Chapter 8

Conclusions and Future Scope

This thesis has extensive reviewed the existing schemes and also has presented five new effective watermarking schemes. This chapter deals with the overall contributions of the thesis. The proposed watermarking schemes in chapters 3, 4, 5 and 6 are used for tamper detection, localization, and restoration while proposed scheme in chapter 7 is used for copyright protection. The last section of this chapter enlists the scope for future work.

8.1 Conclusions

This thesis proposed four fragile watermarking schemes for image authentication and restoration and one robust watermarking scheme for copyright protection. The proposed schemes are also validated by their testing and evaluation as compared to other representative state-of-the-art schemes. The research contributions and achievements of the thesis are as follows:

Chapter 1 discussed the general introduction, motivation, thesis objectives, and contributions.

Chapter 2 provided general introduction of the digital watermark, classification of watermarking schemes based on different criterion and various possible types of

attacks. It is also provided overview of Discrete Cosine Transformation (DCT), Discrete Wavelet Transformation (DWT), Singular Value Decomposition (SVD. Further, in this chapter a literature survey of prominent approaches for copyright protection, authentication and restoration are given.

Chapter 3 presented a block truncation coding (BTC) based self-embedding fragile watermarking technique for image authentication and recovery. This scheme improves the accuracy of tampered detection and localization. The recovery quality scores of the proposed scheme are better than the other existing state of art approaches. This scheme is efficient in time due to use of BTC and simple XOR operations.

In chapter 4, a DCT and quantization matrix $Q = \begin{bmatrix} 16 & 11 \\ 12 & 12 \end{bmatrix}$ based effective self-embedding watermarking scheme for image tampered detection and localization with recovery capability is presented. The accuracy of localization is very good because of using the small blocks of size 2×2. The blocking artifacts in recovered image are also negligible because of using small size of blocks and smoothing function. The tampered image can still be recovered with high accuracy up to 50 % tampering rate.

The limitations of the scheme proposed in chapter 4 are removed in chapter 5. This scheme uses two levels encoding for content restoration bits generation. This scheme is used DCT without quantization matrix Q. The performance of the proposed scheme is better than that of previous techniques. The principal content of tampered image can still be restored with high accuracy up to 50 % tampering rate.

Chapter 6 presents an efficient watermarking scheme for image authentication and localization with two chances for restoration capability. This scheme provides second chance for block restoration in the case of one copy is destroyed. The proposed scheme is also effective because the authentication of each block is done by three-level hierarchical tampered detection mechanisms. So the authentication of each block can be ensured with high probability. The proposed scheme is capable to restore with high quality up to 50 % tampering rate from object removing, object adding and cropping attacks.

Chapter 7 deals the false detection problems in copyright protection which normally occurs in the SVD-based watermarking schemes. This scheme is a robust watermarking scheme based on a DWT-SVD. Another major advantage of proposed scheme is that it is a blind scheme. So, there is no requirement of original watermark and cover image for watermark extraction. There is also no requirement to choose the scaling factor. The watermark is embedded in the middle singular value (i.e. second diagonal value), since, the largest singular value is more significant for quality of the image, while the smallest singular values are more sensitive to the noise. Hence, the proposed scheme is more robust and imperceptible.

Finally, the overall conclusion of this thesis is being summarized as follows:

- Investigated and presented a comprehensive literature review of various classical as well as state-of-the art watermarking schemes for copyright protection, authentication and restoration.
- Developed and implemented four new effective fragile watermarking schemes for image authentication and localization with recovery capability. These schemes can localize the tampered areas with high accuracy and are able to recover the tampered regions with high quality. The blocking artifacts are also negligible.
- Developed and implemented one new robust and blind watermarking scheme for copyright protection. This scheme is capable to deal with false detection problem and unauthorized reading problem.

8.2 Future Scope

The proposed schemes could be further improved in future. The direction of work may be as follows:

- The proposed schemes for image authentication and restoration are fragile scheme. These are not capable to differentiate between incidentally or maliciously tampered images. So in future we need to develop a scheme which can be used for selective authentication.

- The proposed fragile watermarking schemes are capable to recover the tampered content up to 50 % tampering rate. So in future, we need to develop schemes which are able to recover tampered content even if tampering rate is more than 50%.

- These are irreversible watermarking scheme schemes and are incapable in some application like medical imaging. So, in future we need to develop reversible watermarking schemes.

- The performance of the proposed robust watermarking scheme is poor against certain types of geometric attacks like rotation, scaling and translation. Novel techniques which are able to resist these attacks are needed to be developed.

- Cryptographic methods could be explored so as to integrate and enhance the security of the watermarking schemes.

- These methods can be extended for watermarking of other multimedia like audio and video.