Fuzzy-based Bacterial Foraging for Watermarking Applications

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Abstract—Digital watermarking has been a popular topic in both researches and applications in the last decade. Based on previous experiences in literature, designing one good watermarking algorithm is desired, and how to assess how good the algorithm is should be based on the preset requirements. Here we use one optimization technique named bacterial foraging and we employ the concept in fuzzy theory to design an effective fitness function with the predetermined requirements. Unlike conventional scheme to fix the components in fitness function, by using the fuzzy concept, better results can be obtained. Simulation results demonstrate the advantages of the proposed algorithm over existing ones in literature.

I. INTRODUCTION

Data watermarking is a way to effectively embed the secret data into the cover media, including audio, video, and image. The major purpose for watermarking is to perform the copyright protection of original contents, and hence to preserve the ownership of content creators. Due to the ease of delivery and modification of digital files, the copyrights might be infringed upon. To deal with this problem, digital rights management (DRM) systems can prevent users from using such contents illegally, and watermarking researches and applications have become a major topic in the last decade. With the major purposes for copyright protection or data authentication, its process usually introduces irreversible degradation of the original multimedia [1][2].

The watermarking algorithms that are suitable for copyright protection are called “robust watermarking” algorithms. For robust watermarking, the secret data is first hidden into the original multimedia by using the pre-defined watermarking algorithm, and the watermarked multimedia is obtained. Next, the watermarked multimedia is expected to experience intentional or unintentional signal processing schemes, called attacks, including recompression, enhancement, or data loss during transmission. After experiencing attacks, partly of the hidden data should be extracted from the attacked watermarked multimedia. If the extracted hidden data is recognizable, the pre-defined algorithm can be classified as robust watermarking, which is one of the major topics in watermarking researches.

With the findings in literature [3][4], in order to design a good watermarking algorithm, there are lots of requirements that should be mostly met. The commonly encountered requirements that are mostly considered are the watermarked image quality (or imperceptibility), the survivability, represented by the correct rate of extracted watermark (or robustness), and the number of bits embedded (or capacity).

As demonstrated in [3], some trade off must be searched for because the three requirements conflict with each other.

We try to search for the tradeoff between watermark imperceptibility and watermark robustness with the aid of an optimization technique named bacterial foraging. In addition, the concept of fuzzy theory is also included into the design of fitness function. Since genetic algorithm (GA) has been used to find an optimized solution for watermarking, by use of fuzzy-based bacterial foraging in this paper, we provide another scope to solve this problem.

This paper is organized as follows. In Section II we discuss the concepts and implementations of both the histogram-based scheme and the difference expansion one. We also make comparisons between the two schemes. In Section III we then describe the proposed algorithm by integrating the histogram-based scheme into difference expansion. Simulation results are demonstrated in Section IV. Finally, we point out the contributions of our algorithm and conclude this paper in Section V.

II. BACKGROUND DESCRIPTIONS OF BACTERIAL FORAGING AND FUZZY CONCEPTS

We use the digital images to represent the multimedia contents in this paper. By use of bacterial foraging (BF) and fuzzy concept, the optimized outcome for image-based watermarking can be obtained.

A. The use of bacterial foraging for watermarking

Considering practical applications, we set the watermark capacity a constant value, and we try to search for the tradeoff between watermark imperceptibility and watermark robustness. By following existing experiences, the conflicts between the two can be briefly discussed as follows.