

# Video Watermarking by Using Geometric Warping Without Visible Artifacts

Dima Proefrock, Mathias Schlauweg, and Erika Müller

Institute of Communications Engineering,  
University of Rostock,  
Rostock 18119, Germany,  
{dima.proefrock, mathias.schlauweg, erika.mueller}@uni-rostock.de

**Abstract.** Our paper proposes an enhanced video watermarking approach. The fundamental idea is to use geometric warping for watermarks with high predictable robustness to lossy compression. We explain the basic watermarking approach which uses a block based statistic (Normed Centre of Gravity - NCG) to describe the geometric structure of blocks. The NCG also is used to choose robust blocks. To embed the watermark information the chosen blocks are changed by geometric warping. To extract the watermark, the original video is not necessary. The NCG is used to detect the watermarked blocks and compute the embedded watermark bit. In some cases, the independent geometric warping of blocks which contain the same object results in visible artifacts. We propose to link blocks in space and time to block groups. In contrast to the basic approach, the blocks of one block group can be warped in dependence on each other. Thus, the visible artifacts are prevented.

## 1 Introduction

Current information technologies are based more and more on digital multimedia data. The use of digital data instead of analogue data offers many advantages. A lot of digital data can be produced in a very short time and it becomes more and more trivial to edit and finish the data. As opposed to analogue data, digital data can be endlessly copied without any loss of quality. However, the technologies to manipulate and copy data are often used in an illegal manner. Hence, there is a growing importance of applications such as data authentication, copyright and data hiding. Digital watermarking offers contributions in these fields. It describes techniques to embed additional information, the watermark, into digital data [1]. Transparency, robustness and capacity are some important and application dependent properties of watermarking. Especially in the case of video watermarking, watermarks with high robustness to lossy compression are required. Generally, videos are compressed with lower data rates as single images. Hence, image watermarking techniques can not be automatically used for video watermarking.

There are watermarking approaches that solve the problem by embedding the watermark into the compressed domain during or after the encoding process

(e.g., [2], [3]). This method has the advantage that the watermarking process is not influenced by the compression. However, the watermarks are generally not robust to a transcoding of the video. This paper presents a watermark approach in the uncompressed domain. The uncompressed video is watermarked and can be compressed with different compression algorithms and data rates. The watermark is robust to the compression.

Generally, the watermark is embedded into the irrelevant information of video data to be invisible. This results in problems because compression algorithms try to remove irrelevant information. In [4], we propose a basic watermarking approach which embeds the watermark in the relevant information of videos but in an imperceptible manner. This approach is based on geometric warping of blocks. Because common compression algorithms are PSNR (Peak Signal to Noise Ratio)-optimized, they try to maintain the geometric structure. With this approach a high robustness to the new H.264/AVC compression standard can be achieved. At present, the new H.264/AVC standard, developed for a broad range of applications, provides the highest coding performance [5], [6]. Because this, especially a H.264/AVC compression is suitable to verify the robustness of this new watermarking approach. However, in some cases the basic watermarking process described in [4] results in visible artifacts. We propose a method to prevent these artifacts and improve the video quality.

In this paper, we present an improvement of a basic watermarking approach. Firstly, the fundamental idea of watermarking by geometric warping is described. Afterwards, the principle of the basic approach is explained. Therefore, a statistic to describe the object borders in blocks is introduced. We propose a method to choose robust blocks for watermarking and to detect watermarked blocks even after lossy compression. The enhanced embedding process is explained. The next section describes the way to reduce the artifacts of the basic approach. The several subsections contain information about the reasons for the artifacts, the approach to prevent them, an algorithm to realize the approach as well as results and analyzes of the basic approach enhancement.

## 2 Watermarking by Geometric Warping

Commonly, the watermark is embedded in the perceptual invisible part of the video. The compression algorithms try to remove the perceptual invisible part of the video. Generally, both systems use the PSNR to measure the perceptual quality degradation. Because this, both systems use the same definition for relevant video data. This implies a contradiction. We can not embed a watermark in video parts which are removed during the compression process. We can solve this problem as shown in Figure 1.

The optimal way to embed the watermark with robustness to lossy compression is to embed the watermark in the relevant part of video data. Because common compression algorithms are PSNR-optimized, the relevance is defined by the PSNR. We propose in [4] to change the geometric structure