ABSTRACT

Digital watermarking has drawn much attention of the world in the recent time due to its infallible proficiency in dealing with some of the key issues related to digital rights management. The major challenge while designing a digital watermarking system is the trade-off among three fundamental requirements, namely, watermarks robustness, visual imperceptibility and embedding capacity. This challenge is further hardened as the watermarked media is likely to be subjected to certain unintentional manipulations such as geometric transformation, compression and transmission noise as well as intentional attacks such as cropping, filtering, collusion, etc. It is a well-known fact that many existing watermarking algorithms are vulnerable to these kinds of manipulations and attacks. Another issue that sturdily needs to be addressed is the speed of embedding and detecting the watermark. Since most of the digital transmission takes place via internet, designing a fast watermarking system that can work in the near real-time will be of immense value for the applications that require validation of authenticated watermarked contents from the unauthenticated ones at the router or server itself. This will help in preventing the circulation of unauthenticated data and nip the evil of digital piracy. Our present research is an endeavor to design algorithms for robust and fast image watermarking that counterfeits all or most of the unintentional and common signal processing manipulations while keeping in mind the complexity and speed issues.

Rotation invariant moments and transforms (RIMTs) are widely proposed for digital watermarking because of their many attractive features like magnitude invariance, minimum information redundancy, resilience to noise and other signal processing distortions. The performance of watermarking schemes based on these moments and transforms are largely affected by the inaccuracies in their computation. It is observed that the existing computational framework based on
zeroth-order approximation methods produces geometric approximation error and numerical integration error. Some of the moments and transform coefficients are more sensitive to these errors and are discarded for watermarking resulting in lower embedding capacity. Further, these moments and transforms also suffer from high computational cost and numerical instability issues that limit their usefulness for robust, fast and high capacity image watermarking scheme.

In this thesis, we propose a robust watermarking scheme based on the accurate computational framework to enhance embedding capacity as well as robustness in image watermarking. In addition, algorithms for fast implementation of accurate framework are applied to enhance the overall speed of watermarking processes. Our other major accomplishment lies in the development of novel image adaptive embedding procedure that decodes the information represented by invariant features of the host image and minimizes the distortions added during embedding. The proposed procedure halves the average number of moments to be modified during embedding resulting in improved visual imperceptibility and watermark robustness.

The proposed watermarking scheme based on adaptive embedding procedure and accurate and fast computational framework improves the watermark robustness, embedding capacity, visual imperceptibility, and speed in chorus, which earlier had been considered as one of the greatest challenges in digital watermarking. Exhaustive experimental studies are presented in support our claims.