B15 Removing JPEG Artifacts in Skin Images for Forensic Analysis

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After attending this presentation, attendees will understand a new method which removes blocking artifacts in JPEG-compressed skin images for forensic analysis.

This presentation will impact the forensic science community by providing a useful method to remove blocking artifacts in JPEG- compressed skin images. With this technique, biometric traits in evidence images can be used for criminal and victim identification reliably.

Recent technological advances have allowed for a proliferation of digital media. This media can be used as evidence in legal cases and hints for investigation. Increasing capability of processing this media for criminal and victim identification is becoming an important task. In some cases (e.g., child pornography and masked gunman), faces of criminals or victims cannot be seen, because they are covered or obstructed. Biometric traits on/in the skin (e.g., skin marks and veins) become important features for identification. Dr. Craft and Dr. Kong were recruited by the United States Department of Justice as expert witnesses for a legal case, *United States v. Michael Joseph Pepe (2008)*, which involved sexual acts with seven pre-teen girls in Cambodia. Dr. Craft was required to identify skin marks in digital images (evidence images) collected from a crime scene and skin marks of the suspect, Mr. Pepe, for verification, because the face of the criminal in the evidence images could not be observed. Unfortunately, Dr. Craft's expert opinion was challenged, partially because of blocking artifacts in the evidence images.

Using biometric traits in/on the skin for criminal and victim identification highly depends on quality of evidence images because of the size of these traits. Evidence images, taken by consumer cameras, are always compressed by the JPEG algorithm. Blocking artifacts are a well known problem caused by this algorithm. As a result, vein patterns can be broken and skin marks can be blurred, or even totally removed, especially under high compression ratios. Although many methods have been proposed to remove blocking artifacts, none are developed specifically for skin images. In fact, they make the situation even worse, because they generally smooth images, including the traits, to alleviate blocking artifacts.

This presentation introduces a new algorithm to remove blocking artifacts in skin images. This algorithm formulates skin image deblocking as an estimation problem and embeds statistical information of skin images into a maximum a posteriori (MAP) model to perform the estimation. A statistical analysis is carried out on a skin image database to obtain a cumulative distribution function (CDF) of difference between

two neighboring pixel values. Because intensity values usually do not change abruptly in a skin image, the CDF of the database and that of a testing image are quite similar. However, the JPEG algorithm removes high frequency information and changes the original CDF. This phenomenon is more serious in the *U* and *V* components, because of the down-sampling process and because of the even larger quantization parameters in the JPEG algorithm. The proposed algorithm uses the CDF of the database as a target to modify a compressed image. A potential function is designed based on the difference between the CDF of the database and that of the compressed image. In this way it connects the MAP model and the statistical information from the skin image database. The gradient descent method is utilized to minimize the potential function.

The proposed algorithm has two novel characteristics: first, it exploits the prior knowledge of skin images extensively; and, secondly, it guarantees that the resultant and compressed images have the same quantized Discrete Cosine Transform (DCT) coefficients, which cannot be achieved by most other methods. The performance of the algorithm was evaluated on 762 skin images with different compression ratios, and compared with four other deblocking methods. Both subjective and objective evaluations demonstrated that the results from the proposed algorithm were more close to the original images. It not only removed blocking artifacts, but also recovered skin features. The out-performance was more obvious when the compression ratio increased. From the resultant images, vein patterns and skin marks can be extracted efficiently for forensic analysis.

Child Pornography, Vein Pattern, Skin Mark

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