

Research Article

Classifying Altered Digital Images

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Abstract

This article describes a classification system for digital images wherein three states are outlined depending on the image's relationship with the external world (the original scene or image of subject matter). This system can be applied to all photographs and digital images but is most relevant to medical and forensic pictures. The classification system relates to the veracity of photography in its broadest sense. The system has been developed to facilitate a discussion on the nature of altered images and their consequences to the viewer and user, and the situations in which pictures are presented for viewing, and to provide a baseline for definitions. The three categories are referential, post-referential and non-referential. The defining criterion is the point-to-point connectivity between subject and depicted object.

Keywords

- Digital images
- Photography
- Veracity
- Classification system

INTRODUCTION

Digital images can and should be altered if the intended message to the viewer is made clearer by doing so. Some practitioners feel it is imperative to leave completely unaltered, all digital images used in forensic work but when clarity is essential there are good arguments for doing otherwise [1]. This article provides practitioners and courts of law with a means to easily categorise altered digital images (photographs) for forensic purposes.

Since the establishment of photographic-quality digital images there has grown up around this medium a suspicion that any alteration is 'bad' and 'wrong'. The classification system described here allows definitions to be applied without the emotional weight that terms such as 'manipulation' give. This article describes a classification system for photographic veracity relating to all, but particularly medical and forensic, photo-like images. It gives practical examples to demonstrate the reasons and parameters for using such a system. It also calls for continued discussion on what the limits and extent should be for the parameters.

As well as being applied to digital images, the classification system can be retrospectively applied to photographs produced using traditional silver-halide methods, or applied to any image-recording method developed in the future [2].

MATERIALS AND METHODS

The classification system comprises three categories where each one describes the state of the relationship between the original subject and the object depicted in the image. The categories are:

Referential

A referential image retains all point-to-point references to

the object in the external world from which it was recorded. That is, a bundle of light rays were reflected off an object in the external world and imprinted themselves on a recording medium (for instance, a CCD array) to form an image of the object in an unaltered manner; or as unaltered as the medium allows. For all intent and purpose, in an ideal world a medical or forensic image or a technical or scientific image is a referential image. It purports to be an unaltered, accurate rendition of what appeared in front of a camera (or scanner) to be recorded. A trained and skilled medical or forensic photographer goes to great lengths to achieve such results and present them as works of high ethical standards, accuracy and integrity.

Post-referential

By extension, a post-referential image is one where point-to-point references between the object of the external world and the subject in the image are altered or broken and therefore lost. Alterations made to digital images are usually achieved using a computer and appropriate software whereas with traditional photography a darkroom and artist's skills would be applied. Post-referential images are often referred to as 'enhanced' or 'manipulated', but these are emotive words and are best avoided in scientific and legal circumstances.

Non-referential

A third category: non-referential images are images in which there is no direct point-to-point reference with the external world, for instance in photorealist painting and computer-generated images. This category is best illustrated in a medical and forensic sense by the work at the Wales Institute of Forensic Medicine. Crompton and others [1] describe a situation where the computer-generated anatomical illustration of a head (a non-referential image) is overlaid with a referential medical or forensic

image of sharp-force trauma and bruising that was photographed on a victim of an investigation, and the combination image is post-referential; but its creation has embraced all three categories of the classification system. The value of such presentation is in clarifying information for a court of law particularly where a lay jury is utilized.

RESULTS AND DISCUSSION

In forensic and medical imaging, it is 'best practice' to establish an audit trail and save all original images to an archive. Any alterations to copies of these images can be made later and should be recorded as part of the audit trail. It should be noted that digital image files (jpeg files, for instance) that are 'lossy' when they are saved could be regarded as post-referential when compared to RAW format files. More discussion, of a technical nature, is needed on this aspect of the definitions but is beyond the scope of this article. However the original jpeg file, if that is the shooting platform, is referential in the first instance. The key definitional criterion for this system of classification is a breaking, or otherwise, of point-to-point connectivity between the original scene and the representation of the scene.

As a general rule it can be said that all medical and forensic images should remain as referential images, but there are exceptions to the rule as described herein. However a broader question is, how many changes can occur to an image to take it from a referential classification to a post-referential classification. This is a key question and is from where the debate should continue. Logic says, one change should be the point of difference; that is, if one pixel is altered then point-to-point reference is lost. However, in most practical applications that number might be too restrictive because thousands, indeed millions, of other pixels are unaltered and therefore retain point-to-point reference. The significance of the alteration needs to be considered but the debate needs to be had to determine whether one change is an acceptable limitation.

There are several commonly performed changes to digital images outside the forensic arena. These include red-eye removal, retouching blemishes and wrinkles, removal of overhead power lines, cleaning litter from foregrounds, and so on. In extreme cases, waistlines are narrowed, limbs are lengthened and heads are attached to other bodies; but these are examples that do not relate to forensic work and should not concern us here. However, the forensic photographer needs to be aware of the parameters in the broadest photographic sense to know exactly where their professional images lie as part of a whole.

To give a practical example of where altering a digital image may be warranted, take a situation where a specular highlight from a light-source has appeared on the moist surface of a pathological specimen as white flared area. The effect of reducing such an artifact might not alter the pathological detail (which is already hidden by the specular highlight) but it does alter point-to-point references with the subject. Yet by reducing the

effect of the white flare, that element of the picture becomes less distracting to an unpracticed viewer. If 'healthy' tissue were to be 'cloned' into that area of the image then manipulation of the wrong kind has occurred because that provides misleading information to the viewer even if does not alter the 'truth' of the original situation (that healthy tissue was obscured by a specular highlight). This article does not seek to be prescriptive, but likely *acceptable* changes might include the sorts of alterations that could be made in a darkroom as common photographic practice. These changes have their digital equivalents. Such changes would include colour balance correction, tonal and contrast correction, exposure density correction, and so on. Importantly, these changes do not break the link of point-to-point references that the subject has with the object. Additionally, retouching artifacts produced during manufacture such as dust spots on prints and scratches on negatives might also be regarded as legitimate, as might their digital counterparts—dust on electrically charged surfaces (CCDs), for instance.

This classification system allows images to be narrowly defined once the basic descriptions are understood. In a court of law, for instance, the court need only be told what a referential image is and then shown images that are referential (verified with an audit trail). Or the court might be told that an image is rendered non-referential or post-referential with an explanation of why this was done, and the image has a different purpose and intent. A classification system that simplifies the legal process should be welcomed.

CONCLUSION

There has been presented herein, a classification system that is easy to apply to all photographic and photograph-like (digital) images that allows for clarity and consistency when forensic images are presented in various contexts, such as in courts of law or to ethics committees. At its simplest, the system allows a clear division between referential and post-referential images when the alteration of at least one pixel outside the parameters described above is made. The system described here can be easily understood by the layperson when a brief explanation is given. Using neutral terms like 'referential' and 'post-referential' avoids negative connotations often associated with terms like 'manipulated' or 'enhanced'.

The significance of this system is that it allows forensic photographers and crime scene investigators to understand their own digital images as part of a broader spectrum of images that lay viewers will see in several unfamiliar contexts and situations.

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