, the proposed method intelligently ranked every non-overlapping $8 \times 8$ blocks in order to minimize the overhead bitrate. The proposed block ranking method was also capable to reconstruct the ROI at the decoder side more accurately than the recent state-of-the-art works where the ROI is approximated by a rectangular bounding box. Moreover, the average overhead is also found to get reduced by 36.38% by using delta encoding as post-processing on the rank information matrix.

After proposing a compression framework for CCIs, we explored a new set of images called SCIs. Due to the distinguishing properties of SCIs than CCIs, it was observed that the state-of-the-art compression and quality assessment methods which were designed for CCIs, failed to perform satisfactorily on SCIs. In order to achieve high CR without any significant loss in the salient regions in an SCI, we proposed a two-level saliency-based compression method. The proposed method efficiently included the textual and strong edges in the SCIs as salient regions. The saliency map was then sent to the quantizer in order to achieve a judicious quantization of the DCT coefficients.

The performance of the proposed method was evaluated on two available datasets, SIQAD, and QACS. The proposed method was observed to achieve an average of 15.1% better quality at the salient regions compared to the JPEG baseline at the same bitrate. The average weight of the salient region in an SCI was found to be about 35.4% and due to the improvement in such regions, the overall perceptual quality of the reconstructed image is found to be better than the other state-of-the-art compression methods. Moreover, the experimental results proved that the proposed method outperforms the recently published similar method (HEVC_SCC) in terms of the perceptual quality of the reconstructed images. By ranking every $8 \times 8$ block instead of every pixel, we were able to send the saliency map to the decoder with only 0.0625 bpp overhead. The decoder framework of the proposed method is simpler and more accurate than the recent state-of-the-art

works where the ROI is approximated by a rectangular bounding box.

While working on the compression problem of SCIs, it was observed that the state-of-the-art IQA methods for CCIs and SCIs were not performing adequately on the distortions caused by compression. In order to accurately identify and compare the performance of the proposed SCI compression method with other state-of-the-art methods, we developed a feature based IQA method CSQA. The proposed CSQA is a RR-IQA method where the receiver side is only given the feature information of the RI. Firstly, the features were extracted from the input SCI using SIFT. We proposed a feature matching process called RDM in order to know the number of features preserved in the DI compared to RI. In order to provide more weight to the important features, we proposed the final CSQA index as the inner product of normalized scale and descriptor difference.

The feature matching of the proposed CSQA showed a significant computational cost reduction of about 99.8%, compared to the traditional feature-based IQA techniques. The performance of the proposed CSQA was evaluated on both CCI and SCI datasets, and compared with 8 state-of-the-art RR-IQA methods, and 9 FR-IQA techniques for both CCI and SCIs. CSQA showed promising results over both CCI and SCI datasets. With only about 0.21 bits-per-pixel overhead, the proposed CSQA outperformed all RR and FR IQA methods on QACS dataset and performed under top 3 for the rest of the datasets.

In order to obtain further improvement in the quality assessment of SCIs on certain distortions, and reduce the descriptor size in order to achieve low bitrate in sending the RF, we proposed another RR-IQA based method FQI. In FQI, instead of using SIFT as in CSQA for extracting features, a new feature extraction method was proposed. The motivation here was to remove certain invariance which was present in SIFT and was affecting the performance for contrast-change and motion-blur distortion. Moreover, a reduced size descriptor was also proposed in FQI in order to minimize the bitrate requirement. The consistency, accuracy, and robustness of the proposed FQI are compared with 9 state-of-the-art FR-IQA, and 8 RR-IQA techniques. FQI has shown promising results as it outperformed all RR and FR-IQA methods for QACS dataset, and performed as second best for SIQAD dataset. Finally, the performance of FQI was also observed to be superior than CSQA. The comparison on individual distortion type shows that the proposed FQI is more suitable towards distortion caused by compression, and it can be proven very useful for such research community.

## 5.2 RECOMMENDATIONS FOR FUTURE WORKS

The works discussed in this thesis can be extended in the following domain as listed below:

- **Compression of Hyper-spectral Images:** The performance of the proposed multi-level saliency enabled compression method on arial images was found to be promising. The proposed method can be extended for Hyper-spectral images by analysing inter-spectral correlation in order to evaluate the saliency map.
- **Compression of Camera-Content Compound Image:** The proposed two-level saliency-based compression method for SCIs can be extended for camera-content compound images. There may be some pre-processing required in the compound images to remove sensor noise in order to match its properties with SCIs.
- **Screen-Content Video Quality Assessment:** By extracting the significant frames from a video sequence, a video quality assessment method can be proposed for Screen-content videos on the similar lines of FQI.

- **Quality Assessment of 3D Synthesized Images:** The properties of 3D synthesized Images and SCIs are observed to be similar. Hence, the proposed IQA method can be extended for these images.
- **Hyper-spectral Image Quality Assessment:** The proposed FQI can be extended to evaluate the quality of a compressed hyper-spectral images. This may be very helpful to evaluate the performance of lossy compression method for hyper-spectral images.