Chapter-VII

CONCLUSIONS AND FURTHER WORK
7.1. Conclusions

Processing of digital images involves procedures that are usually expressed in algorithmic form. Thus, with the exception of image acquisition and display, most image processing functions can be implemented in software. The aim of this research is to evaluate the new schemes using application scenarios of copyright protection, Owner identification and Copy control.

Digital watermarking technology is an emerging field in computer science, cryptology, signal processing and communications. The watermarking research is more exciting as it needs collective concepts from all the fields along with Human Psychovisual analysis, Multimedia and Computer Graphics.

There are several types of algorithms for watermarking. Each type of algorithms has its own advantages and limitations. No method can provide fully a perfect solution. Each type of solution has robustness to some type of attacks but is less resilient to some other types of attacks. Main focus of the current research in this field is to make the watermarking algorithms resilient to geometric transformations and many of the image processing attacks. In case of practical application, choice of solution type actually depends on the nature of application and requirements.

The watermark may be of visible or invisible type and each has got its own applications. In this thesis three blind invisible and one non blind hybrid invisible watermarking algorithms are developed as a part of the research work.

This thesis provides a comprehensive evaluation and implementation of a content based hybrid image watermarking schemes using decimal sequences. The name hybrid image watermarking is because the watermarking algorithms are developed by using the combined effect of spatial domain and frequency domain techniques, and the transforms DCT_ DWT in one algorithm and DCT_SVD in another algorithm are used.

Robust watermarks have been proposed to protect the copyright of the media owner because it can resist media manipulations. The geometrical distortions that can easily desynchronize watermark information and defeat the purpose of robust
watermarking. So focusing on the fundamental geometrical operations such as Rotation, Scaling and Transformation (RST) and common image processing attacks, four robust watermarking methods were developed. Out of the four the first one is a blind watermarking algorithm which is developed using only decimal sequences, the second one is developed using only the content based features of an image and the remaining two algorithms are blind watermarking algorithms developed by using both combined properties of content based features and d-sequences.

Hybrid watermarking method uses robust watermark. It can provide an integrated solution in copyright protection, Owner identification, Copy control, and approximate content recovery. The watermark extracted in the detection steps could provide useful investigative information in media forensics. The method is practical given its blind watermark detection capability.

By analyzing the cover object in both frequency and spatial domains, a distortion sensitivity of the image content is determined. Local information that is derived from properties such as texture, corner, edge and luminance is used to determine a mask of Just Noticeable Difference (JND) values. This value, which is based on the image content, determines the strength of the watermark information that will be embedded.

The observations or conclusions are drawn from the research work carried out are summarized below:

> Since, the watermark bit is embedded in the best location, hence the rate of watermark withstanding capacity is very high, and the quality of the retrieved watermark image is good in terms of perceptibility, PSNR and WPSNR. This method is superior and more robust in comparison to all other watermarking algorithms using d-sequences in terms of both PSNR and robustness for different attacks.

> Proposed research work introduces a content based watermarking algorithm using d-sequences and the results are found to be highly satisfactory in terms of watermark detection. Instead of pn-sequence d-sequence is used on the ease with which it can be generated, requiring only a prime number.
Since the content based features are used in the process the perceptual transparency of watermarked image is more hence the watermark can be retrieved with good quality.

A very good balance between robustness and imperceptibility has been achieved in this work as observers can evaluate the quality of the watermarked image as well as the recovered watermark to be good.

The robustness of proposed schemes to JPEG compression is found to be very good. The results for other image processing attacks like median filtering and geometric transformations were also found to be good.

Decimal sequences are used for watermarking instead of pseudo random sequences which provide a greater flexibility can be achieved with the choice of various prime numbers that can be used for this purpose. Since d-sequences which are generated from prime numbers of required choice act as a key provide secure communication.

Experimentation using various sizes of watermarks and different images enables a better understanding of the scheme. WPSNR is used to evaluate the perceptual quality of the watermarked image effectively and accurately, considering the effect of HVS. Since all the proposed algorithms are more robust against many image processing and geometrical attacks and there is trade-off among the three parameters, so the algorithms are very much applicable for applications such as copyright protection, copy control and owner identification.

7.2. Further Scope

It is generally agreed that there is no “one size fits all” watermark methods. The performances of watermark methods usually depend on their applications. For example, a robust watermark may have high level of robustness but poor imperceptibility. Similarly, the watermark methods developed can be improved further. Major limitation of digital watermarking is watermarks cannot survive every possible attack.
Although this thesis is limited to watermarking of gray scale images, further research can be done in implementing content based watermarking using decimal sequence for color images and video frames are possible because they all have similar data representation. All the algorithms proposed in this research work can be extended to video watermarking. However, the effects on the visual quality and watermark robustness need further investigation.

Overall, watermarking studies require a breakthrough in theoretical research. For instance, the upper limits of watermark capacity and robustness are mostly determined through experiments currently. The watermarking research is progressing very fast and numerous researchers from various fields are focusing to develop some workable scheme. In addition, the adoption of watermarking technology in commercial applications can be expanded with good supporting infrastructures. Different companies are also working to get commercial products. It is hoped, some commercial and effective schemes will be available in future.
REFERENCES


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PUBLICATIONS BASED ON THIS RESEARCH WORK


