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## ABSTRACT

In the last decade, watermarking applications have increased considerably. The main reason is that watermarking has emerged as a prospective technique, which can provide copyright protection and authentication of digital content. However, the disadvantage of watermarking is that it introduces small modifications in the original work and thus causes slight degradation. These modifications may be undesirable in some sensitive applications, like medical imagery, *3D* reconstruction, and military applications. As a remedy to this problem, researchers have introduced the concept of reversible watermarking.

The main objective of reversible watermarking scheme is to restore the watermarked image to its original state after watermark extraction. In this thesis, new reversible watermarking techniques as well as their novel applications are presented. In some of these techniques, computational intelligence (*CI*) approaches have been employed to improve the watermark capacity versus imperceptibility tradeoff. The research work is carried out in four phases.

In the first phase, reversible watermarking is employed on medical imagery, which comprises regions of sensitive information. Slight modification in these regions affects the diagnostic analysis and thus can lead to wrong decisions. For this purpose, a novel reversible watermarking technique has been developed that utilizes genetic algorithm (*GA*) to improve capacity versus imperceptibility tradeoff. The algorithm makes use of block based companding technique, which helps in increasing the watermark capacity. Experimental analysis depicts that the developed watermarking technique provides good performance compared to the existing approaches. As the technique is reversible, therefore, it is even capable of embedding in the sensitive regions of the image.

Reversible watermarking of images with depth information is discussed in the second phase of this work. *3D* imaging is widely used in *3D* gaming, robotics, controlling and routing devices etc. Different techniques and algorithms are reported to compute the depth information of an object. In this phase, depth information is computed through shape from focus algorithm. The depth information is reversibly embedded in its corresponding *2D* image. This technique also utilizes *GA* to compute near-optimal

threshold matrix for performance improvement in terms of capacity versus imperceptibility tradeoff. An additional attribute is achieved by using the threshold matrix for authentication purpose.

The third phase focuses on reversible watermarking of *3D* camera images. *3D* cameras work on different principles for depth map computation. Cameras working on time of flight principle for depth map calculation are used in the experimental analysis of the proposed technique. The developed technique utilizes *3D* information to embed as a watermark. In this way, protection and secure transmission of an image along with its corresponding depth map is provided. Two *CI* approaches, namely, differential evolution and a hybrid approach (comprising particle swarm optimization and differential evolution) are utilized to optimize the capacity and imperceptibility tradeoff. This technique is also able to provide authentication capability against manipulation and collage attacks.

In the first three phases, *CI* is exploited to improve the performance of the proposed reversible watermarking techniques. However, *CI* approaches are more time and resource consuming. Therefore, in fourth phase, a novel and fast reversible watermarking technique is proposed based on histogram processing and down sampling. Histogram based reversible watermarking techniques are easy to implement and are computationally less expensive. A concept of down sampling is employed to generate a reference image and thus create more space for hiding bits. Block selection is used to generate a location map. However, the location map is required at the receiving side to perform extraction and recovery processes. An additional use of location map is devised, which makes the technique capable of authenticating digital images.