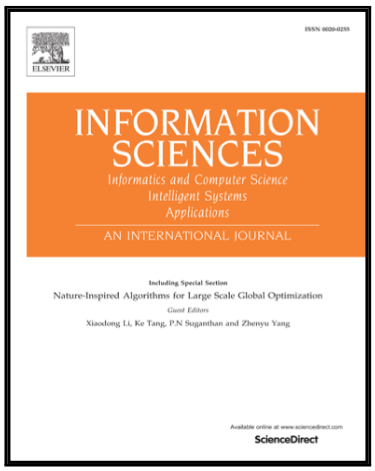

Non-Unit Mapped Radial Moments Platform for Robust, Geometric Invariant Image Watermarking and Reversible Data Hiding

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Non-Unit Mapped Radial Moments Platform for Robust, Geometric Invariant Image Watermarking and Reversible Data Hiding

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Abstract- In this paper to adapt radial moment based watermarking for reversible cases, we have developed non-unit mapped radial moments. They have been used to extract the image invariant features to produce robust geometric invariant watermarking and reversible data hiding. This aim has been achieved through using two other newly introduced methods called reversible interval phase modulation and diagonal rotation estimation. In this paper, at first a mathematical procedure to compute these newly modified radial moments has been proposed. Then a watermarking platform has been suggested which can be used for either robust or reversible data hiding fields. The proposed robust watermarking provides robustness against signal processing and both local and global geometric attacks while at the same time the achieved robust watermarked image can remain integer as the original one. Also, the proposed radial moment computation procedure has been used to produce reversible data hiding. Reversible interval phase modulation and diagonal rotation estimation methods have been proposed to avoid any type of normalization-like degradation in the embedding and extraction. Various aspects of the proposed watermarking scheme have been thoroughly examined through several experiments and the results are highly promising.

Keyword: Global and Local Desynchronization, Radial moments, Invariant features, Reversible and robust watermarking, Reversible Interval Phase Modulation, Diagonal Rotation Estimation

1. Introduction

Image watermarking has been proposed to respond copy protection concerns [4, 28]. Digital watermark is a signal added to the digital data to be extracted or detected later to make an assertion about the data. The effectiveness of a digital watermarking algorithm is indicated by the robustness of the embedded watermarks against various attacks. These attacks can be classified into two types, noise-like signal processing and de-synchronization attacks.

An important problem of virtually all the watermarking algorithms proposed so far is their weakness against desynchronization attacks (DA).[3] These attacks induce synchronization between the original and the extracted watermark during the detection process. In the case of still images, de-synchronization attacks can be simply implemented by applying a geometric transformation to the watermarked image. In general, geometric transformations can be divided into two main classes, global and local ones. Rotation, scaling, translation (RST) or in the general case, affine transformations are typical examples of the global transformations. Random bending attacks (RBAs) including global bending attacks (GBAs), high-frequency bending (HFB) and random jitter attacks (RJAs) are the most well known examples of the local transformations. [23]

Though none of them are perfect, various methods have been proposed in literature to resist global geometric transformations, which try to handle them in a variety of ways, including exhaustive search methods[13], template based methods [9,20] watermarking in invariant subspaces[1, 6, 8, 11, 12, 16, 26, 27] and methods using feature points of the image called second generation schemes [22]. Although they are the simplest methods, exhaustive search methods rapidly become intractable as the amount of possible distortions increase and furthermore, they tend to largely increase the false positive probability [13]. Invariant subspace watermarking is usually performed through mapping the host image onto a geometrically invariant domain such as Fourier-Mellin [14] or using image moments. This mapping procedure is also called image normalization. In practice, due to the computational errors, including the interpolation errors in the normalization process and the sampling errors in converting formulas from continuous to discrete, these methods usually suffer from efficiency issues, especially when image encounters a severe attack. The feature-based methods use image content to recover watermark after geometrical transformations [22].