IGI PUBLISHING
701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.igi-global.com

ITJ 4722

This paper appears in the publication, International Journal of Digital Crime and Forensics, Volume 1, Issue 2
edited by **Chang-Tsun Li © 2009, IGI Global**

Conditions for Effective Detection and Identification of Primary Quantisation of Re-Quantized JPEG Images

Matthew James Sorell, University of Adelaide, Australia

ABSTRACT

The choice of Quantisation Table in a JPEG image has previously been shown to be an effective discriminator of digital image cameras by manufacturer and model series. When a photograph is recompressed for transmission or storage, however, the image undergoes a secondary stage of quantization. It is possible, however, to identify primary quantisation artifacts in the image coefficients, provided that certain image and quantisation conditions are met. This article explores the conditions under which primary quantisation coefficients can be identified, and hence can be used image source identification. Forensic applications include matching a small range of potential source cameras to an image. [Article copies are available for purchase from InfoSci-on-Demand.com]

Keywords: *Digital Camera; Forensics; JPEG; Re-Compression; Source Identification*

INTRODUCTION

In previous work (Sorell, 2008) which is summarized briefly in this article, the author demonstrated that the choice of Quantisation Table in the JPEG image compression algorithm used in a digital camera is highly dependent on the particular camera manufacturer, and to a lesser extent on the model series. A sample set of over 5000 digital photographs were used to extract 330 Quantisation Tables from 27 different camera models from 10 brands, and it was shown that just 42 Tables were common to more than one camera model. After aggregating the results by camera model *series*, just 25 tables were found to be common across more than one manufacturer, and of this set, 19 of a possible 20 were common to the manufacturers Nikon and Olympus, suggesting a common source of JPEG encoding algorithm.

The Quantisation Table is a useful source discriminator in cases where metadata (notably Exif metadata, see JEITA (2002)) has been removed or is suspected of having been modified. Under certain conditions, the effect of the original quantisation can also survive subsequent compression, such that it is at least possible to narrow down the range of potential source cameras of a recompressed image of interest. Further, if the quantisation history of a set of images can be established, it is possible to collate image sets by that quantisation history.

In Sorell (2008), a multi-hypothesis test based on the 330 sample Quantisation Tables was demonstrated, using a weighted sum of matched filters for each of the 64 quantisation coefficients. This article takes that analysis further, by examining the conditions under which detection of two-stage quantisation is possible, using these results to establish the subset of plausible primary Quantisation Tables.

Previous work on this problem includes Farid (2006), which provided an incomplete analysis based on single photographs from 300 candidate cameras; Lukáš and Fridrich (2003), which used a neural network approach for pattern matching; and Neelamani et al (2006), which focused on a maximum-likelihood approach for overall Quantisation Table estimation.

MOTIVATION

In Sorell (2008), we used multiple commercial online sources to identify as many camera brands and models as we could find as listed on January 1, 2007. We identified over 70 brands of cameras and mobile phones with built-in cameras, with a total of over 2500 models. We note that many camera models follow an obvious series within a particular brand and that some cameras are identical but have different model names depending on the market in which the cameras are released. In addition, we recognise that our list is almost certainly incomplete and that some are branded versions of unbranded OEM (original equipment manufacturer) models.

Various market sources indicate that over 500 million digital cameras, and a similar number of mobile phones with in-built digital cameras, had been sold worldwide by the end of 2006. It is well known that digital photography has almost completely displaced conventional film photography in the consumer market, and it is common knowledge that digital photography bypasses the conventional censorship bottleneck available through a film development service.

A further challenge is that as film cameras are withdrawn from the market, crime scene forensic photography will be forced to move from film to digital equipment. The challenge is to establish the forensic chain of evidence in such a way that digital images (not to mention digital video) can meet the burden of proof in court. Thus, the development of digital camera forensic techniques is timely.

The number of camera models available actually suits forensic purposes quite well – small enough that a complete database of all cameras is technically and commercially viable, but large enough that identification of the make and model series of a candidate camera is of significant assistance in forensic investigation.

JPEG COMPRESSION

The JPEG standard is defined in ITU (1993) and the details of the standard are given in Wallace (1991) for the interested reader. There are a number of modes of operation of the JPEG compression algorithm, but we consider only the progressive mode which is designed for lossy compression of continuous-toned images and is ubiquitously implemented in digital cameras and image editing software. The JPEG compression stages are introduced briefly here.

Image Compression

The JPEG compression algorithm takes as its input three color planes representing Red, Green and Blue light. These undergo a reversible color-space transform into Luminance (Y), Chrominance Red (Cr) and Chrominance Blue (Cb). The Y plane is identical to that used in black-and-white television and contains high resolution information which stimulates the many broad-spectrum rods in the eye. The Cb and Cr planes represented the “coloredness” of the image, stimulating the color-sensitive

Related Content

Reversible Data Hiding with Multiple Data for Multiple Users in an Encrypted Image
Asad Malik, Hongxia Wang, Hanzhou Wuand Sani M. Abdullahi (2019). *International Journal of Digital Crime and Forensics (pp. 46-61).*
www.irma-international.org/article/reversible-data-hiding-with-multiple-data-for-multiple-users-in-an-encrypted-image/215321

Laser Scanning Confocal Imaging of Forensic Samples and Their 3D Visualization
Anya Salih (2011). *Digital Forensics for the Health Sciences: Applications in Practice and Research (pp. 13-28).*
www.irma-international.org/chapter/laser-scanning-confocal-imaging-forensic/52282

Identifying the Use of Anonymising Proxies to Conceal Source IP Addresses
Shane Miller, Kevin Curranand Tom Lunney (2021). *International Journal of Digital Crime and Forensics (pp. 1-20).*
www.irma-international.org/article/identifying-the-use-of-anonymising-proxies-to-conceal-source-ip-addresses/279371

Mobile Cloud Forensic Readiness Process Model for Cloud-Based Mobile Applications
Puneet Sharma, Deepak Aroraand T. Sakthivel (2020). *International Journal of Digital Crime and Forensics (pp. 58-76).*
www.irma-international.org/article/mobile-cloud-forensic-readiness-process-model-for-cloud-based-mobile-applications/252868

Effectiveness of Cyber Bullying Sensitization Program (CBSP) to Reduce Cyber Bullying Behavior Among Middle School Children
Surabhi Negiand Sunita Magre (2019). *International Journal of Cyber Research and Education (pp. 43-51).*
www.irma-international.org/article/effectiveness-of-cyber-bullying-sensitization-program-cbsp-to-reduce-cyber-bullying-behavior-among-middle-school-children/218897