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Need of Photo Forensics in Era of Social Media

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Abstract

In era of social media and digital age, it is very easy to manipulate and alter the photos or images due to the accessibility of numerous powerful editing software tools. Such issues worsen as the processing tools have become much more sophisticated. As a result, this alters the originality of the image. It is feasible to supplement or eliminate important features from an image without leaving any undeniable proof of image manipulation which is leading to increase in the image forgeries cases. At present people are facing image forgeries in many real-time applications such as court, financial data, legal evidence, medical transcripts, high value assets even in scientific literature. Nowadays, people use social media like Instagram, Facebook, etc. and post their photos or images onto it. Some people use these photos or images and manipulate them for malicious activities such as cyber defamation. In this article you will get to know about what is photo forensics, different manipulation techniques using it photos are manipulated and how these manipulations are detected.

Keywords: Social Media, Photos, Photo Forensics, Photo manipulation

1. Introduction

In today's digital life, digital images are everywhere around us. An **image** is defined as a visual representation of an object, a person, or a scene. A **digital image** is defined as a two-dimensional function f(x, y) which is a projection of a 3-dimesional scene into a 2-dimensional projection plane, where x, y represents the location of the each pixel and contains the intensity value. [8] In Computer graphics, the smallest addressable physical element of picture is called **pixel** or dot which is represented by numerical values: for grayscale images, a single value representing the intensity of the pixel (usually in a [0, 255] range) is enough while for color images, each pixel is represented by three values : the amount of red (R), green (G), and blue (B). [8]

Photo manipulation *or* ***Image forgeries*** are the process of modifying or altering the photo or image by removing or adding information without leaving any obvious traces of altering. Due to the vast availability of low-cost, very easy-to-use and advanced image editing software that are available on the internet freeware; the manipulation of a photo can be easily done even by beginners. That's the reason that manipulated photos are usually seen on the internet, social media, newspapers, official documents, passport, mark sheets etc. Even fake IDs are created using these manipulated images on the social networking sites, images are morphed to play pranks, for cyber defamation thus posing a big challenge and serious vulnerabilities and also lower the value of digital images as evidence.

Photo or Image Forensics is a relatively new & sub-field of Digital Forensics aiming to gather information on the history of an image in such a way that its authenticity can be evaluated. [2] It is possible to verify the history of an image blindly, which means without the help of the original image prior to the alterations.

Today, with the easy accessibility to commonly used photo / image editing software such as Adobe Photoshop, Adobe Lightroom; make it discreetly simple to generate the fake photo. As the image resolutions are shifted to Mega pixels (MPs), new photo altering techniques have been emerging and because of it the detection of photo manipulation has emerged as an implausible field of research in various applications of digital image processing such as Criminal investigation, Biomedical technology, Photo Forensics, etc.

2. Important Characteristics of a Digital Image

2.1 Type of Image [8]

With regard to the manner in which they are stored, digital images are classified into two types: (1) Raster or Bitmap image (2) Vector image.

(1) Raster or Bitmap image

Bitmap is a type of graphics that represents a rectangular grid of pixels, viewable via digital output devices or paper. Size of Bitmap image is relatively more than Vector image. It is usually suitable for photographs. File types such as .jpg, .gif, .png, etc. are example of Bitmap image.

(2) Vector image

Vector image is a type of graphics defined in the terms of 2D points that are connected by lines, curves to form geometric shapes. Size of Vector image is relatively less. It is usually suitable for logos, icons, clipart, etc. File types such as .ps, .svf, .ai, etc. are example of Vector image.

2.2 Different Image File Formats

Images / Photos are stored on storage media in specialized file formats. File format defines how the image information will be stored in the file and subsequently how that information will be displayed on an output screen or hardcopy output device. There are many different image file formats in existence, i.e., JPEG, GIF, BMP, PNG, etc. [3]

2.3 Header File

Usually, image file comprises of the header of file, ***the header*** is a section of binary data that is found at the beginning of the file. The header section contains the following information: (a) Horizontal dimensions of the image (in pixels) (b) Vertical dimensions of the image (in pixels) (c) Image data type (grayscale or color) (d) Image bit depth (e) Compression technique if used.

A header usually starts with some sort of unique identification value called as file identifier, file ID, or ID value or Magic numbers which are usually the first bits of a file which uniquely identify the type of file, for example a JPG file starts FF D8 FF E0 and a PNG file with 89 50 4E 47. Therefore, the header section of an image file helps in forensic analysis of an image and may help in reconstructing the original data. [7]

2.4 Time Stamp

A timestamp is a sequence of characters or encoded information identifying when a specific event occurred, usually giving date and time of day, sometimes accurate to a small fraction of a second. [6]

2.5 EXIF (Exchangeable Image File Format)

When a digital image is clicked using camera or mobile device, the digital camera records the date and time information in the actual image as EXIF (Exchangeable Image File Format) metadata. The accuracy of this information depends on the date and time settings of camera & mobile phones. On mobile phones, it's usually not a big problem because they tend to be online and update themselves automatically, but if the setting is turned off for any reason, the information of date & time might not be available at all.

When user imports a photo from his camera or mobile phone to his computer, the EXIF metadata will carry along with the actual image, and it's always the most reliable source for the date and time of the original shot. [6]

2.6 Digital Watermark

Digital watermarking is a technique that enables the user to embed digital mark on/in the image during image acquisition process by the productive camera, mainly utilized to protect the authenticity of the digital image.

2.7 Digital Signature

A digital signature is a cryptographic term which inserts the digital signatures on/in the digital images to ensure that no alteration or modifications is done on the image.

3. Methods of Photo / Image Alteration & Manipulation

Image manipulation, tampering, Image editing refers to any operation that can be done to a digital image by software on a computer or other digital devices such as tablets and mobiles. Simply it can be defined as the process of inserting or eliminating the specific features from an image without any proof of altering and to evade for malicious purposes. In some cases, it is very hard to recognize the altered image part from the authenticate image.

The digital images are generally tampered by region duplication (cloning), image retouching, resizing, cropping, blurring, morphing, etc.

Photoshopping is a common term used for the editing of digital images; Photoshop is a very common and most popular tool for image editing. The word "Photoshopping" has its origin from Adobe Photoshop, this image editor has been most commonly used by professionals. There are also various freeware tools are available such as Paint.NET, Coral paint shop and other applications such as Picsart are there that is supported by Android OS.

Region Duplication or Cloning or Copy-move attack: in this selective region from an image are copied, sometimes transformed, and then pasted to new locations within the image itself to conceal some original image contents.

Image Splicing: In image splicing, selected regions from two or more images to be pasted together to generate a new image.

Tampering Operation: It is image retouching, where images with poor quality (low contrast, low brightness, etc.) are modified for enhanced appeal. [4]

Resizing: This brings a geometric change to minimize or to enlarge the size of an image or a part of an image. Resizing is an altering the size of your image without cropping any part of that image. [5]

Cropping: It is photo manipulation process practiced by all of us, where an image is cut off at the borders, generally performed in order to remove an unwanted subject or irrelevant detail from a photo, change its aspect ratio, to improve an image. [5]

Noising or Blurring: Image blurring is usually performed with a simple image convolution matrix. Each pixel of the image is replaced with the average of it and its surrounding 8 pixels. Blurring is used to make an image smooth in which edges are invisible. Blurring is even used to hide tempered areas.

Morphing: Morphing is an image processing technique used for the transformation from one image to another; provide a unique effect in motion images and animations.

4. Methods / Techniques to Detect Alterations & Manipulations

Photo manipulation detection plays a significant role in forensics to give authenticity to the photo/image. The manipulation detection techniques try to find the inconspicuous anomalies or we can say that which are not easily noticeable in the color shade, illumination changes in images. The active approach includes pre-processing operations like watermark embedded or signatures for a digital image which are produced during the formation of image, other than the watermarking, image hash, message authentication code, image shielding, and image checksum are means of providing security to an image and help in manipulation & alteration detection. [2]

Mostly manipulation detection methods or tools rely on Metadata Analysis (EXIF). This supplementary metadata provides information regarding the date, time, camera settings, and possible copyright information and also the photo processing software.

Clone Detection – The clone detector highlights copied regions within an image. These can be a good indicator that a picture has been manipulated.

Error Level Analysis or ELA analysis –This method is based on characteristics of image formats that are based on lossy image compression, so this method attempts to highlights areas of an image with different degree of compressions.

Other image forensic tools use special algorithms which are based on:

Pixel based techniques, Format based techniques, Camera-based techniques, Physical environment-based techniques, Geometry based techniques, etc.

Freeware Tools for Photo Forensics or to detect photo alterations :

1. EXIF Info
2. FotoForensics
3. JPEGSnoop
4. Forensically

For this study two images are selected which are as below, out of which one is original and other is edited or tempered and analyzed by the freeware tool FotoForensics.

Figure 1 : Original Image

Figure 2 : Modified Image

The above image is captured and edited by author Mr. Shreyas Patel

The results of the analysis of both of the images are as below: (FotoForensics Tool is Used)

Metadata of Original Image :

File	
File Type	JPEG
File Type Extension	jpg
MIME Type	image/jpeg
Exif Byte Order	Little-endian (Intel, II)
Image Width	6000
Image Height	3376
Encoding Process	Baseline DCT, Huffman coding
Bits Per Sample	8
Color Components	3
Y Cb Cr Sub Sampling	YCbCr4:2:2 (2 1)
EXIF	
Image Description	
Make	SONY
Camera Model Name	ILCE-6000
Orientation	Horizontal (normal)
X Resolution	350
Y Resolution	350
Resolution Unit	inches
Software	ILCE-6000 v3.21
Modify Date	2021:02:22 22:51:37
Y Cb Cr Positioning	Co-sited
Exposure Time	1/200
F Number	8.0
ISO	100
Sensitivity Type	Recommended Exposure Index
Recommended Exposure Index	100
Exif Version	0230
Date/Time Original	2021:02:22 22:51:37
Create Date	2021:02:22 22:51:37
Components Configuration	Y, Cb, Cr, -
Compressed Bits Per Pixel	2
Brightness Value	7.53671875
Exposure Compensation	0
Max Aperture Value	4.5
Metering Mode	Multi-segment
Light Source	Daylight
Flash	Off, Did not fire
Focal Length	59.0 mm
User Comment	
Flashpix Version	0100
Color Space	sRGB
Exif Image Width	6000
Exif Image Height	3376
Interoperability Index	R98 - DCF basic file (sRGB)
Interoperability Version	0100
File Source	Digital Camera
Scene Type	Directly photographed
Custom Rendered	Normal

Exposure Mode	Auto
Digital Zoom Ratio	1
Focal Length In 35mm Format	88 mm
Scene Capture Type	Standard
Contrast	Normal
Saturation	Normal
Sharpness	Normal
Lens Info	55-210mm f/4.5-6.3
Lens Model	E 55-210mm F4.5-6.3 OSS
Compression	JPEG (old-style)
Thumbnail Offset	38470
Thumbnail Length	8080
Thumbnail Image	(Binary data 8080 bytes)
	MakerNotes
Rating	0
Brightness	0
Long Exposure Noise Reduction	On (unused)
High ISO Noise Reduction	Normal
HDR	Off; Uncorrected image
WB Shift AB GM	0 0
Face Info Offset	94
Sony Date Time	2021:02:22 22:51:37
Sony Image Width	6000
Faces Detected	0
Face Info Length	37
Meta Version	DC7303320222000
Creative Style	Standard
Color Temperature	Auto
Color Compensation Filter	0
Scene Mode	Standard
Zone Matching	ISO Setting Used
Dynamic Range Optimizer	Off
Image Stabilization	On
Color Mode	Standard
Full Image Size	6000x3376
Preview Image Size	1920x1080
File Format	ARW 2.3.1
Quality	Fine
Flash Exposure Compensation	0
White Balance Fine Tune	0
White Balance	Daylight
Sony Model ID	ILCE-6000
Teleconverter	None
Multi Frame Noise Reduction	Off
Picture Effect	Toy Camera (normal)
Soft Skin Effect	Off
Vignetting Correction	Auto
Lateral Chromatic Aberration	Auto
Distortion Correction Setting	Off
Lens Type	E-Mount, T-Mount, Other Lens or no lens
Lens Spec	E 55-210mm F4.5-6.3 OSS
Auto Portrait Framed	No
Flash Action	Did not fire

Electronic Front Curtain Shutter	On
Focus Mode	AF-A
AF Area Mode Setting	Wide
Flexible Spot Position	0 0
AF Point Selected	n/a
AF Points Used	(none)
AF Tracking	Off
Focal Plane AF Points Used	(none)
Multi Frame NR Effect	Normal
Flash Level	Normal
Release Mode	Normal
Sequence Number	Single
Anti-Blur	On (Shooting)
Shot Number Since Power Up	4
Sequence Image Number	1
Sequence File Number	1
Sequence Length	1 file
Camera Orientation	Horizontal (normal)
Quality 2	JPEG
Sony Image Height	3376
Model Release Year	2014
ISO Setting	100
ISO Auto Min	100
ISO Auto Max	3200
Ambient Temperature	34 C
AF Area Mode	Multi
Focus Position 2	193
Exposure Program	Program AE
Intelligent Auto	Off
Lens Zoom Position	7%
Sony ISO	100
Base ISO	100
Stops Above Base ISO	0
Sony Exposure Time 2	1/209
Sony Max Aperture Value	4.7
Sony Image Width Max	6024
Sony Image Height Max	4024
Picture Effect 2	Toy Camera
Distortion Correction	None
Distortion Corr Params	4 2 8 20 40 66 100 142 196 266 356 0 0 0 0 0
Vignetting Corr Params	0 96 192 320 512 736 1024 1280 1760 2688 4224 0 0 0 0 0
Chromatic Aberration Corr Params	148 212 270 322 366 398 436 506 596 702 820 0 0 0 0 0 980 860 736 612 488 364 236 108 -20 -132 -240 0 0 0 0 0
Battery Temperature	46.1 C
Battery Level	81%
Lens Mount 2	E-mount
Lens Type 3	Sony E 55-210mm F4.5-6.3 OSS
Camera E-mount Version	1.50
Lens E-mount Version	1.35
Lens Firmware Version	Ver.02.006
Release Mode 3	Normal
Self Timer	Off
Flash Mode	Fill-flash

HDR Setting	Off
Picture Profile	Gamma Still - Standard/Neutral (PP2)
WB RGB Levels	686 255 435
Min Focal Length	55.0 mm
Max Focal Length	210.0 mm
Distortion Corr Params Number	11 (APS-C)
Shutter	Mechanical (3196 5451 6161)
Flash Status	Built-in Flash present
Shutter Count	11591
Sony Exposure Time	1/209
Sony F Number	8.1
Shutter Count 2	11591
Sony Date Time 2	2021:02:22 17:21:38
Release Mode 2	Normal
Internal Serial Number	24002f0c
Lens Mount	E-mount
Lens Format	APS-C
Lens Type 2	Sony E 55-210mm F4.5-6.3 OSS
Distortion Corr Params Present	Yes
Lens Spec Features	E OSS
	PrintIM
PrintIM Version	0300
	MPF
MPF Version	0100
Number Of Images	2
MP Image Flags	Dependent child image
MP Image Format	JPEG
MP Image Type	Large Thumbnail (full HD equivalent)
MP Image Length	580386
MP Image Start	3950592
Dependent Image 1 Entry Number	0
Dependent Image 2 Entry Number	0
Preview Image	(Binary data 580386 bytes)
	Composite
Aperture	8.0
Blue Balance	1.705882
Lens ID	Sony E 55-210mm F4.5-6.3 OSS
Red Balance	2.690196
Shutter Speed	1/200
Focus Distance 2	11.85 m
Image Size	6000x3376
Light Value	13.6
Megapixels	20.3
Scale Factor To 35 mm Equivalent	1.5
Circle Of Confusion	0.020 mm
Field Of View	23.1 deg
Focal Length	59.0 mm (35 mm equivalent: 88.0 mm)
Hyperfocal Distance	21.60 m

Metadata of Edited Image :

File	
File Type	JPEG
File Type Extension	jpg
MIME Type	image/jpeg
Exif Byte Order	Big-endian (Motorola, MM)
Current IPTC Digest	d81296db53eb60ded1269f1ed9c0290d
Image Width	5364
Image Height	3376
Encoding Process	Baseline DCT, Huffman coding
Bits Per Sample	8
Color Components	3
Y Cb Cr Sub Sampling	YCbCr4:2:0 (2 2)
JFIF	
JFIF Version	1.01
EXIF	
Processing Software	Windows Photo Editor 10.0.10011.16384
Photometric Interpretation	RGB
Make	SONY
Camera Model Name	ILCE-6000
Orientation	Horizontal (normal)
Samples Per Pixel	3
X Resolution	350
Y Resolution	350
Resolution Unit	inches
Software	Windows Photo Editor 10.0.10011.16384
Modify Date	2021:04:20 09:55:42
Y Cb Cr Positioning	Co-sited
Exposure Time	1/200
F Number	8.0
Exposure Program	Program AE
ISO	100
Sensitivity Type	Recommended Exposure Index
Recommended Exposure Index	100
Exif Version	0230
Date/Time Original	2021:02:22 22:51:37
Create Date	2021:02:22 22:51:37
Components Configuration	Y, Cb, Cr, -
Compressed Bits Per Pixel	2
Shutter Speed Value	1/200
Aperture Value	8.0
Brightness Value	7.53671875
Exposure Compensation	0
Max Aperture Value	4.5
Metering Mode	Multi-segment
Light Source	Daylight
Flash	Off, Did not fire
Focal Length	59.0 mm
User Comment	
Flashpix Version	0100
Color Space	sRGB
Exif Image Width	5364
Exif Image Height	3376

Interoperability Version	0100
File Source	Digital Camera
Scene Type	Directly photographed
Custom Rendered	Normal
Exposure Mode	Auto
White Balance	Manual
Digital Zoom Ratio	1
Focal Length In 35mm Format	88 mm
Scene Capture Type	Standard
Contrast	Normal
Saturation	Normal
Sharpness	Normal
Lens Info	55-210mm f/4.5-6.3
Lens Model	E 55-210mm F4.5-6.3 OSS
Padding	(Binary data 2060 bytes)
Compression	JPEG (old-style)
Thumbnail Offset	5462
Thumbnail Length	17424
Thumbnail Image	(Binary data 17424 bytes)
	PrintIM
PrintIM Version	0300
	IPTC
Application Record Version	0
Time Created	22:51:37
	Photoshop
IPTC Digest	d81296db53eb60ded1269f1ed9c0290d
Displayed Units X	inches
Displayed Units Y	inches
Print Style	Centered
Print Position	0 0
Print Scale	1
Global Angle	30
Global Altitude	30
URL List	
Slices Group Name	DSC00842_1
Num Slices	1
Pixel Aspect Ratio	1
Photoshop Thumbnail	(Binary data 7799 bytes)
Has Real Merged Data	Yes
Writer Name	Adobe Photoshop
Reader Name	Adobe Photoshop 2020
Photoshop Quality	12
Photoshop Format	Standard
Progressive Scans	3 Scans
	XMP
XMP Toolkit	Adobe XMP Core 6.0-c002 79.164460, 2020/05/12-16:04:17
Creator Tool	Windows Photo Editor 10.0.10011.16384
Metadata Date	2021:04:20 09:54:22+05:30
Lens	E 55-210mm F4.5-6.3 OSS
Date Created	2021:02:22 22:51:37
Color Mode	RGB
ICC Profile Name	sRGB IEC61966-2.1
Document ID	adobe:docid:photoshop:0d667d62-4a23-bb45-a698-e1375504e53f
Instance ID	xmp.iid:4a01c8e2-1d2f-2245-9e09-97cedfc62b4d

Original Document ID	B4D6B1A673880F5A02E08E98977F3165
Format	image/jpeg
History Action	saved, saved
History Instance ID	xmp.iid:ede8e010-0224-5840-8d2f-dd4e725728dd, xmp.iid:4a01c8e2-1d2f-2245-9e09-97cedfc62b4d
History When	2021:04:20 09:54:22+05:30, 2021:04:20 09:54:22+05:30
History Software Agent	Adobe Photoshop 21.2 (Windows), Adobe Photoshop 21.2 (Windows)
History Changed	/, /
Description	.....
	Composite
Aperture	8.0
Lens ID	E 55-210mm F4.5-6.3 OSS
Shutter Speed	1/200
Date/Time Created	2021:02:22 22:51:37
Image Size	5364x3376
Light Value	13.6
Megapixels	18.1
Scale Factor To 35 mm Equivalent	1.5
Circle Of Confusion	0.020 mm
Field Of View	23.1 deg
Focal Length	59.0 mm (35 mm equivalent: 88.0 mm)
Hyperfocal Distance	21.60 m

By observing the metadata info of original and edited images, we get information regarding to image capturing device, time of image capture, manipulations in image, software used to manipulate/edit image, time of image manipulation, etc.

Conclusion

Nowadays, in era of social media and internet, the questions may arise on the authenticity of Digital Image/Photo. Every digital image / photo captured using any device such as smartphone, DSLR camera, etc. has specific file format, timestamp, EXIF data, etc. These all data are useful to check authenticity of that image. i.e. by analyzing EXIF data, we can say that the image is modified/altered or not, and if altered then which type of manipulations are done and we can also identify the software which was used for image modifications and the time when an image was modified. So, by performing these types of analysis, forensic examiner can prove the authenticity of digital image / photo.

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