Enhanced Detection Performance Design for Robust Digital Image Watermarking

Student: Chih-Wei Tang Advisor: Dr. Hsueh-Ming Hang

Department of Electronics Engineering & Institute of Electronics

National Chiao Tung University

Abstract

In the past few years, digital watermarking has received much attention mainly due to the urgent demand for the copyright protection on the widely distributed digital data. In this thesis, we study the relationship among watermark robustness, detection reliability, data payload, and imperceptibility for digital images.

We propose two different types of image watermarking schemes. They both include theoretical analysis and realization and testing. In the first part of this thesis, we design an optimization procedure for selecting the most effective DCT coefficients for watermark embedding. Using this set of coefficients improves the watermark robustness and reliability against attacks and in the meanwhile it maintains the visual transparency of the embedded watermark. To a certain extent, we try to find the “performance limit” of the DCT-domain invisible watermarking technique under the assumptions of known attack and non-blind detection. Since digital images are often compressed for efficient storage and transmission, the popular JPEG compression is used as one attacking example in our design. However, what we propose is a generic and systematic approach of finding the most effective watermarking coefficients in DCT-domain watermarking. A second example using JPEG2000 as the attacking source is also presented.

Based on the theoretically optimized data set obtained using the preceding scheme, a set of coefficient selection rules is derived with the help of parametric classification technique for determining the effective DCT watermarking coefficients without going through a costly iterative process. These rules are simple in computation. They improve the watermark robustness (correctly decoding) and, in the mean time, decrease the error detection probability (correct detection).

In the second part of this thesis, a robust and blind digital image watermarking scheme combining image feature extraction and image normalization is developed. Its goal is to resist both geometric distortion and signal processing attacks. The extracted feature points can survive a variety of attacks and can be used as reference points for both watermark embedding and detection. The normalized image of an image (object) is nearly invariant with respect to rotations. As a result, the watermark detection task can be much simplified when it is applied to the normalized image. Simulation results show that our scheme can survive low quality JPEG compression, color reduction, sharpening, Gaussian filtering, median filtering, row or column removal, shearing, rotation, local warping, cropping, and linear geometric transformation.