A NEW FUZZY PERFORMANCE MODELING FOR EVALUATING THE TRADE-OFF AMONG ROBUSTNESS, QUALITY AND CAPACITY IN WATERMARKING ALGORITHMS

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ABSTRACT. There are several digital watermarking metrics proposed by researchers. These metrics can determine the robustness and the imperceptibility of watermarking schemes discretely. Here, there is a lack of an effective strategy to evaluate the balanced trade-off between these requirements. Meanwhile, it is hardly possible to determine crisp thresholds to limit the acceptable and unacceptable boundaries for robustness and imperceptibility. Hence, it is difficult to obtain an accurate mathematical model in order to evaluate the degree of trade-off between watermarking requirements. Thus, it is most advantageous to adopt the fuzzy-based model to fulfill this need. This paper develops a fuzzy inference system (FIS) effectively for exploring the performance trade-off among watermarking performance requirements. We implemented this technique to evaluate EISB (Enhanced Intermediate Significant Bit) watermarking scheme. We also focused on different intensities of Reset Removal Attack which were less considered before, by other researchers. Two main contributions of this paper are the performance fuzzy model itself, and the performance analysis of this model which was carried out and confirmed by results via simulation.

Keywords: Watermarking, Performance measurement, Fuzzy, ISB, EISB, Trade-off, Robustness, Imperceptibility

1. Introduction. Free access multimedia communication through the Internet provides opportunities for piracy of digital multimedia intellectual properties. Therefore, the commercial demand for digital watermarking has been increasing. In order to meet this demand, since the last decade, researchers have been challenged with the introduction of many digital watermarking techniques [53,54], and in the coming decades, the challenge for more advanced techniques will be more intense.

A digital watermark is an ownership identification message in the form of a pattern of bits which is embedded into digital media during the embedding process. This watermark can be extracted through the extracting procedure in order to identify the ownership of the multimedia object. Unfortunately, the embedding process normally degrades the image quality. Thus, the visible imperceptibility (quality) of a watermarking algorithm should be seriously given attention. Moreover, the watermarking algorithm must be robust and able to resist against intentional and unintentional attacks [1,7,33]. Otherwise, embedded owner information hidden in the watermarked multimedia content can easily be detected and destroyed or replaced by malicious users or some software tools intentionally or unintentionally. Furthermore, a high-embedding capacity is always considered