# Robust and Adaptive Watermarking Technique for Secure Authorship of Digital Images

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# Declaration

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**Dedicated to**

*Dr. Lochandaka Ranathunga*

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# Abstract

There has been an increase in the broadcasting media since the last thirty years. The Tera Byte level multimedia data has been created, copied and transmitted via Internet every second. The access, sharing, replication and manipulation of images have become daily needs. Originators mind has a fear of illegal distribution and violation of copyright protection by malicious users. Hidden digital watermarking techniques have come to the rescue as a powerful solution to such potential problems. Several hidden type watermarking techniques have been proposed with a variety of their usage, complexity and security which are the primary concerns of such technique.

Digital watermarking describes methods and technologies that embed hidden information in digital media, such as images, video, audio or any other kind of multimedia object. Hidden digital watermarking techniques have many more challenges such as robustness, fidelity, extraction, and capacity. Robustness is a considerable feature of hidden watermarking techniques. This feature refers to the ability to detect the watermark after some signal processing operation, for example rotation, scaling, compression, noise adding, and image cutting. Resistance against several types of attacks is a real challenge for researcher's long years back. The robustness feature of hidden digital watermark will give huge benefits. Fidelity requirement of watermarking could be called invisibility. Fidelity feature preserves the similarity between the watermarked image and the original image according to human perception. The watermark must remain invisible notwithstanding the occurrence of small degradations in image features, contrast and brightness. Meeting the psycho-visual fidelity criteria is very important to every digital watermarking technique. Psycho-visual fidelity, is a huge challenging research gap of digital watermarking. Several previous researches have shown the evidence that invisibility and robustness are both very difficult to maintain mutually in available watermarking methodologies. Adaptive extraction feature determines, which resources are necessary for the analysis to extract the watermark from the watermarked image. Resource requirement should be minimized by a good watermark detection technique. The number of bits that can be inserted through watermark embedding process is a considerable research challenge to hidden digital watermarking. Increasing capacity of watermarking methods and fidelity of watermark can be conflicting. These two goals of watermarking

techniques should be balanced without any conflict.

This thesis describes a novel approach to hidden digital watermarking, based on low level features of digital image. It was hypothesized that, the above problem can be solved by a novel method of invisible watermarking of the digital images, based on low level features of the image and transform domain techniques. Corners are the salient feature of digital image. Corner detection is very important to the image processing operation. The Harris operator has been widely used for corner detection. This thesis has proposed a novel corner detector which is an extended and improved version of Harris operator. Novel operator is a step by step process, which improves corner detection ability and scale invariant property. The novel solution proposed in this thesis will giving the guarantee of features which robustness, fidelity, capacity and adaptive extraction. Proposed method in this thesis is to divide the entire process in to three major parts which are the analysis of the low-level features of image and detecting of the corner points in original or host image, watermark embedding into detected corner points, and adaptive watermark extraction. This study has abstracted a novel model by supporting Sobel operator of edge detection and Laplacian of Gaussian (LoG) filter. Using Sobel operator x-direction, y-direction and diagonal directions over host image, having improved edge detection ability of novel operator. LoG filter has provided a smoothing property and it's less sensitive to noise. LoG filter has improved scale invariant property of novel operator. Proposed watermarking solution can be used on color images and watermark object also can be small color images. Recover data matrix have generated by analyzing and comparing features of host image and intensity values of watermark image. Thus, recover data is generated dynamically. Generated recover data has been embedded in to host image at the prominent corner points of host image. Corner points are immutable points of image against many types of image processing operation. Specially corners provide good surveillance against rotation operations. Novel operator of this thesis has used LoG filter for the purpose of smoothing the host image. Thus, it has provided a good surveillance against scaling operation. Generated recover data are light weight. Due to the recover data generation process, it compares the host image and watermark object. Embedding process achieves the minimum degradation to original image. Thus, the novel approach of watermarking has guaranteed robustness and fidelity characteristics.

After embedding the recover data into host image, it produces uncompressed watermarked image. Study has proposed, represent watermarked image in a more efficient transferable and store-able manner. For the purpose of efficient representation, row-watermarked object has been converted into encoded format. Discrete Cosine Transformation (DCT) has been used to encode the row watermarked object. Other major function of watermarking system is an extracting watermark from watermarked object. Extraction process also has used low level features of watermarked image. Proposed extraction method of thesis is an adaptive process. It required minimum number of inputs included in watermarked image and meta data of watermark only. Extraction process has never required original image.

Comprehensive experiments have been conducted for the testing of novel watermarking approach. Study has used common data set widely used in image processing experiments. Experimental environment was a prototype application developed in C/C++ programing language. Evaluation process has been designed by covering all characteristics of watermarking algorithm. This thesis represents a complete evaluation of novel proposed solution by using a large data set. The thesis has represented test data results and analysis of results according to major characteristics of watermarking systems.

Evaluation has given evidence, that novel feature detection operator and watermark embedding algorithm provide higher robustness against rotation, scaling, filtering and noise adding attacks. The experimental results have given evidence that novel approach of digital watermarking can balance in between robustness and fidelity vis versa. Extraction method proposed by this thesis is a minimum number of inputs and it never required original image. Conclusion is that the proposed approach of digital watermarking gives many advantages over available methods.

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# Abbreviations

| | |
|---|---|
| LoG: | Laplacian of Gaussian |
| DCT: | Discrete Cosine Transformation |
| I-DCT: | Inverse Discrete Cosine Transformation |
| DWT: | Discrete Wavelet Transformation |
| MTWC: | Multi Threshold Wavelet Codec |
| JPEG: | Joint Photographic Experts Group |
| SVD: | Singular Value Decomposition |
| LWT: | Lifting Wavelet Transform |
| DFRNT: | Discrete Fractional Random Transform |
| FFT: | Fast Fourier Transform |
| RT: | Ridgelet Transform |
| EHD: | Edge Histogram Descriptor |
| LSB: | Least Significant Bit |
| ITU: | International Telecommunications Union |
| GCC: | GNU Compiler Collection |
| MSE: | Mean Square Error |
| PSNR: | Peak Signal to Noise Ratio |
| NCC: | Normalized Cross-Correlation |
| NAE: | Normalized Absolute Error |
| SSIM: | Structural Similarity Index Matrix |
| FSIM: | Feature Similarity Index Matrix |
| PVD: | Pixel Value Differencing |
| TPVD: | Try-way Pixel Value Differencing |