早稲田大学大学院情報生産システム研究科

博 士 論 文 概 要

論 文 題 目

High Fidelity Information Hiding and Extracting Algorithm for Image Processing

申 請 者

Xinwei XUE

情報生産システム工学専攻
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For image processing, information hiding and extracting is very necessary. Information hiding is generally designed for cryptography by means of hiding the secret data or information into unnoticeable media such as images, audios and videos, as well as other textual documents. Digital watermarks hiding in image data is one of the most popular research topics in information hiding, so-called digital watermarking, to prevent images from copyright attacks and illegal modifications during/after image compression and transmission. Information extracting is to extract or to remove information from media data for automatic understanding of the signals. The information may includes content features, edges, noises, etc. Information extraction can improve the performance of image analysis or image processing. The adverse weather signal (for example: fog, rain, snow, etc) extraction from images or videos is one of problems of information extraction. The adverse weather condition causes complex spatio-temporal intensity fluctuations in videos, leading to deterioration in the performance of video applications such as tracking, detection and compression. In this dissertation, high fidelity information hiding and extracting methods are proposed based on hybrid transform domain.

For the information hiding, image digital watermarking is introduced. The image digital watermarking is the embedded information insensible to human visual system. The existing image watermarking techniques are distinguished on the bases of two domain methods: spatial domain method and transform (Discrete Cosine Transform(DCT) or Discrete Wavelet Transform(DWT)) domain method. These methods only apply to the low dynamic range (LDR) images. However, High Dynamic Range (HDR) images(e.g. contrast ratio of 10^8: 1) have been widely applied in daily applications. Since the visual quality of HDR images is very sensitive to luminance value variations, conventional watermarking methods for LDR images are not suitable and may even cause catastrophic visible distortion. In this dissertation, the first target is to propose the watermarking for HDR image, we combine the spatial domain and DWT domain to add insensible and robustness watermark in our proposed method.

For the information extracting, we introduce rain detection from video; in this dissertation rain is regarded as kind of unnecessary information (it is similar to noise) can affect the tracking accuracy. The existing rain detection and removal approaches use some characteristics of rain to detect rain in the spatial domain of video. These approaches have some weak points as high complexity, huge computation; false detections when moving objects exist in the rain and image quality loss. Therefore, the second target in this dissertation is to propose a new approach for rain detection and removal. Compared with existing approaches, the proposed method based on combining spatial and DWT domain features presents robust for the videos with both rain streaks and moving objects.

This dissertation consists of five chapters which are as follows:

Chapter 1 [Introduction] introduced the brief of information hiding and extracting for image processing first. For information hiding, the digital watermarking is introduced. For information extracting, rain detection and removal is introduced.

Chapter 2 [Watermarking for HDR image] introduced HDR image, tone mapping operator and the proposed watermarking methods for HDR image.

Many methods for watermarking have been proposed in the last several years. For example, the DWT based method (Huang: ICASSP, 2005), and the DCT based method (Cox: IEEE Trans. Image Processing, 1997). But these methods are only applied to the Low Dynamic Range Image (LDRI).

In this chapter, two digital watermarking schemes targeting HDR images are proposed. The first proposed method(Prop.1), is based on combining the spatial domain and DWT domain. Since many methods for watermarking are successfully applied to LDR image, the HDR images are converted to the LDR image part and the residual part. In which, the LDR image part is generated by tone mapping based on μ-Law. The watermark is embedded in the LDR image part by DWT based watermarking method. In the second proposed method(Prop.2), considering the tone mapping applied during displaying an HDR image on a normal display still preserves the image details with the reduction in image contrast, this method attempts to embed watermarks into the detail part of the HDR image. The HDR image is decomposed into a large scale part and a detail part. The large scale part is a bilateral filtered image of the HDR image. The detail part is the residual image between the HDR image and the bilateral filtered image, where the watermark is embedded. In this method, the spatial and DWT domain are also combined. Compared with conventional watermarking method (Huang：ICASSP, 2005) for LDR image apply to the HDR image directly, an average of 15dB increase in PSNR can be achieved by the two proposed algorithms. What's more, the watermarked images quality is also improved by subjective evaluation. These two schemes also show higher robustness (the embedded watermarking can be detected) against copyright attacks.

Chapter 3 [Rain Detection and Removal from Videos] proposed a new algorithm for rain detection and removal based on combining the spatial and wavelet domain features. Adverse weather, such as rain, can cause difficulties in the processing of video streams. Because the appearance of raindrops can affect the performance of human tracking and reduce the efficiency of video compression, the detection and removal of rain is a challenging problem in outdoor surveillance systems.

There are a number of existing approaches to the detection and removal of rain from videos. For example, Garg (CVPR2004) proposed a method based on an analysis of rain's physical and photometric properties and a model of its dynamic and chromatic effects. Zhang (ICME2006) developed a method utilizing K-means clustering based on both temporal and chromatic properties of rain. These methods detect rain only in the spatial domain of video and presents the following disadvantages: high complexity, huge computation; false detections when moving objects exist in the rain and image quality loss.

In this chapter, we propose a new approach for rain detection and removal by combining the spatial and DWT domain features. To distinguish rain motion from object motion, we consider raindrops and streaks as small edges in the details of the image that can be retrieved by wavelet decomposition. Moreover, bilateral filtering is used to detect the dominant edges, which usually belong to major objects and strong edges in the background. By combining these features and using only two successive frames, the proposed approach effectively detects and removes rain from videos with moving objects. The performance of our proposed method is introduced as following. There is some noise around the moving objects of previous methods, but our method is effective at removing the rain streaks without affecting the moving objects. For the objective quality comparison, the temporal variance of the intensities of consecutive frames at a particular pixel is computed. By removing raindrops and streaks from the video, the intensity variations are reduced and the variance of the pixel in consecutive frames is also reduced. The variance in our proposed method is the lowest(only 40% of other methods on average), signifying the best performance. For the complexity comparison, we only use two frames, we can achieve 57% time reduction on average than other methods.

Chapter 4 [The applications of Rain Detection] the particular applications for rain removal and detection are described. For example, human tracking, is one of its applications. 200 frames from original video and the same video handled by rain removal are selected and applied by human tracking method respectively. The tracking results show that by using the rain removal method, frames which the human inside can be tracked successfully are increased by two times compared with those without using this method. Besides, human detection is another application. We try to detect the human bodies out of the background from 10 frames in a video sequence. The detection rate for the frames with rain removal is 93% while the detection rate for the original frames is only 20%, which proves that the higher detection accuracy can be obtained through the removal of rain.

Chapter 5 [Conclusion of the dissertation] summarizes this dissertation.