Chapter V
A Survey of Current Watermarking Synchronization Techniques

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ABSTRACT

The resistance of watermarking schemes against geometric distortions has been the subject of much research and development effort in the last 10 years. This is due to the fact that even the minor geometric manipulation of the watermarked image can dramatically reduce the ability of the watermark detector to detect the watermark, that is, the watermark detector can lose the synchronization. By this, the watermark synchronization can be defined as a process for finding the location for watermark embedding and detection. A variety of techniques have been proposed to provide partial robustness against geometrical distortions. These techniques can be divided into two groups: (1) techniques that use the original image to recover to synchronization and (2) techniques that do not have the access to the original image content during the synchronization process. This chapter classifies and analyzes techniques and approaches that are currently used in watermarking schemes to recover the synchronization.

INTRODUCTION

Digital watermarking is an approach to solving copyright protection problems of digital information (i.e., audio, video, text, or images). The watermark is embedded in the original image and then extracted to verify the ownership.

The ideal properties of a digital watermark include the invisibility and robustness. The watermarked data should retain the quality of the original one as closely as possible. Robustness refers to the ability to detect the watermark after various types of intentional or unintentional alterations (so called *attacks*). In both cases the

watermarking system should be able to detect and extract the watermark after attacks. The best-known watermarking attacks, which may be intentional or unintentional, depending on the application, are: additive noise; filtering; denoising attacks; watermark removal and interference attacks; compressions; statistical averaging; multiple watermarking; geometrical attacks; cropping; random geometric distortions; and printing-scanning.

Various watermarking schemes have been proposed in the present. Unfortunately, up to now there is no algorithm that perfectly fulfils the aforementioned fundamental watermarking requirements: the imperceptibility to the human visual perception and the robustness to any kind of watermarking attacks.

The robustness of the watermark against geometrical attacks is still an open problem in the field of watermarking. Even the minor geometric manipulation of the watermarked image can dramatically reduce the ability of the watermark detector to detect the watermark.

Most previous watermarking algorithms perform weakly against geometric distortions, which desynchronize the location for the embedded watermark. Therefore, the watermark synchronization, which can be defined as a process for finding the location for watermark embedding and detection, is a crucial issue for robust image watermarking.

The effect of geometrical distortions can be better understood by making the analogy between the watermark and any communication system (Cox, Miller, & Bloom, 2001). In a communication system the synchronization between the encoder and decoder is related to the time-synchronization. In a watermarking system the synchronization principle can be applied and it is related to the geometric synchronization. The geometric synchronization refers to the ability of the watermarking detector to perform the watermark detection on the same image part used for the watermark embedding by using the same image coordinates. If the received image is geometrically manipulated the coordinates of the received image will be changed comparing to the coordinates of the original image. As a consequence, the watermark detector will lose the synchronization. Hence, it is required to implement a synchronization recovery technique as a pre-processing step at the decoder side.

A typical geometric distortion affecting an image or a video can be global (rotation, spatial scaling, translation, skew or shear, projective transformation, and change in aspect ratio) or local. We distinguish between global and local geometrical manipulations because the synchronization recovery methods significantly differ. In the first case, there are enough samples to estimate the parameters of the undergone transformation, whereas in the second case, the number of samples is limited since the transformation must be estimated locally.

In this chapter we survey and classify current watermarking techniques (*synchronization* techniques) that provide robustness against geometrical attacks. Roughly, the watermarking schemes dealing with the problem of synchronization can be divided into two groups:

1. Techniques without the access to the original image content (blind synchronization techniques); and
2. Techniques that use the original image content (image registration techniques).

This chapter is organized as follows. Firstly, the geometrical distortion will be classified in the next section. Then, the overview of the existing watermarking techniques which consider the problem of synchronization without access to the original image content will be given in the third section. After that, an image registration technique is described and experimentally tested. At the end the final conclusions will be given.