School of Engineering and Applied Science (SEAS), Ahmedabad University

ECE501: Digital Image Processing
Mid semester REPORT

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Project: **8. Digital Image Watermarking and Extraction Embed a watermark in an image and later extract or detect it**

Abstract

Digital image watermarking is an important technique used to ensure copyright protection, authentication, and ownership verification in multimedia content. In this project, we aim to embed a hidden watermark into a digital image such that it remains invisible to the human eye but can later be extracted or detected. The study focuses on spatial and frequency domain methods — particularly Least Significant Bit (LSB), Discrete Cosine Transform (DCT), and Discrete Wavelet Transform (DWT). So far, the LSB method has been implemented and tested, showing that watermark embedding can be achieved without affecting image quality. Further implementation of DCT and DWT techniques is planned to enhance robustness against image compression and noise.

Keywords

Digital Watermarking, Image Security, LSB, DCT, DWT, Frequency Domain, Copyright Protection

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1. Introduction

In today's digital era, the rapid sharing of multimedia content increases the risk of data theft and copyright violations. Digital image watermarking addresses this problem by embedding an invisible mark into an image to confirm its authenticity or ownership. The embedded watermark can be extracted later for verification, ensuring content protection.

A robust watermarking system must satisfy three major requirements: **invisibility** (the watermark should not distort the image), **robustness** (resistance to image manipulations), and **security** (protection from unauthorized access).

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2. Methodology

Two main approaches to watermarking were explored — **spatial domain** and **frequency domain** techniques.

2.1 Spatial Domain – LSB Method

- The watermark image bits are mapped into the least significant bits of the cover image pixels.
- A secret key is used to store mapping positions for secure extraction.
- The LSB approach is easy to implement and provides good imperceptibility but lower robustness.

2.2 Frequency Domain – DCT and DWT Methods

- **DCT (Discrete Cosine Transform)** converts the image into frequency components.
  The watermark is embedded in mid-frequency coefficients to balance invisibility and robustness.
- **DWT (Discrete Wavelet Transform)** decomposes the image into sub-bands (LL, LH, HL, HH).
  The watermark is embedded in the LL or LH bands for better resistance to compression and attacks.

Both frequency-based methods provide improved stability compared to LSB but require higher computation.

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3. Results

- **Watermark successfully embedded** using the LSB technique.
- The **visual quality** of the image remained unchanged, proving good imperceptibility.
- The **watermark was accurately extracted** using the secret key.

- Initial testing confirmed that **digital watermarking is feasible and effective** for image protection.

- Work on **DCT and DWT-based embedding** is in progress.

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4. Discussions

From our initial experiments, the spatial domain watermarking using the LSB method is simpler and produces visually identical results. However, it is vulnerable to attacks such as compression, filtering, or noise addition. On the other hand, frequency domain techniques like DCT and DWT are expected to offer higher robustness and security. Our next stage involves implementing and comparing these methods on performance metrics such as **PSNR (Peak Signal-to-Noise Ratio)** and **MSE (Mean Squared Error)** to evaluate image quality and extraction accuracy.

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5. Conclusion

The study provided a strong understanding of digital image watermarking techniques and their importance in securing digital media. The LSB method has been implemented successfully, maintaining visual quality while embedding the watermark. Future work involves completing the DCT and DWT implementations, testing their robustness, and analyzing performance metrics. The project demonstrates how watermarking effectively combines **invisibility**, **robustness**, and **security** for digital image protection.

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6. References

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