

COMPARATIVE ANALYSIS OF IPHONE IMAGE DATA ACROSS VARIOUS TRANSFER
METHODS

by

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Comparative Analysis of iPhone Image Data Across Various Transfer Methods

Thesis directed by Associate Professor Catalin Grigoras

ABSTRACT

This study investigated and analyzed image metadata from various iPhones across non-destructive and destructive transfer methods in order to better recognize forensic patterns associated with EXIF data, file structures and DCT compression. By using participant contributors, images were collected from the primary rear iPhone camera as well as from the secondary front camera. These images were transferred two different ways, non-destructive or baseline and destructive using several modes of transfer. A comparative analysis was done using these transfer methods along with using digital forensic software tools such as ExifTool, FIAS and 010 Editor for analysis. These software programs were used to authenticate, analyze and extract image metadata from several iPhone models and iOS versions. There were significant findings from the image metadata analysis that included inconsistencies within the metadata across the models of the iPhones identified in this study. Additional findings were associated with the destructive transfer methods compared to the non-destructive transfer methods. Law enforcement agencies and forensic analysts will find this study useful to help inform decision making during analysis within the mobile phone forensic field.

Keywords: comparative analysis, iPhone, EXIF, file structures, DCT compression.

The form and content of this abstract are approved. I recommend its publication.

Approved: Catalin Grigoras

DEDICATION

This thesis is dedicated to my parents. To my mom for always supporting everything I do and encouraging me to pursue my dreams and aspirations. To my dad for making me strive and push for excellence. Thank you both for help guiding me through this crazy thing called life!

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LIST OF ABBREVIATIONS

DCT – Discrete Cosine Transform

EXIF – Exchangeable Image File Format

FIAS – Forensic Image Authentication Software

GPS – Global Positioning System

HDR – High Dynamic Range

HEIC – High Efficiency Image Codec

HEIF – High Efficiency Image Format

JFIF – JPEG File Interchange Format

JPEG – Joint Photographic Experts Group

MMS – Multimedia Messaging Service

SWDGE – Scientific Working Group On Digital Evidence

USB – Universal Serial Bus

CHAPTER I

INTRODUCTION

On June 29, 2007, Apple released the first generation iPhone, which became a game changer in the commercial market, increasing competition among smartphone manufacturing companies. More than just a phone, the new Apple iPhone included many other features, including a camera, GPS locator, an audio recording device, a personal health monitor, a digital music player, and an exceedingly novel visual interface unlike anything before. Apple, while not the first, designed a smartphone capable of revolutionizing the way humans communicate across the world. This new age of communication technology brought forth a capability of sharing digital files including audio, video and images on a mass scale.

With the introduction of Apple's iPhone, photographic capabilities emerged in phone technology through its on-unit camera sensor. What resulted was a new world of image-based content suddenly now in the hands of millions of users. These images have been downloaded onto computer hard drives, shared through email attachments, instant messaging, and uploaded via social media and transferred widely across multiple devices. Photographic images have been shared across communication networks at a volume and rate previously unimagined. With literally millions of iPhones actively in use every second of every day, it is critically important for researchers and forensic law enforcement agencies to carefully understand deviations of image metadata with each updated model and iOS version to ensure consistency in analysis of digital evidence. According to an article from an online technology website Lifewire, from 2007 to 2018 there were 2.2 billion iPhones sold worldwide. As of November 1st 2018, Apple stopped reporting sales figures.

Since 2007, Apple has introduced an evolutionary line of 29 separate models of the iPhone and over 50 operating system software versions, which have become ever-more sophisticated with the release of each model and version. (“List of iPhones”, 2020). No doubt this evolving technology will continue to dominate the public market for smartphones for many years to come.

The purpose of this study was to determine what differences occur in image metadata, file structures, and re-compression across a select number of iPhone models, iOS versions, and transfer methods. Analysis and evaluation of this dataset, including subsequent findings will provide a useful resource for law enforcement agencies as well as digital forensic examiners who all require the skills and knowledge necessary to recognize potential patterns and irregularities between iPhone models, iOS versions and transfer methods.

This study explored three techniques of data collection including analyzing Exchangeable Image File (EXIF) data, file structures and Discrete Cosine Transform (DCT) compression as well as exploration of Joint Photographic Experts Group (JPEG) and High Efficiency Image Codec (HEIC). Image data were gathered from a wide range of iPhone models and iOS versions. This study also investigated various types of transfer methods through the iPhones including USB cable, Google Drive, AirDrop, e-mail, iMessage, and Facebook Messenger.

Two types of images were used with nine different iPhones models, white wall images using the rear camera or primary camera, and selfie images using the front camera or secondary camera. Each phone image was transferred two ways, one using non-destructive methods as a reference and one using destructive methods. These particular transfer methods were used to investigate the metadata across several iPhone models. For example, a non-destructive transfer method such as using Apple’s AirDrop would keep the image in an original state while

transferring to a particular device. A destructive method like Facebook Messenger would alter the original images metadata when transferring to a device.

This study followed the standards set forth by the Scientific Working Group on Digital Evidence (SWGDE) Best Practices for Image Authentication 1.0 (2018). In this document, SWGDE has organized and categorized the most efficient and appropriate techniques for the collection and analysis of image data with non-biased and forensically ethical procedures. The best practices drawn for this study focused on image structure, metadata and the non-visual material within the image itself. “This document provides basic information and best practices on the evidentiary value, methodology, range of conclusions, and limitations when conducting image authentication as a part of image analysis” (SWGDE, pg. 4). SWGDE best practice documents like this one help maintain forensic integrity throughout the process of analysis and authentication.

Image forensics continues to grow as a substantial aspect of professional digital forensic community work. With a seemingly endless growth of social media platforms and digital camera phone use, image forensics has become increasingly important to law enforcement and digital forensic researchers and practitioners. However, with the technological advances of smartphone photography, comes forensic challenges that practitioners need to be aware of including combating forging and manipulation of image metadata. (Farid, pg. 570).

Previous Research

Mobile phone forensics has become an increasingly significant aspect of the digital forensic community’s roles and responsibilities since the rise of smart phones. There have been scientific papers addressing digital image forensics, including that of images taken by mobile phones, including the Apple iPhone. Considerable research has been done not only on image

content analysis and authentication, but also on metadata within images. Hany Farid, a well-known Computer Science professor at the University of California, Berkeley, stated in his book *Photo Forensics* “Metadata is data about data. The metadata for a digital image is the data about the camera make and model, the camera settings, the data and time of image capture, the GPS location of image capture and much more. The wealth of information provided by an image’s metadata makes it an excellent starting point for any forensic analysis” (Farid pg. 188).

A referenced paper titled “*Forensic source identification using JPEG image headers: The case of smartphones*” by Mullan, Reiss and Freiling (2019) described how the JPEG file format has changed through the use of modern day tablets and smartphones including the iPhone. Their study examined quantization frequency and Exchangeable Image File (EXIF) data across several models of Apple iPhones and iPads.

One area of emphasis within this study is the presence of the High Efficiency Image Format (HEIF) container, which has limited software or research support. A paper titled, *Forensic Considerations for the High Efficiency Image File Format (HEIF)*, by McKeown and Russell (2020) focused on the forensic challenges of this relatively new file format, which has become a newer format standard, replacing the common JPEG format. The authors explained it this way, “Unfortunately this lack of widespread software support is also an issue for forensic investigators, as many forensic tools have been slow to implement decoders. Two reasons for this is that HEIF is a complex container format which allows multiple images, or burst shots, to be stored in many potential configurations, while also lacking mature publicly available implementations or documentations” (pg.1). With the technological development of this newer file format, there will be a need for more testing.

Limitations

During this study there were several limitations that need to be discussed. The original first generation iPhone was not used for analysis due to availability issues. The iPhone 3GS did not support Facebook Messenger for iOS 6.1.6 and therefore no experiments were performed. The iPhone 3GS did not have a rear camera and thus selfie images were not produced for this study. Many of the iPhones tested in this study were from participant contributors remotely located and some transfer methods were not practical. For example AirDrop has limited transfer distance capabilities.

The HEIC files that were found in the iPhone models 8, XR and 11 Pro needs additional research and testing before a conclusion can be made regarding the images and relative metadata. When analyzing HEIC image files they should be converted to JPEG uncompressed or a similar uncompressed format and then be studied with verified authentication tools.

CHAPTER II

DATA COLLECTION

Image collection occurred two ways: in person and remotely. Four of the nine iPhones collected were in person, by the researcher himself, and five were gathered remotely from participant contributors. For the iPhones that were remotely collected, detailed instructions were sent to all participant contributors via email. The instructions were designed to keep the images and transfer methods as uniform as possible to mitigate bias and help to maintain forensic integrity. Those detailed instructions, procedures and guidelines can be found in Appendix A.

Two distinct images were captured by each iPhone for the purposes of analyzing image metadata. These images were categorized by white wall images by the primary camera, and selfie images by the secondary camera. The two types of images were transferred to a MacBook Pro laptop computer using non-destructive and destructive transfer methods for analysis. These methods include the use of USB cable, AirDrop, Google Drive, e-mail, iMessage, and Facebook Messenger. Working copies were made to ensure forensic integrity and organized into specific folders for later analysis.

MATERIALS

Table 1: iPhone Models, iOS Versions and Non-Destructive and Destructive Transfer Methods

<u>iPhone Model</u>	<u>iOS Version</u>	<u>Non-Destructive</u>	<u>Destructive</u>
iPhone 3GS (2009)	6.1.6	USB Cable	iMessage
iPhone 4S (2011)	9.3.6	USB Cable	Facebook Messenger
iPhone 5S (2013)	12.4.8	Google Drive	iMessage
iPhone 6 (2014)	12.4.8	Google Drive	E-mail
iPhone 6S Plus (2015)	13.6	Google Drive	E-mail
iPhone 7 (2016)	13.6.1	Google Drive	E-mail
iPhone 8 (2017)	13.5.1	Google Drive	E-mail
iPhone XR (2018)	13.5.1	AirDrop	Facebook Messenger
iPhone 11 Pro (2019)	13.6.1	AirDrop	Facebook Messenger

The following iPhone data and model information was gathered from the website EveryiPhone.com as a reference. This data included pertinent information relating to each iPhone model studied and differences between them. Each iPhone used portrayed different camera sensors, resolutions and specific features that were essential to this study.

iPhone 3GS (iOS 6.16)

The iPhone 3GS was introduced by Apple in 2009, and featured a rear 3-megapixel camera with a maximum capture resolution of 2048 x 1536. This phone did not feature a front facing camera.

iPhone 4S (iOS 9.3.6)

iPhone 4S was introduced by Apple in 2011 and featured an upgraded rear 8-megapixel camera with a maximum capture resolution of 3264 x 2448. The 4S also included a front facing camera,

first introduced in the iPhone 4 a year earlier. This camera featured a 0.3-megapixel camera, 640 x 480 resolution.

iPhone 5S (iOS 12.4.8)

iPhone 5S was introduced by Apple in 2013. The camera remained the same resolution and megapixels as the 4S, however a larger aperture was added in order to increase light intake. The front facing camera sensor was updated to handle 1.2 megapixels and a resolution of 1512 x 792.

iPhone 6 (iOS 12.4.8)

iPhone 6 was introduced by Apple in 2014. 8-megapixel rear camera with updated front facing camera sensor. Front camera is 1.2 megapixels with automatic HDR technology. High-dynamic range (HDR) offers greater light and dark contrasts within the images. This created richer and more vibrant images compared to earlier models.

iPhone 6S Plus (iOS 13.6)

iPhone 6S Plus was introduced by Apple in 2015. This was the larger model of the 6S and featured a new larger 12-megapixel camera and 4290 x 2800 image resolution. The front facing camera improved to a 5-megapixel sensor and a resolution of 2560 x 1920. Face detection technology was added for swifter more efficient resolution of selfie images.

iPhone 7 (iOS 13.6.1)

iPhone 7 was introduced by Apple in 2016. The rear camera used the same 12-megapixel camera from the 6S, however the front facing camera was upgraded to 7-megapixels and a resolution of 3072 x 2304. This model also added optical image stabilization as a standard feature not found in previous models.

iPhone 8 (iOS 13.5.1)

iPhone 8 was introduced by Apple in 2017. There were no significant changes in the camera sensor from the iPhone 7.

iPhone XR (iOS 13.5.1)

Apple introduced the XR in 2018. The 12-megapixel camera still remained the same but with a wider lens than previous models. The front facing camera, still 7-megapixels added a new SL 3D depth and biometrics sensor for superior selfie images. Portrait mode was made a standard feature using the rear camera.

iPhone 11 Pro (iOS 13.6.1)

Apple introduced the iPhone 11 Pro in 2019. This iPhone is equipped with three separate rear camera sensors. The wide (standard) lens, telephoto lens, and an ultra-wide lens, all 12-megapixels. Each sensor is triggered differently by the user when taking an image. The front facing camera was also upgraded to 12-megapixels. With four camera sensors, the iPhone 11 Pro became the latest and most advanced photography smartphone.

Images

White Wall Images from Primary Camera

All white wall images were captured 3-5 feet away from a blank white wall. No artificial lighting or manipulation were used and all camera settings were set to default. These methods were utilized for the purpose of standardization of data collection. For EXIF data, these images were used to mainly examine sensor information including focal length and aperture, as well as Global Positioning System (GPS) data across the iPhone model spectrum. For file structure analysis, the white wall images were used to compare iPhone models from the years 2007-2019.

DCT compression analysis was used to look at re-compression through various transfer methods.

These white wall images were used with the rear camera or primary camera.

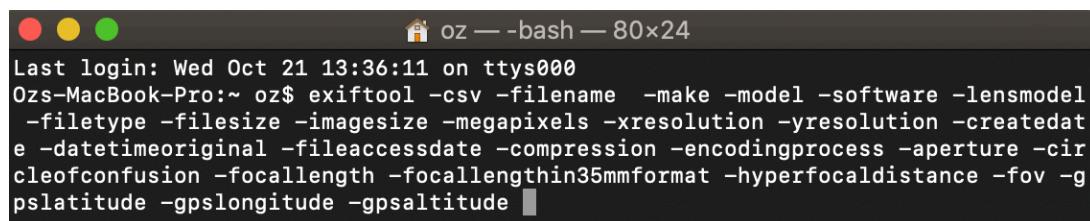
Selfie Images from Secondary Camera

The selfie images were captured for the analysis of EXIF data, file structure analysis and DCT compression using the front or secondary camera. The front camera was introduced in the iPhone 4S and has become associated with the infamous “selfie photo”. Selfies have become commonplace within the last few years and have spawned a new generation of image and video applications like Instagram, SnapChat and TikTok. With the increasing amount of selfie images being used for social media, and the high risk of digital crime associated with these images, it was imperative to analyze and describe the metadata from that front facing camera sensor.

Software

ExifTool

The open sourced ExifTool was founded by Harvey (2003) and provided a reliable tool to extract, write and manipulate metadata. ExifTool in this study was used to extract and analyze EXIF data from each image. Mac terminal command line was used to obtain the pertinent camera sensor data. The image data was compiled into a .csv file for organization and analyzed.



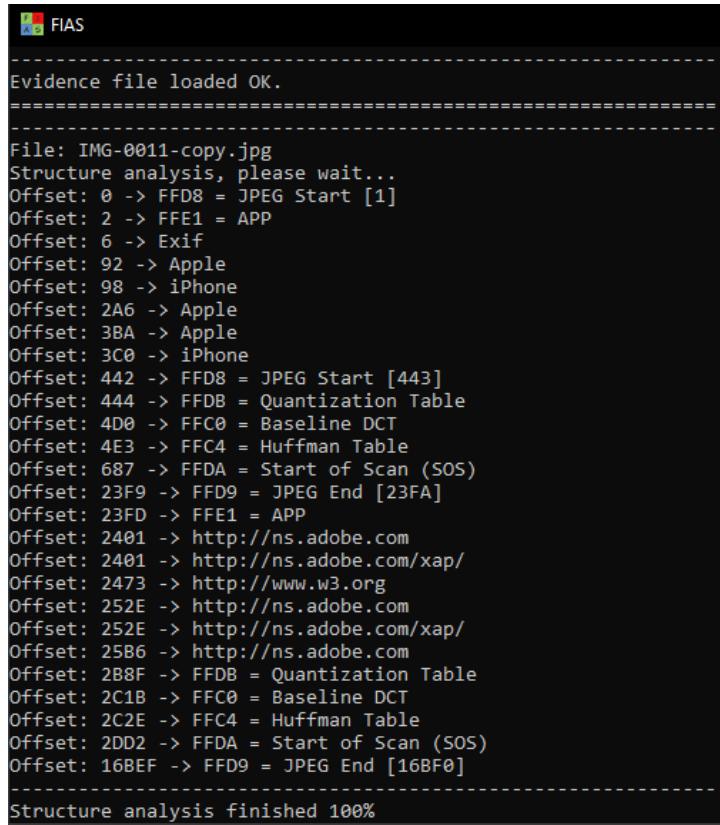
A screenshot of a Mac OS X terminal window titled "oz — -bash — 80x24". The window shows the command line interface for the ExifTool. The command entered is:

```
Last login: Wed Oct 21 13:36:11 on ttys000
Ozs-MacBook-Pro:~ oz$ exiftool -csv -filename -make -model -software -lensmodel
               -filetype -filesize -imagesize -megapixels -xresolution -yresolution -createdat
               -datetimoriginal -fileaccessdate -compression -encodingprocess -aperture -cir
               cleofconfusion -focallength -focallengthin35mmformat -hyperfocaldistance -fov -g
               pslatitude -gpslongitude -gpsaltitude
```

Figure 1: Command Line for ExifTool

FIAS

FIAS is a forensic image authentication tool designed by Grigoras (1998). For this study FIAS was used for file structure analysis as well as DCT compression histograms. For file structure analysis, each image was loaded into FIAS and the “Structure & EXIF” function was used. For DCT compression information and histograms, the “Quantization Tables (QT) & DCT Histogram” button was used. FIAS created folders for each image and image metadata for convenient access for analyzing. FIAS was also used for gathering raw data for EXIF, file structures and DCT compression for the appendices. An example of analysis can be seen in figures 2 and 3.



The screenshot shows the FIAS software interface with a dark background and white text. At the top, it says "Evidence file loaded OK." followed by a dashed line. Below that, it says "File: IMG-0011-copy.jpg" and "Structure analysis, please wait...". It then lists numerous offsets and their corresponding file structures, such as JPEG Start, Quantization Table, Baseline DCT, Huffman Table, Start of Scan (SOS), and JPEG End. The list continues with various offsets and structures, including several occurrences of "Apple" and "iPhone". Finally, at the bottom, it says "Structure analysis finished 100%" followed by another dashed line.

```
Evidence file loaded OK.
-----
File: IMG-0011-copy.jpg
Structure analysis, please wait...
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2A6 -> Apple
Offset: 3BA -> Apple
Offset: 3C0 -> iPhone
Offset: 442 -> FFD8 = JPEG Start [443]
Offset: 444 -> FFDB = Quantization Table
Offset: 4D0 -> FFC0 = Baseline DCT
Offset: 4E3 -> FFC4 = Huffman Table
Offset: 687 -> FFDA = Start of Scan (SOS)
Offset: 23F9 -> FFD9 = JPEG End [23FA]
Offset: 23FD -> FFE1 = APP
Offset: 2401 -> http://ns.adobe.com
Offset: 2401 -> http://ns.adobe.com/xap/
Offset: 2473 -> http://www.w3.org
Offset: 252E -> http://ns.adobe.com
Offset: 252E -> http://ns.adobe.com/xap/
Offset: 25B6 -> http://ns.adobe.com
Offset: 2B8F -> FFDB = Quantization Table
Offset: 2C1B -> FFC0 = Baseline DCT
Offset: 2C2E -> FFC4 = Huffman Table
Offset: 2DD2 -> FFDA = Start of Scan (SOS)
Offset: 16BEF -> FFD9 = JPEG End [16BF0]
-----
Structure analysis finished 100%
```

Figure 2: File Structure Analysis iPhone 4S in FIAS

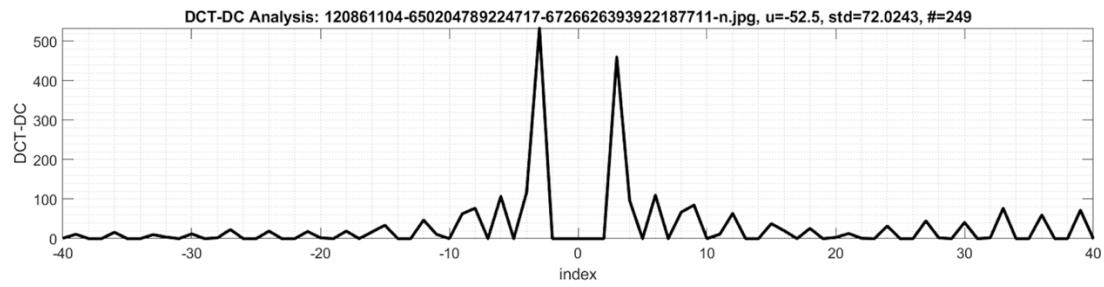


Figure 3: DCT Compression Analysis iPhone 4S Facebook Messenger

CHAPTER III

TESTING

Several forms of destructive and non-destructive transfer methods were used to determine patterns in EXIF data, file structures and re-compression of the images. The non-destructive methods in this study were used as a reference, while the destructive methods were tested using the varied software tools. Non-destructive methods included USB cable, AirDrop and Google Drive, while the destructive methods included iMessage, e-mail and from the Facebook Messenger mobile application (see Appendix B for transfer methods for each phone). Images from USB cable were not used with the “Photos” application due to re-compression issues. The “Photos” application that is standard on Macintosh computers is often used for downloading images, this application does change the compression factors as well as the hash if used. Instead Apple’s Image Capture was used to ensure forensic validity and maintain integrity throughout the study.

iPhones typically produce JPEG files, and that was the case for six of the nine iPhones used in this study. JPEG, is a common standard file format for lossy compressed images. The iPhone 8, XR and 11 Pro produced HEIC files. High Efficiency Image Codecs are a relatively new lossy compressed standard from Apple and only require half the storage space compared to JPEG.

Three methods of image analysis in this study were used to determine potential patterns and missing data: EXIF data, file structures and DCT compression plots. Each technique examined various forms of metadata within the images. These specific techniques tell a different story of image authentication for investigative purposes.

Transfer Methods

Non-Destructive Methods

Three transfer methods were used as a referenced baseline in the experimental design and to maintain image integrity: USB Cable, AirDrop, and Google Drive. These transfer methods were used to directly compare to the destructive transfer methods. Each transfer method was verified using hash software to ensure image reliability. Hashing acts as digital fingerprint with a unique alphanumeric set given to a particular media file. Software program iHash was used and SHA256 hashing algorithm was performed.

Table 2: White Wall Images and Hash Values (Non-Destructive vs Destructive)

iPhone	Non-Destructive/Destructive
iPhone 3GS	4e8be566265ad4f57f9abf7f79f69716347c2026e7a4d160a0b60d2d1eef6246 ee81beb9381177f00d3a6a90d32d87673c7bd295fad677bf51f81695421236ee
iPhone 4S	361d4de0e18f3220bde68a8ca956f739c96f56edc4366f4d7ad0bd3a2e604e88 86ab1b91ed0cc178973aff4be4296fcc5963f0fc8b583672398052c6e9d570e9
iPhone 5S	96666229d6b54f788bd43fd7bf9bc0cfedcd08d1acad67a0d93a209a34afec1 96666229d6b54f788bd43fd7bf9bc0cfedcd08d1acad67a0d93a209a34afec1
iPhone 6S	5fe5149cce647d360db0b7bf87bc91b4acd9c372bea6ce89c87ddfdc7a9e1eb3 5fe5149cce647d360db0b7bf87bc91b4acd9c372bea6ce89c87ddfdc7a9e1eb3
iPhone 6S+	ef5636b81a6835f245439ba4e52383345d153b3024b998b264ff7482555403db ef5636b81a6835f245439ba4e52383345d153b3024b998b264ff7482555403db
iPhone 7	d0f93b6775077699583d67f3d2fa5efd99b456db27a12e9b0eb3bdaf2f62d5f d0f93b6775077699583d67f3d2fa5efd99b456db27a12e9b0eb3bdaf2f62d5f
iPhone 8	65fe4c1161a8a01c010cc12ec98d7d9a3926896351e59f0078d38a794dc4c73d 25c1fb574e82863a06ed3298f5ddb14457d330deeb655fa7928d26521047681
iPhone XR	2729ebdded4448c5506e8a9daa64b24e706d7703ea3e80014941422aad048264 5685e79abf7edb3f97c7f993d9fd1e4b3e3f135503684a8b90a59b966c6cf4e
iPhone 11 Pro	89b3d7c7eeab70446faf59de157d81baf4f3f6c0b16e9c3f16f150d01850b5aa cacd26bb03fab2cde5dedabad7b813c6d1f71a15de38feb850d5ccb6088b187

Table 3: Selfie Images and Hash Values (Non-Destructive vs Destructive)

<u>iPhone</u>	<u>Non-Destructive/Destructive</u>
iPhone 4S	89ef2a34066a872a592623608ffa2c890a6ed7834200dead57fb52530485523c 7fa4c13bb3c187f2131a359d2b7af680664fc57c57292b33d97e52b8ad8559fb
iPhone 5S	be980aab0c893057b4b943e6ca4155ed88ba64ebbf847a80a5d2578e3437b98f be980aab0c893057b4b943e6ca4155ed88ba64ebbf847a80a5d2578e3437b98f
iPhone 6S	a63a72d6bf30b4fb3df55225b865e52a8cb5522cf3cc43ea34fb3d4982f5b675 a63a72d6bf30b4fb3df55225b865e52a8cb5522cf3cc43ea34fb3d4982f5b675
iPhone 6S+	76274828f67e3b846224d39778fb0c02407977256aabe763bda24040d61c66d0 76274828f67e3b846224d39778fb0c02407977256aabe763bda24040d61c66d0
iPhone 7	9427e2558567f501ca96982093eb497df0591452401d992b55649fe77d7fb73 9427e2558567f501ca96982093eb497df0591452401d992b55649fe77d7fb73
iPhone 8	09b324562bebc672832914f7fbadc118e02d5dd610c7a3191f888f8dfa292e0e d6667dd59459bcfa36df2264f0a441979acd057c27d16b0bba8709757bb76d4b
iPhone XR	d0fa3c9f0880c982e67d12cdc562b1bb8ce717a91eae7dbf7f6651da9482f0f8 c09c9eb19f05942a803690a34c52de39bd5f047d292a0144a2bac33f2eb61aa1
iPhone 11 Pro	87fc4dd2822805850ffd317610dea54ce60d7c1b939ea1507cc7ccd29622c845 628aaa1bf811860bcd195677840e80f7c60245a771b754ba9fc756919b9cff3b

The OSX native application Image Capture was used on the MacBook Pro for the iPhone 3GS and 4S via USB cable. Using Image Capture ensured image integrity and no loss of detail compared to other forms of USB cable transfer. The images were downloaded from the Image Capture interface to specific folders of the MacBook for further analysis.

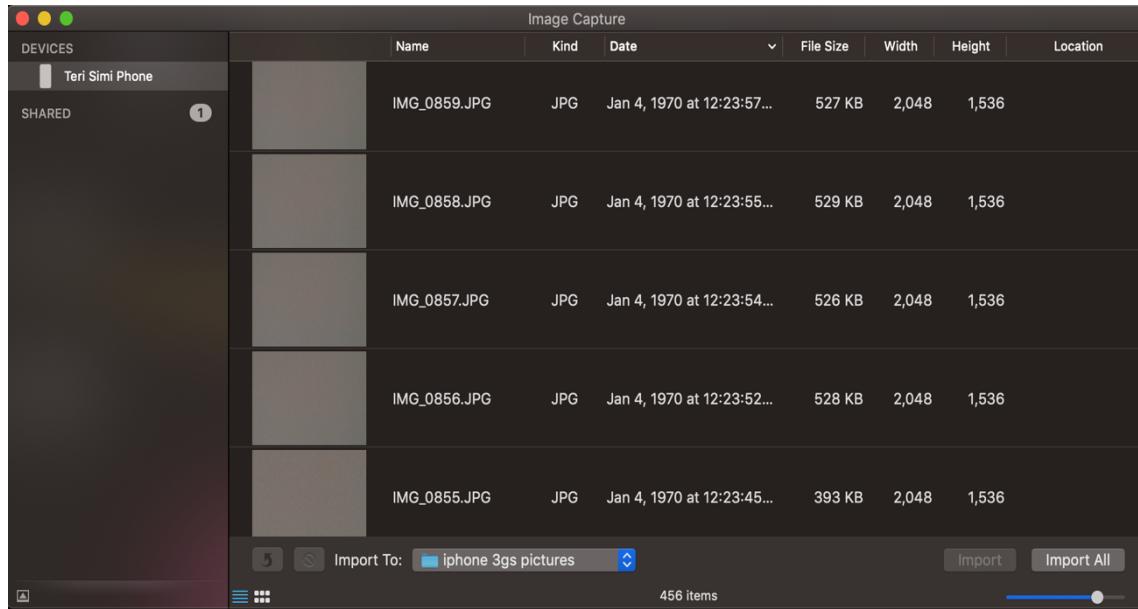


Figure 4: Apple’s Image Capture of iPhone 3GS

The AirDrop function was applied for iPhone XR and 11 Pro. This transfer method was the fastest, as the images were transferred from phone to computer in a matter of seconds. The images were downloaded onto the MacBook and organized into specific folders for later analysis. According to a Lifewire article titled “*What Is AirDrop, How Does It Work?*” AirDrop “uses Bluetooth to create a peer-to-peer Wi-Fi network between devices. Each device creates a firewall around the connection and files are sent encrypted, which actually makes it safer than transferring via email”

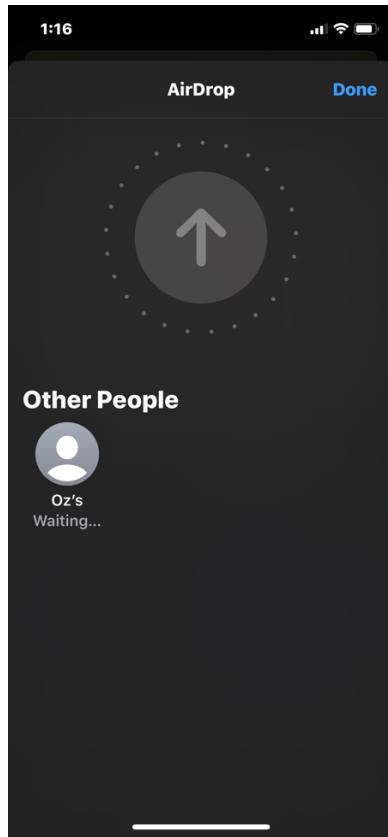


Figure 5: Apple's AirDrop iPhone 11 Pro

Cloud storage service, Google Drive was a preferred method from all participant contributors and used on iPhones 5, 6, 6S Plus, 7 and 8. This particular method was the only way to receive non-destructive images remotely in this study. The participant contributors were given a set of detailed instructions to send the images via Google Drive and later for download. All participants were asked to upload the images they captured to Google Drive using the mobile version.

Destructive Methods

The three destructive transfer methods: e-mail, iMessage, and Facebook Messenger were used to determine differences in metadata and compression across all of the iPhones tested, as well as the non-destructive methods mentioned above. Hash software was used to verify images from each transfer method.

The e-mail transfer method was used on the iPhone 6, 6S Plus, 7 and 8. E-mail was the most logical and simplistic form of transfer of image files from the remote participant contributors. The participants uploaded the iPhone images to their preferred e-mail service provider, using the appropriate settings including using “actual size” to send the images for image integrity. The images were sent to the researcher’s provided email address and downloaded for further analysis.

Text messaging is another widely accepted form of communication and thus a valuable method to use for this study. Because only iPhones were used in all experiments, all incoming image texts were iMessage based and did not use Multimedia Messaging Service (MMS) texts. iPhone 3GS and 5S were used for texting transfer methods. Facebook Messenger has become one of the major platforms for social media chatting and for sending and receiving various forms of media.

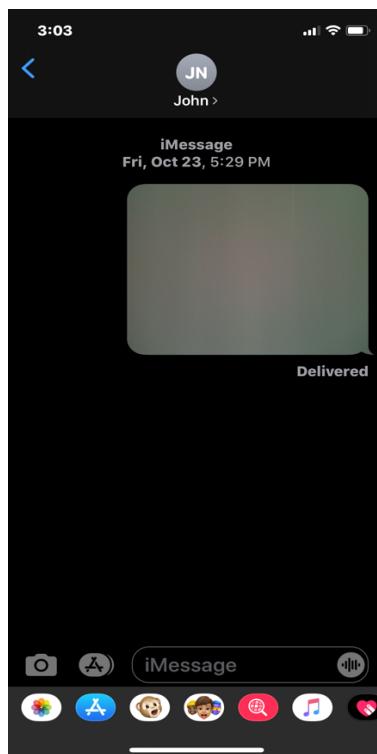


Figure 6: iMessage Transfer Method

Facebook Messenger has been integrated with iPhones for many years, including having the ability to send direct camera images to the application. iPhone 4S, XR and 11 Pro were used to send images straight to the Facebook Messenger application. Using Facebook Messenger with an older iPhone compared to newer iPhones could potential result in differences in metadata.

EXIF Data

There are many types of metadata that are revealed when analyzing an image. EXIF data is the metadata information from a particular camera . In this study the use of EXIF data was to determine if the iPhones were missing data or had any differences in crucial data from model to model. Each image was analyzed for EXIF data and transcribed into a searchable Excel spreadsheet. When analyzing images with EXIF data, it was important to understand each piece of image data. In digital photography, each image taken has a myriad of associated EXIF data. These data included date and time information, camera settings used, and GPS location data. The iPhone 5S, 7, 8, XR and 11 Pro showed GPS location data. The iPhone 3GS, 4S, 6 and 6S Plus did not show any GPS data. This could be that the internal location settings were based on the user's preferences.

ExifTool was the primary software for initial analysis. Exiftool operated as a command line within the Macintosh's terminal to analyze the pertinent EXIF data related to the study. The image data was organized in Microsoft Excel for further analysis. FIAS was used as a secondary reference to verify the EXIF data as well as to extract the raw data for this thesis.

Using the iPhone 7 and 8 as an example, the figures below show the EXIF data with FIAS. For all EXIF data related to this study (See Appendix C).

```
        Filename: 'C:\Users\STUDENT_14\Desktop\non destructive images send to fias\IMG-3550-copy\IMG-3550-copy.jpg'
        FileModDate: '13-Oct-2020 17:58:58'
        FileSize: 1081373
        Format: 'jpg'
        FormatVersion: ''
            Width: 3088
            Height: 2320
            BitDepth: 24
            ColorType: 'truecolor'
        FormatSignature: ''
        NumberOfSamples: 3
            CodingMethod: 'Huffman'
            CodingProcess: 'Sequential'
            Comment: {}
                Make: 'Apple'
                Model: 'iPhone 7'
        Orientation: 6
        XResolution: 72
        YResolution: 72
        ResolutionUnit: 'Inch'
            Software: '13.6.1'
            DateTime: '2020:09:02 12:06:32'
        YCbCrPositioning: 'Centered'
        DigitalCamera: [1x1 struct]
            GPSInfo: [1x1 struct]
        ExifThumbnail: [1x1 struct]
```

Figure 7: EXIF Data with iPhone 7

```
        Filename: 'C:\Users\STUDENT_14\Desktop\destructive FIAS-results\IMG-1918-copy-email\IMG-1918-copy-email.jpg'
        FileModDate: '22-Oct-2020 15:15:17'
        FileSize: 1305072
        Format: 'jpg'
        FormatVersion: ''
            Width: 4032
            Height: 3024
            BitDepth: 24
            ColorType: 'truecolor'
        FormatSignature: ''
        NumberOfSamples: 3
            CodingMethod: 'Huffman'
            CodingProcess: 'Sequential'
            Comment: {}
                Make: 'Apple'
                Model: 'iPhone 8'
        Orientation: 6
        XResolution: 72
        YResolution: 72
        ResolutionUnit: 'Inch'
            Software: '13.5.1'
            DateTime: '2020:08:22 17:46:21'
        YCbCrPositioning: 'Centered'
        DigitalCamera: [1x1 struct]
            GPSInfo: [1x1 struct]
        ExifThumbnail: [1x1 struct]
```

Figure 8: EXIF Data with iPhone 8

File Structure and Hex Analysis

File structure analysis is a method to consider in the construction of data for forensic purposes. In this study, each image tested was loaded into FIAS and file structure analysis was performed. This method organized the file header, encoded image, and footer into an accessible readout. Furthermore, hex data analysis is a method for media examination and authentication associated with a file's binary data. These values are an essential part of image metadata. Software based hex editors such as 010 Editor and Hex Fiend can look at the entire image file and gather important metadata such as file format, time and date and possible manipulations involved. Hex Fiend was used as a supplementary tool for data analysis with HEIC files.

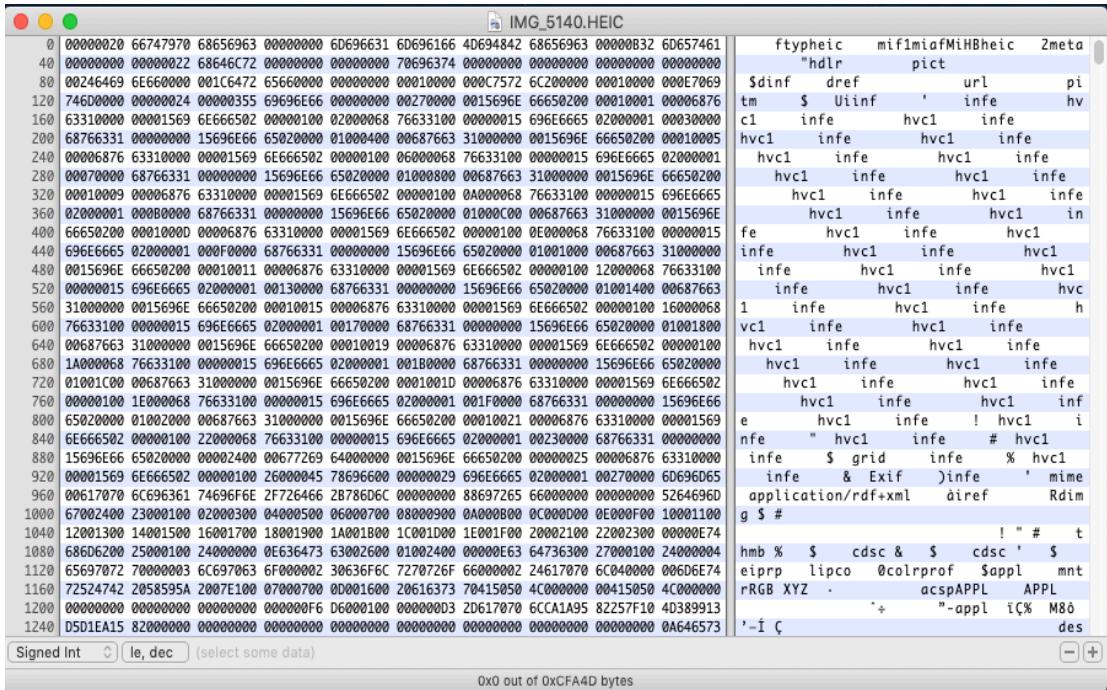


Figure 9: Hex Fiend HEIC Image File from iPhone 11 Pro

DCT Compression

The Discrete cosine transform (DCT) is the algorithm at the heart of JPEG compression. By using this transform, low frequency image data can be removed with minimal loss of quality. This is done by quantizing 8 x 8 blocks of image data using a prescribed compression

quantization table. The lower the numbers in the table the lower the JPEG compression and furthermore the higher the numbers in the table, the higher the JPEG compression.

In this study, all images were loaded into FIAS and a DCT analysis was applied. The purpose of using DCT analysis was to look at re-compression within the images that have been transferred in destructive methods. FIAS analyzed all images and produced DCT histograms and quantization tables as well as a JPEG quality factor number. JPEG quality factor percentage is a scale of 1-100. The higher the number the lower the compression and the closer to the original JPEG image. Figure 4 below is an example of a low and high compression quantization table (Smith, 1999, n.p).

a. Low compression								b. High compression							
1	1	1	1	1	1	2	2	4	1	2	4	8	16	32	64
1	1	1	1	1	1	2	2	4	2	4	4	8	16	32	64
1	1	1	1	1	2	2	2	4	4	4	8	16	32	64	128
1	1	1	1	1	2	2	2	4	8	8	16	32	64	128	256
1	1	1	2	2	2	2	2	4	8	16	32	64	128	256	512
2	2	2	2	2	2	4	4	8	8	16	32	64	128	256	512
2	2	2	2	4	4	8	8	16	16	32	64	128	256	512	1024
4	4	4	4	8	8	8	16	16	128	128	256	256	256	256	256

Figure 10: JPEG Quantization Table

White Wall Images

Table 4: White Wall Images and JPEG Quality Factor Percentages

iPhones	<u>Non Destructive Method</u>	<u>Destructive Method</u>
	<u>JPEG Quality %</u>	<u>JPEG Quality %</u>
iPhone 3GS	95	93
iPhone 4S	96	92
iPhone 5S	93	93
iPhone 6	96	96
iPhone 6S Plus	94	94
iPhone 7	93	93
iPhone 8	N/A	93
iPhone XR	N/A	71
iPhone 11 Pro	N/A	73

Selfie Images

Table 5: Selfie Images and JPEG Quality Factor Percentages

iPhones	<u>Non Destructive Method</u>	<u>Destructive Method</u>
	<u>JPEG Quality %</u>	<u>JPEG Quality %</u>
iPhone 3GS	N/A	N/A
iPhone 4S	96	92
iPhone 5S	93	93
iPhone 6	96	96
iPhone 6S Plus	96	96
iPhone 7	93	93
iPhone 8	N/A	93
iPhone XR	N/A	71
iPhone 11 Pro	N/A	71

The tables above show the JPEG image quality percentage of the various iPhone models studied through the two types of transfer methods discussed. Note that the images transferred from iPhone 3GS had a small drop in JPEG quality using the USB cable and the iMessage transfer methods. The iPhone 4S used USB cable and Facebook Messenger for direct comparison. While there was not available data for the iPhone 8, XR and 11 Pro using the non-destructive because of the HEIC file format; there was a noticeable JPEG quality drop in the Facebook Messenger transfer method.

This table also shows that there is not any significant differences in the JPEG quality percentage with the non-destructive Google Drive and the destructive e-mail and iMessage methods.

CHAPTER IV

RESULTS

Overview

Image data analysis of 36 iPhone images through various transfer methods were collected and analyzed. Many noteworthy findings were emerged. This chapter is devoted to describing the differences in metadata, file structures and re-compression found during analysis.

Findings

The analysis of EXIF data, file structures and DCT compression between models of iPhones and transfer methods brought forth some key outcomes. The most substantial finding from this study had to do with transferring the white wall images from the iPhone 3GS using both destructive and non-destructive transfer methods with USB cable and iMessage. Both of these transfer methods produced different hashes and changes within the metadata not found in the other iPhone models. For an example iPhone 6S Plus, transferred both using Google Drive and e-mail produced the same hash and metadata.

The figures below are a comparison of metadata from the iPhone 3GS and iPhone 6S Plus. The iPhone 3GS produced different hash and DCT histograms and the iPhone 6S Plus produced the same hash and DCT compression histograms using the same form of non-destructive and destructive transfer methods.

The image shows two separate windows of the Windows Notepad application. Both windows have the title 'jacksum.txt - Notepad'.

Top Window (Left):

```

File Edit Format View Help
Filename: IMG_0848_USBcable.jpg
Filepath: C:\Users\STUDENT_14\Desktop\non destructive images send to fias\
Filesize: 982221 bytes
MD5: d1da74804201a5ee85fd826823c5797b
SHA1: 1bd21e7cebf3467ed84df342af0cd74838b761d4
SHA256: 4e8be566265ad4f57f9abf7f79f69716347c2026e7a4d160a0b60d2d1eef6246

```

Bottom Window (Right):

```

File Edit Format View Help
Filename: IMG-0848-copy-text.jpg
Filepath: C:\Users\STUDENT_14\Desktop\destructive FIAS-results\
Filesize: 836540 bytes
MD5: b106dfb766eaa4ad97ad9f458c6c8300
SHA1: acd1a5ac47d133318f1add8afb38a1756913ee0
SHA256: ee81beb9381177f00d3a6a90d32d87673c7bd295fad677bf51f81695421236ee

```

Figure 11: Hash Values iPhone 3GS Cable vs iMessage (Different Hash)

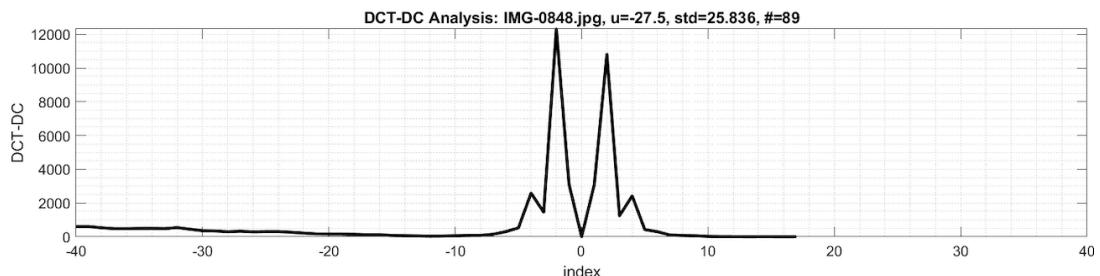


Figure 12: iPhone 3GS USB Cable DCT Histogram

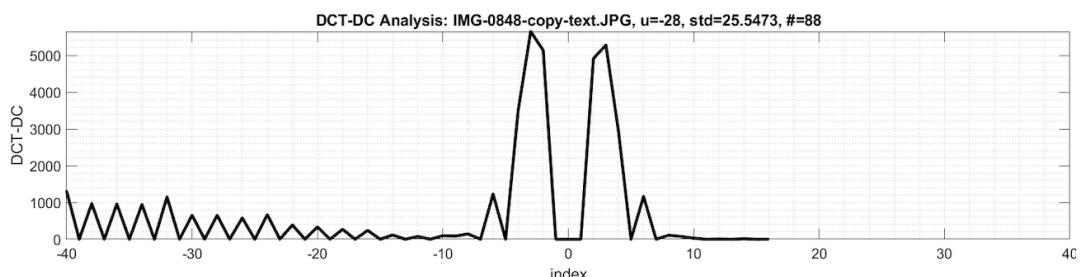


Figure 13: DCT Re-Compression Histogram iPhone 3GS (iMessage)

```

jacksum.txt - Notepad
File Edit Format View Help
Filename: IMG-0652-copy_email.JPG
Filepath: C:\Users\STUDENT_14\Desktop\
Filesize: 830425 bytes
MD5: 29d647975cd80f5ea836db866c2c2a62
SHA1: b54d43a30f7c565a0570ec45e2c274a6f0a01957
SHA256: 76274828f67e3b846224d39778fb0c02407977256aab763bda24040d61c66d0

jacksum.txt - Notepad
File Edit Format View Help
Filename: IMG-0652-copy_GD.jpg
Filepath: C:\Users\STUDENT_14\Desktop\
Filesize: 830425 bytes
MD5: 29d647975cd80f5ea836db866c2c2a62
SHA1: b54d43a30f7c565a0570ec45e2c274a6f0a01957
SHA256: 76274828f67e3b846224d39778fb0c02407977256aab763bda24040d61c66d0

```

Figure 14: Hash Values iPhone 6S Plus Transferred Google Drive and email

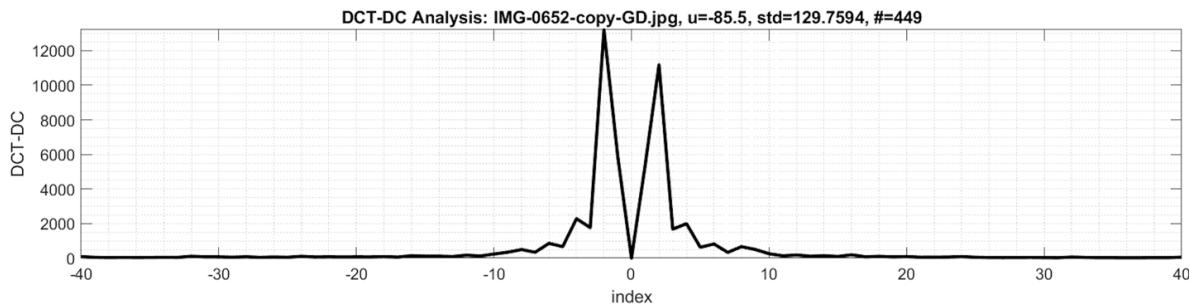


Figure 15: DCT Re-Compression Histogram iPhone 6S Plus (Google Drive)

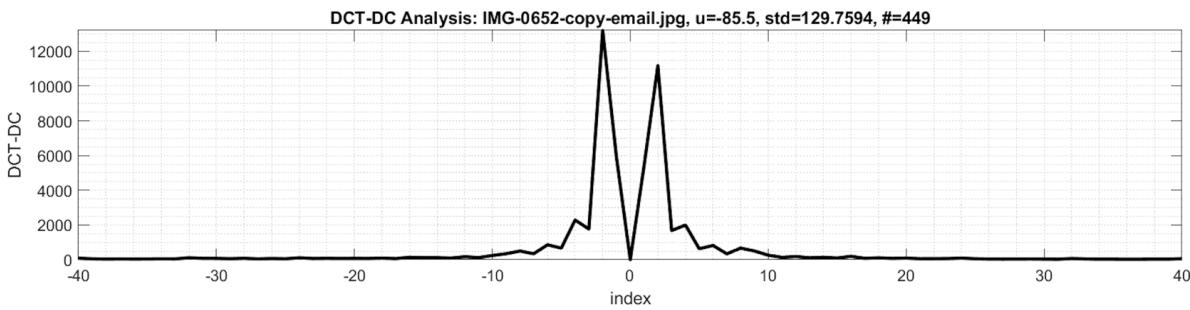


Figure 16: DCT Re-Compression Histogram iPhone 6S Plus (e-mail)

Analyzing the EXIF data from the iPhone 3GS resulted in missing data. The lens model was not present. All of the other iPhones specified which lens the image was taken, as well as which camera was used. Missing EXIF GPS data was also an interesting discovery. The GPS data from the iPhone 3GS, 4S, 6 and 6S Plus were absent. This most likely was due to the user's internal security preferences. Facebook Messenger did not report any GPS data when transferring.

<u>iPhone</u>	<u>GPSLatitude</u>	<u>GPSLongitude</u>	<u>GPSAltitude</u>
3GS			
4S			
5S	39 deg 53' 5.20" N	105 deg 5' 38.87" W	1638.8 m Above Sea Level
6			
6S Plus			
7	39 deg 53' 5.14" N	105 deg 5' 38.85" W	1632.9 m Above Sea Level
8	48 deg 13' 28.66" N	114 deg 19' 45.86" W	928.6 m Above Sea Level
XR	39 deg 32' 41.80" N	104 deg 47' 12.33" W	1760.6 m Above Sea Level
11 Pro	39 deg 32' 41.77" N	104 deg 47' 11.92" W	1760.2 m Above Sea Level

Figure 17: EXIF GPS Data with Non-Destructive Transfer Methods

<u>iPhone</u>	<u>GPSLatitude</u>	<u>GPSLongitude</u>	<u>GPSAltitude</u>
3GS			
4S			
5S	39 deg 53' 5.20" N	105 deg 5' 38.87" W	1638.8 m Above Sea Level
6			
6S Plus			
7	39 deg 53' 5.14" N	105 deg 5' 38.85" W	1632.9 m Above Sea Level
8	48 deg 13' 28.66" N	114 deg 19' 45.86" W	928.6 m Above Sea Level
XR			
11 Pro			

Figure 18: EXIF GPS Data with Destructive Transfer Methods

Table 6: EXIF Lens Information for iPhones

<u>iPhone</u>	<u>Lens Model Information</u>
<u>Primary Camera</u>	
iPhone 3GS	MISSING
iPhone 4S	iPhone 4S back camera 4.28mm f/2.4
iPhone 5S	iPhone 5s back camera 4.15mm f/2.2
iPhone 6	iPhone 6 back camera 4.15mm f/2.2
iPhone 6S Plus	iPhone 6s Plus back camera 4.15mm f/2.2
iPhone 7	iPhone 7 back camera 3.99mm f/1.8
iPhone 8	iPhone 8 back camera 3.99mm f/1.8
iPhone XR	iPhone XR back camera 4.25mm f/1.8
iPhone 11 Pro	iPhone 11 Pro back triple camera 4.25mm f/1.8

Facebook Messenger was used as a destructive transfer method and some of the EXIF data findings were quite significant. iPhones 4S, XR and 11 Pro were put through this method in order to reveal the relationship between older and newer phones when transferred through a social media platform. One of the discoveries was that the image file name changed when downloading from the Messenger online application. This was a unique set of values and not hash related. The file format stayed the same as a JPEG. When analyzing these images and their EXIF data, some data were missing including the make and model of the iPhone, as well as created date and file access date. Lens specific data including aperture, focal length and field of view were also missing. The images themselves were re-compressed into much smaller file sizes and image sizes and the encoding process and compression changed from Baseline DCT to Progressive DCT.

Baseline vs Progressive JPEG

It is important to understand the differences between Baseline and Progressive JPEG systems. Baseline JPEG images will start to present the image as the data is made available, line by line and top to bottom. Progressive JPEG images are images when displayed will be blurry and then become clearer as the image is rendered.

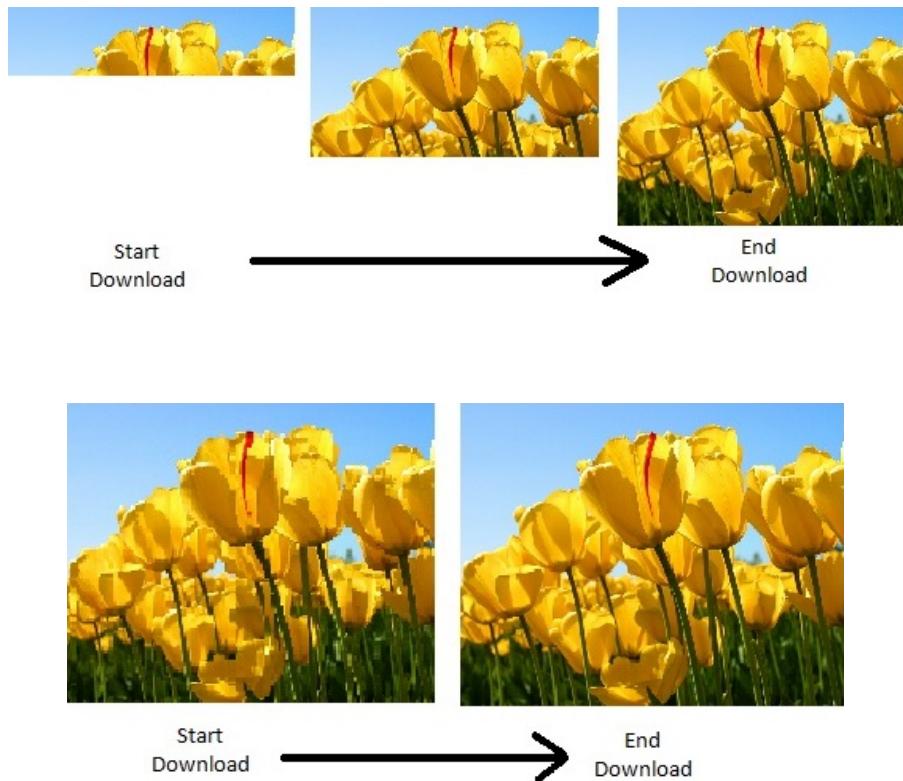


Figure 19: Baseline vs Progressive JPEG Images

With file structure analysis there was little variance compared to the EXIF data, however there were some notable findings. One, the selfie images from the iPhone 4S and iPhone 6 had “adobe.com” information found in the file structures and hex, not found on any of the other iPhones.

```
.File: IMG-0011-copy.jpg
Structure analysis, please wait...
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2A6 -> Apple
Offset: 3BA -> Apple
Offset: 3C0 -> iPhone
Offset: 442 -> FFD8 = JPEG Start [443]
Offset: 444 -> FFDB = Quantization Table
Offset: 4D0 -> FFC0 = Baseline DCT
Offset: 4E3 -> FFC4 = Huffman Table
Offset: 687 -> FFDA = Start of Scan (SOS)
Offset: 23F9 -> FFD9 = JPEG End [23FA]
Offset: 23FD -> FFE1 = APP
Offset: 2401 -> http://ns.adobe.com
Offset: 2401 -> http://ns.adobe.com/xap/
Offset: 2473 -> http://www.w3.org
Offset: 252E -> http://ns.adobe.com
Offset: 252E -> http://ns.adobe.com/xap/
Offset: 25B6 -> http://ns.adobe.com
Offset: 2B8F -> FFDB = Quantization Table
Offset: 2C1B -> FFC0 = Baseline DCT
Offset: 2C2E -> FFC4 = Huffman Table
Offset: 2DD2 -> FFDA = Start of Scan (SOS)
Offset: 16BEF -> FFD9 = JPEG End [16BF0]
```

Figure 20: File Structure of iPhone 4S with Adobe Information

Another finding during the file structure analysis of Facebook Messenger, images in Hex Fiend produced keywords “JFIF” and “Photoshop”. HEIC file format was found in the non-destructive transfer methods of the iPhone 8, XR and 11 Pro. Metadata analysis was performed on these files, however more research needs to be conducted on HEIC files for specific use in digital forensics.

CHAPTER V

CONCLUSIONS

There were a number of conclusions made based on the analysis and findings of the EXIF data, file structures and DCT compression relating to images from the iPhones studied. These conclusions are organized into separate sections below.

Facebook Messenger

Based on the findings from this study, there were several notable metadata differences when transferring images from Facebook Messenger. First, there were differences in EXIF data, file structure and DCT re-compression analysis. The EXIF data, when transferring from Facebook Messenger was missing data including camera sensor information, make and model of the iPhone, data and time, and GPS data. This was consistent with every iPhone image transferred using Facebook Messenger.

The file structures analyzed with FIAS were consistent when transferring using Facebook Messenger. Every image analyzed from the iPhone 4S, XR and 11 Pro using Facebook Messenger as a transfer method held many of the same file structure features including Progressive DCT and the keyword “Photoshop”. All images had 10 “Start of Scan” (SOS) points, which was used to scan the image top to bottom and found in progressive JPEG images.

For DCT compression analysis, the images that were re-compressed with Facebook Messenger were highly re-compressed with a JPEG quality factor between 71-73%. This was also evident with the image and file size significantly reduced. In conclusion, images that were transferred from an iPhone using the on-board Facebook Messenger platform and downloaded to a computer were missing substantial EXIF data, have differentiating file structures and have higher rate of re-compression.

Other Destructive Transfer Methods

The other two destructive transfer methods including iMessage and e-mail had both consistencies and inconsistencies depending on the phone model and transfer method used. The EXIF data showed inconsistencies with GPS data in certain iPhone models as well as lens model and camera identification. However, analyzing the data from destructive and non-destructive transfer methods, there was no significant changes. The same images ran through Google Drive and e-mail showed the same EXIF data. This was also true for file structures.

Another inconsistency occurred in images transferred from the iPhone 3GS. The identical images transferred through USB and iMessage had some significant changes in EXIF data, file structures and DCT compression. The EXIF data showed the two images having a different file size but the same image size. The iMessage version was also missing the compression name. This was inconsistent with all of the other iPhones analyzed. The file structures were also dissimilar having different offsets from one another. The DCT compression histograms were also different and inconsistent from the rest of the iPhones.

When the iPhone images were emailed and texted with iMessage they were found to be non-destructive and the truth hash from the non-destructive Google Drive matched, therefore the emailed and texted versions of these images were not missing any metadata and the re-compression were the same as Google Drive.

iOS Versions

There were nine versions of iOS used in this study. Four of the iOS versions were the same. Part of the study was to see if there were any changes in metadata with the same iOS versions, however there were no significant changes in metadata between these similar iOS

versions. This was due to the iOS updates not having any substantial metadata modifications from version to version.

Future Research

There is no doubt that smartphones will continue to occupy and dominate our daily lives. Smartphones will become more sophisticated as technology evolves, and forensically these “super phones” will require more scientific attention within the media structures and metadata and specifically photographic images

The digital forensic community has many references, papers and studies related to image metadata in mobile phone devices, however with the growing and changing digital forensic technology more research needs to be conducted. For example, there also needs to be more testing and analyses conducted with HEIC file format found in newer iPhone models. This file format is not yet fully developed for forensic studies. A study like this one, could be designed to explore Android smartphones and to investigate any pertinent metadata differences. Future research should also focus on iPhones not tested in this study.

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APPENDIX A

E-MAILED INSTUCTIONS

PARTICIPANT CONTRIBUTORS

1. Take 1 photo of a white wall standing 3-5 feet away using the back camera. This needs to be a blank white wall with no artificial lighting. Use the standard camera default settings.
(Make sure “live photo” and flash setting is off)
2. Take 1 photo using the front facing camera (selfie camera), this doesn’t need to be a face shot.
3. From the photos application on the phone send me the images you just took through email, iMessage and Google Drive (for Google Drive the app must be used from the phone). When uploading through email, make sure the images are “actual size”.

APPENDIX B
IPHONE TRANSFER METHODS

iPhone & Version	Transfer Methods					
	Cable	Air Drop	Google Drive	Text	E-mail	Facebook Messenger
3Gs (6.1.6)	■			■		
4s (9.3.6)	■					■
5s (12.4.8)			■	■		
6 (12.4.8)			■		■	
6s Plus (13.6)			■		■	
7 (13.6.1)			■		■	
8 (13.5.1)			■		■	
XR (13.5.1)		■				■
11 Pro (13.6.1)		■				■

APPENDIX C

RAW DATA FROM IPHONE 3GS

Note – No Data available for selfie images

EXIF DATA

White Wall Non-Destructive (USB Cable)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0848.jpg
Directory                   : .
File Size                   : 959 kB
File Modification Date/Time : 2020:10:13 17:59:00-06:00
File Access Date/Time       : 2020:10:22 15:06:12-06:00
File Creation Date/Time    : 2020:10:13 18:03:59-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 3GS
Orientation                  : Horizontal (normal)
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 6.1.6
Modify Date                  : 1970:01:04 12:23:25
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/24
F Number                      : 2.8
Exposure Program             : Program AE
ISO                          : 80
Exif Version                 : 0221
Date/Time Original           : 1970:01:04 12:23:25
Create Date                   : 1970:01:04 12:23:25
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/24
Aperture Value                : 2.8
Brightness Value              : 3.284987277
Metering Mode                 : Average
Flash                         : No flash function
Focal Length                  : 3.9 mm
Subject Area                  : 1023 767 614 614
Flashpix Version              : 0100
```

Color Space	:	sRGB
Exif Image Width	:	2048
Exif Image Height	:	1536
Sensing Method	:	One-chip color area
Exposure Mode	:	Auto
White Balance	:	Auto
Focal Length In 35mm Format	:	35 mm
Scene Capture Type	:	Standard
Compression	:	JPEG (old-style)
Thumbnail Offset	:	690
Thumbnail Length	:	2178
Image Width	:	2048
Image Height	:	1536
Encoding Process	:	Baseline DCT, Huffman coding
Bits Per Sample	:	8
Color Components	:	3
Y Cb Cr Sub Sampling	:	YCbCr4:2:0 (2 2)
Aperture	:	2.8
Image Size	:	2048x1536
Megapixels	:	3.1
Scale Factor To 35 mm Equivalent:	:	9.1
Shutter Speed	:	1/24
Thumbnail Image to extract)	:	(Binary data 2178 bytes, use -b option
Circle Of Confusion	:	0.003 mm
Field Of View	:	54.4 deg
Focal Length	:	3.9 mm (35 mm equivalent: 35.0 mm)
Hyperfocal Distance	:	1.60 m
Light Value	:	7.9

White Wall Destructive (iMessage)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0848-copy-text.JPG
Directory                   : .
File Size                   : 817 kB
File Modification Date/Time : 2020:10:22 15:15:08-06:00
File Access Date/Time       : 2020:10:22 15:16:14-06:00
File Creation Date/Time    : 2020:10:22 15:15:11-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
JFIF Version                : 1.01
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 3GS
Orientation                  : Horizontal (normal)
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 6.1.6
Modify Date                  : 1970:01:04 12:23:25
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/24
F Number                     : 2.8
Exposure Program             : Program AE
ISO                          : 80
Exif Version                 : 0221
Date/Time Original           : 1970:01:04 12:23:25
Create Date                  : 1970:01:04 12:23:25
Components Configuration      : -, -, -, Y
Shutter Speed Value          : 1/24
Aperture Value                : 2.8
Brightness Value              : 3.284987277
Metering Mode                 : Average
Flash                         : No flash function
Focal Length                  : 3.9 mm
Subject Area                  : 1023 767 614 614
Flashpix Version              : 0100
Color Space                   : sRGB
Exif Image Width              : 2048
Exif Image Height             : 1536
Sensing Method                 : One-chip color area
Exposure Mode                 : Auto
White Balance                  : Auto
Focal Length In 35mm Format   : 35 mm
Scene Capture Type             : Standard
Image Width                   : 2048
Image Height                  : 1536
Encoding Process               : Baseline DCT, Huffman coding
Bits Per Sample                : 8
Color Components               : 3
Y Cb Cr Sub Sampling          : YCbCr4:2:0 (2 2)
```

Aperture	:	2.8
Image Size	:	2048x1536
Megapixels	:	3.1
Scale Factor To 35 mm Equivalent	:	9.1
Shutter Speed	:	1/24
Circle Of Confusion	:	0.003 mm
Field Of View	:	54.4 deg
Focal Length	:	3.9 mm (35 mm equivalent: 35.0 mm)
Hyperfocal Distance	:	1.60 m
Light Value	:	7.9

FILE STRUCTURES

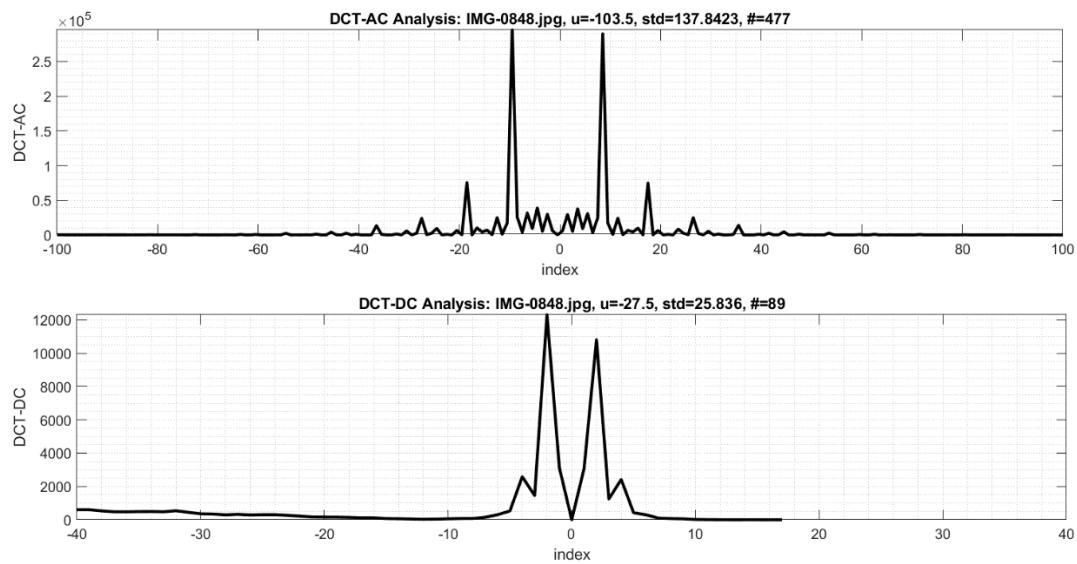
White Wall Non-Destructive (USB Cable) White Wall Destructive (iMessage)

File: IMG-0848-copy.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 2 -> FFE1 = APP
 Offset: 6 -> Exif
 Offset: 92 -> Apple
 Offset: 98 -> iPhone
 Offset: 2B2 -> FFD8 = JPEG Start [2B3]
 Offset: 2B4 -> FFDB = Quantization Table
 Offset: 2F9 -> FFDB = Quantization Table
 Offset: 33E -> FFC0 = Baseline DCT
 Offset: 351 -> FFC4 = Huffman Table
 Offset: 372 -> FFC4 = Huffman Table
 Offset: 429 -> FFC4 = Huffman Table
 Offset: 44A -> FFC4 = Huffman Table
 Offset: 501 -> FFDA = Start of Scan (SOS)
 Offset: B32 -> FFD9 = JPEG End [B33]
 Offset: 1002 -> FFDB = Quantization Table

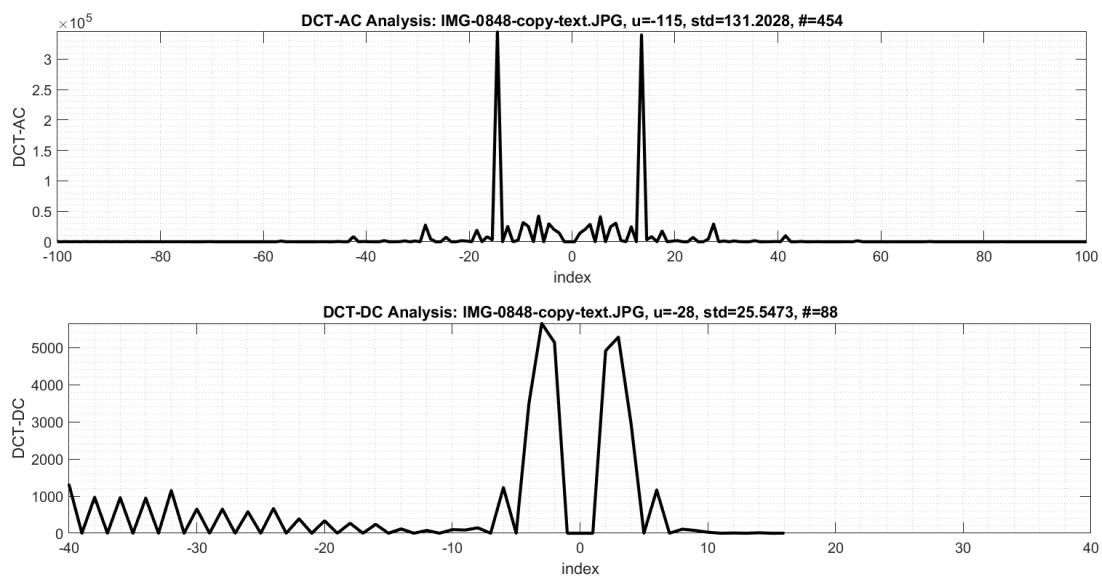
File: IMG-0848-copy_text.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 6 -> JFIF
 Offset: 14 -> FFE1 = APP
 Offset: 18 -> Exif
 Offset: A4 -> Apple
 Offset: AA -> iPhone
 Offset: 266 -> FFDB = Quantization Table
 Offset: 2AB -> FFDB = Quantization Table
 Offset: 2F0 -> FFC0 = Baseline DCT
 Offset: 303 -> FFC4 = Huffman Table
 Offset: 324 -> FFC4 = Huffman Table
 Offset: 3DB -> FFC4 = Huffman Table
 Offset: 3FC -> FFC4 = Huffman Table
 Offset: 4B3 -> FFDA = Start of Scan (SOS)
 Offset: CC3BA -> FFD9 = JPEG End [CC3BB]

DCT COMPRESSION HISTOGRAMS

White Wall Non-Destructive (USB Cable)



White Wall Destructive (iMessage)



APPENDIX D

RAW DATA FROM IPHONE 4S

EXIF DATA

White Wall Non-Destructive (USB Cable)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0009-copy.jpg
Directory                   : .
File Size                   : 1739 kB
File Modification Date/Time : 2020:10:13 17:58:57-06:00
File Access Date/Time       : 2020:10:22 16:05:16-06:00
File Creation Date/Time    : 2020:10:22 16:05:16-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 4S
Orientation                  : Horizontal (normal)
X Resolution                : 72
Y Resolution                : 72
Resolution Unit              : inches
Software                     : 9.3.6
Modify Date                 : 2020:08:31 15:29:14
Y Cb Cr Positioning         : Centered
Exposure Time               : 1/20
F Number                     : 2.4
Exposure Program             : Program AE
ISO                          : 80
Exif Version                : 0221
Date/Time Original          : 2020:08:31 15:29:14
Create Date                  : 2020:08:31 15:29:14
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/20
Aperture Value               : 2.4
Brightness Value             : 2.709133805
Exposure Compensation        : 0
Metering Mode                : Multi-segment
Flash                        : Auto, Did not fire
Focal Length                 : 4.3 mm
Subject Area                  : 1631 1223 881 881
Run Time Scale                : 1000000000
Run Time Value                : 6452460153625
Run Time Epoch                : 0
Run Time Flags                : Valid
```

Acceleration Vector : -1.01157865 0.0006443907929 -
0.01250071351
Sub Sec Time Original : 378
Sub Sec Time Digitized : 378
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3264
Exif Image Height : 2448
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 35 mm
Scene Capture Type : Standard
Lens Info : 4.28mm f/2.4
Lens Make : Apple
Lens Model : iPhone 4S back camera 4.28mm f/2.4
Compression : JPEG (old-style)
Thumbnail Offset : 1110
Thumbnail Length : 2891
Image Width : 3264
Image Height : 2448
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 1:47:32
Aperture : 2.4
Image Size : 3264x2448
Megapixels : 8.0
Scale Factor To 35 mm Equivalent: 8.2
Shutter Speed : 1/20
Create Date : 2020:08:31 15:29:14.378
Date/Time Original : 2020:08:31 15:29:14.378
Thumbnail Image : (Binary data 2891 bytes, use -b option
to extract)
Circle Of Confusion : 0.004 mm
Field Of View : 54.4 deg
Focal Length : 4.3 mm (35 mm equivalent: 35.0 mm)
Hyperfocal Distance : 2.08 m
Light Value : 7.2

White Wall Destructive (Facebook Messenger)

```
ExifTool Version Number      : 11.65
File Name                   : 120764923-679309346351146-
818609989735739223-n.jpg
Directory                   : .
File Size                   : 26 kB
File Modification Date/Time : 2020:10:22 15:15:27-06:00
File Access Date/Time       : 2020:10:22 16:10:03-06:00
File Creation Date/Time    : 2020:10:22 16:10:03-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
JFIF Version                : 1.02
Resolution Unit              : None
X Resolution                 : 1
Y Resolution                 : 1
Current IPTC Digest        : 59edb3e1af93a462373eeae344a68df3
Special Instructions          :
FBMD01000a870100000e0d00000b11000065110000bb110000081200000f3e0000c741000
0db430000f145000022660000
Image Width                  : 640
Image Height                 : 480
Encoding Process             : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components              : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                   : 640x480
Megapixels                    : 0.307
```

Selfie Non-Destructive (USB Cable)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0011-copy.jpg
Directory                   :
File Size                    : 91 kB
File Modification Date/Time : 2020:10:13 17:58:59-06:00
File Access Date/Time       : 2020:10:14 11:40:12-06:00
File Creation Date/Time    : 2020:10:13 17:59:47-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 4S
Orientation                  : Rotate 90 CW
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                      : 9.3.6
Modify Date                  : 2020:08:31 15:29:58
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/30
F Number                      : 2.4
Exposure Program             : Program AE
ISO                           : 800
Exif Version                 : 0221
Date/Time Original           : 2020:08:31 15:29:58
Create Date                   : 2020:08:31 15:29:58
Components Configuration      : Y, Cb, Cr, -
Shutter Speed Value          : 1/30
Aperture Value                : 2.4
Brightness Value              : -0.02570003836
Exposure Compensation        : 0
Metering Mode                 : Multi-segment
Flash                          : No flash function
Focal Length                  : 1.9 mm
Run Time Scale                : 1000000000
Run Time Value                 : 6496302905500
Run Time Epoch                 : 0
Run Time Flags                  : Valid
Acceleration Vector           : -0.03605556894 -0.9583883752
0.1330115312
Sub Sec Time Original         : 221
Sub Sec Time Digitized        : 221
Flashpix Version              : 0100
Color Space                    : sRGB
Exif Image Width               : 640
Exif Image Height              : 480
Sensing Method                 : One-chip color area
Scene Type                     : Directly photographed
Exposure Mode                  : Auto
White Balance                  : Auto
```

Focal Length In 35mm Format : 35 mm
Scene Capture Type : Standard
Lens Info : 1.85mm f/2.4
Lens Make : Apple
Lens Model : iPhone 4S front camera 1.85mm f/2.4
Compression : JPEG (old-style)
Thumbnail Offset : 1090
Thumbnail Length : 8121
XMP Toolkit : XMP Core 5.4.0
Region Applied To Dimensions H : 480
Region Applied To Dimensions W : 640
Region Applied To Dimensions Unit: pixel
Region Extensions Time Stamp : 1290845398
Region Extensions Face ID : 3
Region Extensions Confidence Level: 287
Region Extensions Angle Info Yaw: 0
Region Extensions Angle Info Roll: 270
Region Area Y : 0.420833
Region Area W : 0.217187
Region Area Unit : normalized
Region Area X : 0.492969
Region Area H : 0.291667
Region Type : Face
Image Width : 640
Image Height : 480
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 1:48:16
Aperture : 2.4
Image Size : 640x480
Megapixels : 0.307
Scale Factor To 35 mm Equivalent: 18.9
Shutter Speed : 1/30
Create Date : 2020:08:31 15:29:58.221
Date/Time Original : 2020:08:31 15:29:58.221
Thumbnail Image : (Binary data 8121 bytes, use -b option
to extract)
Circle Of Confusion : 0.002 mm
Field Of View : 54.4 deg
Focal Length : 1.9 mm (35 mm equivalent: 35.0 mm)
Hyperfocal Distance : 0.90 m
Light Value : 4.4

Selfie Destructive (Facebook Messenger)

```
ExifTool Version Number      : 11.65
File Name                   : 120861104-650204789224717-
6726626393922187711-n.jpg
Directory                   : .
File Size                   : 61 kB
File Modification Date/Time : 2020:10:22 15:14:59-06:00
File Access Date/Time       : 2020:10:22 16:15:55-06:00
File Creation Date/Time    : 2020:10:22 16:15:55-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
JFIF Version                : 1.02
Resolution Unit              : None
X Resolution                 : 1
Y Resolution                 : 1
Current IPTC Digest        : 03a402c6284e31f1d4a23ec7720344d6
Special Instructions          :
FBMD01000a8e010000411300005231000077340000db360000554f000027820000e385000
0b1890000398d000066f50000
Image Width                  : 480
Image Height                 : 640
Encoding Process             : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components              : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                   : 480x640
Megapixels                    : 0.307
```

FILE STRUCTURES

White Wall Non-Destructive (USB Cable)

File: IMG-0009-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2BA -> Apple
Offset: 3CE -> Apple
Offset: 3D4 -> iPhone
Offset: 3DE -> back camera
Offset: 456 -> FFD8 = JPEG Start [457]
Offset: 458 -> FFDB = Quantization Table
Offset: 4E4 -> FFC0 = Baseline DCT
Offset: 4F7 -> FFC4 = Huffman Table
Offset: 69B -> FFDA = Start of Scan (SOS)
Offset: F9F -> FFD9 = JPEG End [FA0]
Offset: 1002 -> FFDB = Quantization Table
Offset: 108E -> FFC0 = Baseline DCT
Offset: 10A1 -> FFC4 = Huffman Table
Offset: 1245 -> FFDA = Start of Scan (SOS)
Offset: 1B2C06 -> FFD9 = JPEG End [1B2C07]

White Wall Destructive (Facebook)

File: 120764923-679309346351146-818609989735739223-n.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 6 -> JFIF
Offset: 18 -> Photoshop
Offset: 22 -> 3.0 8BIM
Offset: 9A -> FFDB = Quantization Table
Offset: DF -> FFDB = Quantization Table
Offset: 124 -> FFC2 = Progressive DCT
Offset: 137 -> FFC4 = Huffman Table
Offset: 153 -> FFC4 = Huffman Table
Offset: 16D -> FFC4 = Huffman Table
Offset: 187 -> FFDA = Start of Scan (SOS)
Offset: CED -> FFC4 = Huffman Table
Offset: D0E -> FFDA = Start of Scan (SOS)
Offset: 10E8 -> FFC4 = Huffman Table
Offset: 110B -> FFDA = Start of Scan (SOS)
Offset: 1141 -> FFC4 = Huffman Table
Offset: 1165 -> FFDA = Start of Scan (SOS)
Offset: 119D -> FFC4 = Huffman Table
Offset: 11BB -> FFDA = Start of Scan (SOS)
Offset: 11E0 -> FFC4 = Huffman Table
Offset: 1208 -> FFDA = Start of Scan (SOS)
Offset: 3E0F -> FFDA = Start of Scan (SOS)
Offset: 41A6 -> FFC4 = Huffman Table
Offset: 41C7 -> FFDA = Start of Scan (SOS)
Offset: 43B9 -> FFC4 = Huffman Table
Offset: 43DB -> FFDA = Start of Scan (SOS)
Offset: 45C8 -> FFC4 = Huffman Table
Offset: 45F1 -> FFDA = Start of Scan (SOS)
Offset: 6620 -> FFD9 = JPEG End [6621]

Selfie Non-Destructive (USB Cable)

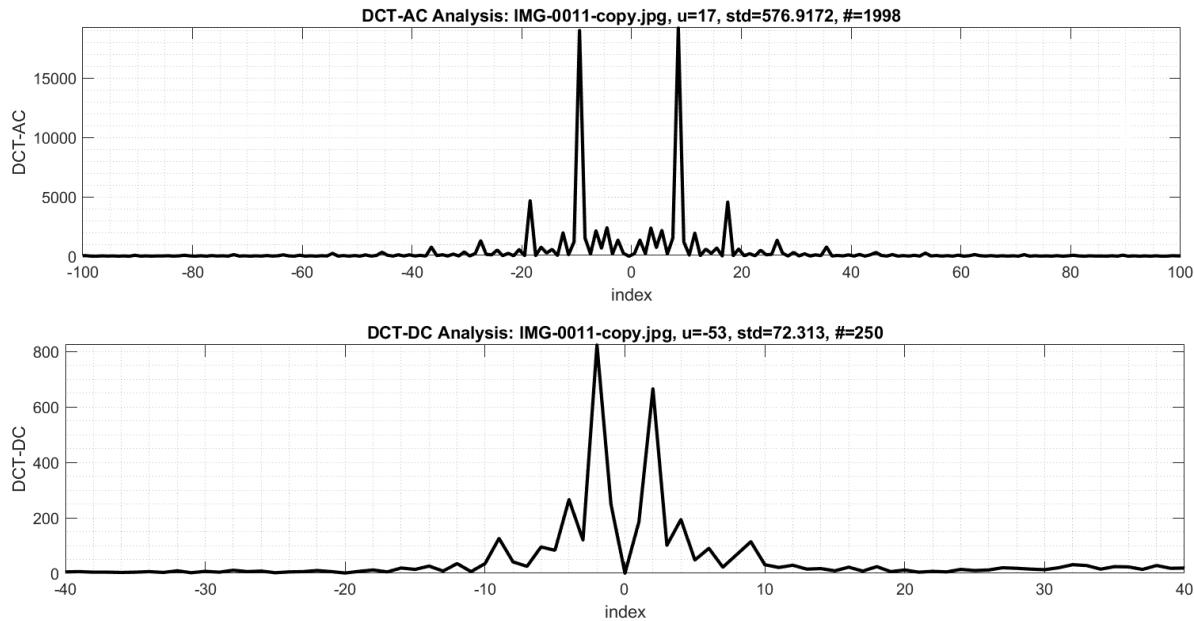
File: IMG-0011-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2A6 -> Apple
Offset: 3BA -> Apple
Offset: 3C0 -> iPhone
Offset: 442 -> FFD8 = JPEG Start [443]
Offset: 444 -> FFDB = Quantization Table
Offset: 4D0 -> FFC0 = Baseline DCT
Offset: 4E3 -> FFC4 = Huffman Table
Offset: 687 -> FFDA = Start of Scan (SOS)
Offset: 23F9 -> FFD9 = JPEG End [23FA]
Offset: 23FD -> FFE1 = APP
Offset: 2401 -> http://ns.adobe.com
Offset: 2401 -> http://ns.adobe.com/xap/
Offset: 2473 -> http://www.w3.org
Offset: 252E -> http://ns.adobe.com
Offset: 252E -> http://ns.adobe.com/xap/
Offset: 25B6 -> http://ns.adobe.com
Offset: 2B8F -> FFDB = Quantization Table
Offset: 2C1B -> FFC0 = Baseline DCT
Offset: 2C2E -> FFC4 = Huffman Table
Offset: 2DD2 -> FFDA = Start of Scan (SOS)
Offset: 16BEF -> FFD9 = JPEG End [16BF0]

Selfie Destructive (Facebook)

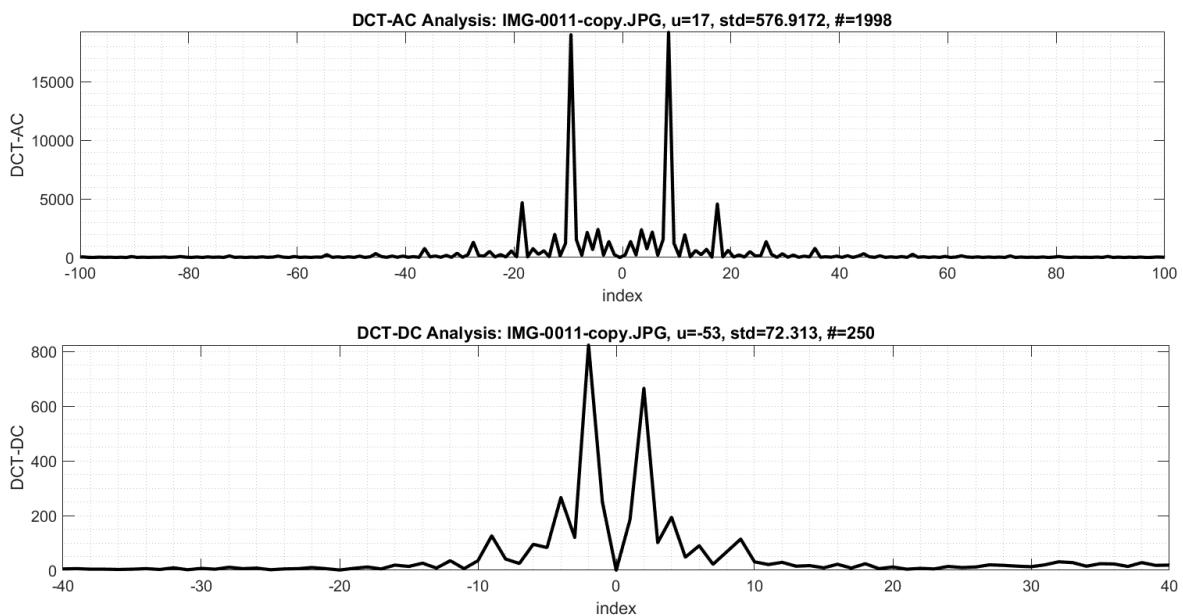
File: 120861104-650204789224717-6
726626393922187711-n.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 6 -> JFIF
Offset: 18 -> Photoshop
Offset: 22 -> 3.0 8BIM
Offset: 9A -> FFDB = Quantization Table
Offset: DF -> FFDB = Quantization Table
Offset: 124 -> FFC2 = Progressive DCT
Offset: 137 -> FFC4 = Huffman Table
Offset: 156 -> FFC4 = Huffman Table
Offset: 172 -> FFC4 = Huffman Table
Offset: 18E -> FFDA = Start of Scan (SOS)
Offset: 130C -> FFC4 = Huffman Table
Offset: 1341 -> FFDA = Start of Scan (SOS)
Offset: 311F -> FFC4 = Huffman Table
Offset: 3152 -> FFDA = Start of Scan (SOS)
Offset: 344C -> FFC4 = Huffman Table
Offset: 3477 -> FFDA = Start of Scan (SOS)
Offset: 3696 -> FFC4 = Huffman Table
Offset: 36DB -> FFDA = Start of Scan (SOS)
Offset: 4F2A -> FFC4 = Huffman Table
Offset: 4F55 -> FFDA = Start of Scan (SOS)
Offset: 8227 -> FFDA = Start of Scan (SOS)
Offset: 85BA -> FFC4 = Huffman Table
Offset: 85E3 -> FFDA = Start of Scan (SOS)
Offset: 898F -> FFC4 = Huffman Table
Offset: 89B1 -> FFDA = Start of Scan (SOS)
Offset: 8D0E -> FFC4 = Huffman Table
Offset: 8D39 -> FFDA = Start of Scan (SOS)
Offset: C05F -> ACD
Offset: F564 -> FFD9 = JPEG End [F565]

DCT COMPRESSION HISTOGRAMS

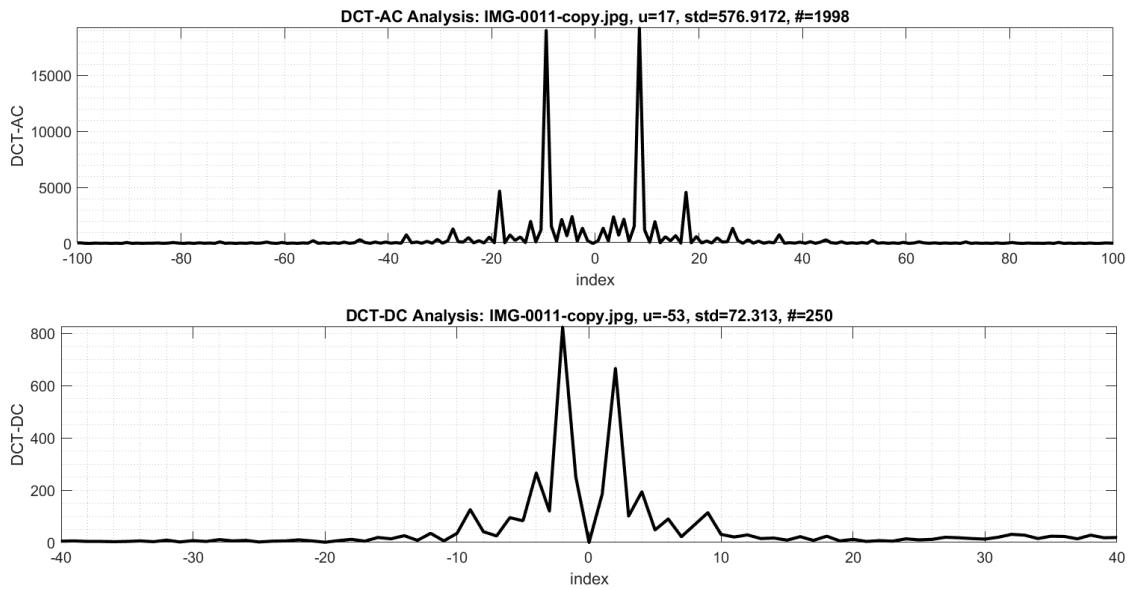
White Wall Non-Destructive (USB Cable)



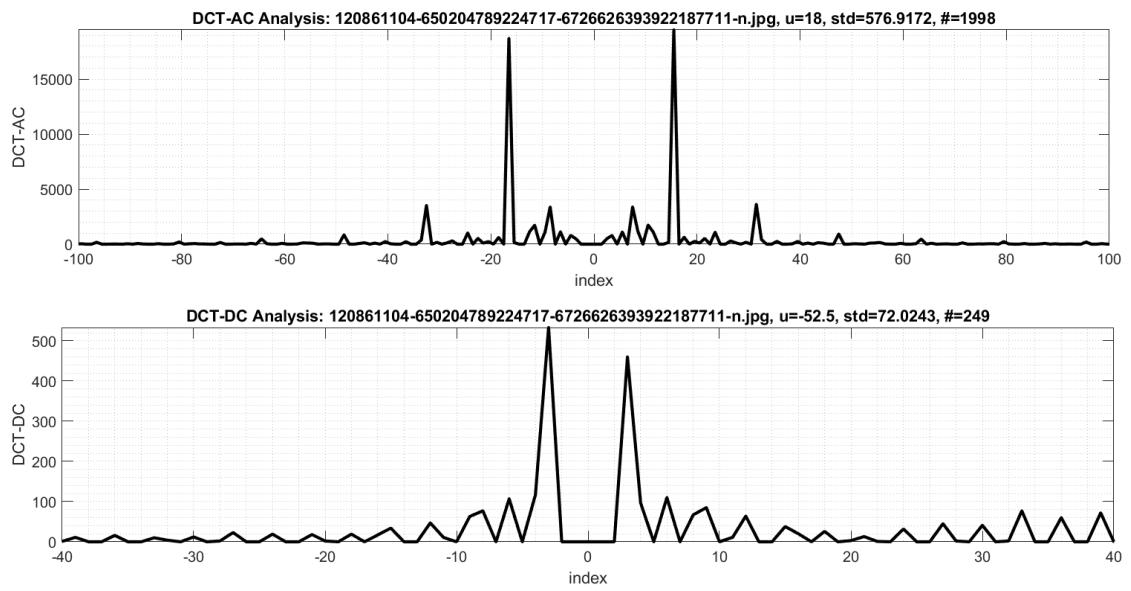
White Wall Destructive (iMessage)



Selfie Non-Destructive (USB Cable)



Selfie Destructive (Facebook Messenger)



APPENDIX E

RAW DATA FROM IPHONE 5S

EXIF DATA

White Wall Non-Destructive (Google Drive)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0231-copy.jpg
Directory                   : .
File Size                   : 999 kB
File Modification Date/Time : 2020:10:13 17:58:55-06:00
File Access Date/Time       : 2020:10:26 13:36:09-06:00
File Creation Date/Time    : 2020:10:26 13:36:09-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 5s
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit             : inches
Software                     : 12.4.8
Modify Date                  : 2020:09:02 15:10:21
Y Cb Cr Positioning         : Centered
Exposure Time               : 1/20
F Number                     : 2.2
Exposure Program             : Program AE
ISO                          : 250
Exif Version                 : 0221
Date/Time Original           : 2020:09:02 15:10:21
Create Date                  : 2020:09:02 15:10:21
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/20
Aperture Value               : 2.2
Brightness Value              : 0.751728716
Exposure Compensation        : 0
Metering Mode                : Multi-segment
Flash                        : Off, Did not fire
Focal Length                 : 4.2 mm
Subject Area                  : 1631 1223 1795 1077
Run Time Flags                : Valid
Run Time Value                : 496077169644375
Run Time Scale                : 1000000000
```

```

Run Time Epoch : 0
Acceleration Vector : 0.04407652095 -1.007152796 -
0.02233076467
Sub Sec Time Original : 727
Sub Sec Time Digitized : 727
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3264
Exif Image Height : 2448
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type : Standard
Lens Info : 4.15mm f/2.2
Lens Make : Apple
Lens Model : iPhone 5s back camera 4.15mm f/2.2
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Time Stamp : 21:10:20
GPS Speed Ref : km/h
GPS Speed : 0
GPS Img Direction Ref : True North
GPS Img Direction : 331.6378784
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 331.6378784
GPS Date Stamp : 2020:09:02
GPS Horizontal Positioning Error: 5 m
Compression : JPEG (old-style)
Thumbnail Offset : 2108
Thumbnail Length : 2311
Image Width : 3264
Image Height : 2448
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
YCbCr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 5 days 17:47:57
Aperture : 2.2
Image Size : 3264x2448
Megapixels : 8.0
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed : 1/20
Create Date : 2020:09:02 15:10:21.727
Date/Time Original : 2020:09:02 15:10:21.727
Thumbnail Image : (Binary data 2311 bytes, use -b option
to extract)
GPS Altitude : 1638.8 m Above Sea Level
GPS Date/Time : 2020:09:02 21:10:20Z
GPS Latitude : 39 deg 53' 5.20" N
GPS Longitude : 105 deg 5' 38.87" W
Circle Of Confusion : 0.004 mm

```

Field Of View	: 63.7 deg
Focal Length	: 4.2 mm (35 mm equivalent: 29.0 mm)
GPS Position	: 39 deg 53' 5.20" N, 105 deg 5' 38.87" W
Hyperfocal Distance	: 1.82 m
Light Value	: 5.3

White Wall Destructive (iMessage)

ExifTool Version Number	: 11.65
File Name	: IMG-0231-copy-text.jpg
Directory	: .
File Size	: 999 kB
File Modification Date/Time	: 2020:10:22 15:15:38-06:00
File Access Date/Time	: 2020:10:26 13:40:29-06:00
File Creation Date/Time	: 2020:10:22 15:15:41-06:00
File Permissions	: rw-rw-rw-
File Type	: JPEG
File Type Extension	: jpg
MIME Type	: image/jpeg
Exif Byte Order	: Big-endian (Motorola, MM)
Make	: Apple
Camera Model Name	: iPhone 5s
Orientation	: Rotate 90 CW
X Resolution	: 72
Y Resolution	: 72
Resolution Unit	: inches
Software	: 12.4.8
Modify Date	: 2020:09:02 15:10:21
Y Cb Cr Positioning	: Centered
Exposure Time	: 1/20
F Number	: 2.2
Exposure Program	: Program AE
ISO	: 250
Exif Version	: 0221
Date/Time Original	: 2020:09:02 15:10:21
Create Date	: 2020:09:02 15:10:21
Components Configuration	: Y, Cb, Cr, -
Shutter Speed Value	: 1/20
Aperture Value	: 2.2
Brightness Value	: 0.751728716
Exposure Compensation	: 0
Metering Mode	: Multi-segment
Flash	: Off, Did not fire
Focal Length	: 4.2 mm
Subject Area	: 1631 1223 1795 1077
Run Time Flags	: Valid
Run Time Value	: 496077169644375
Run Time Scale	: 1000000000

```

Run Time Epoch : 0
Acceleration Vector : 0.04407652095 -1.007152796 -
0.02233076467
Sub Sec Time Original : 727
Sub Sec Time Digitized : 727
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3264
Exif Image Height : 2448
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type : Standard
Lens Info : 4.15mm f/2.2
Lens Make : Apple
Lens Model : iPhone 5s back camera 4.15mm f/2.2
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Time Stamp : 21:10:20
GPS Speed Ref : km/h
GPS Speed : 0
GPS Img Direction Ref : True North
GPS Img Direction : 331.6378784
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 331.6378784
GPS Date Stamp : 2020:09:02
GPS Horizontal Positioning Error: 5 m
Compression : JPEG (old-style)
Thumbnail Offset : 2108
Thumbnail Length : 2311
Image Width : 3264
Image Height : 2448
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
YCbCr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 5 days 17:47:57
Aperture : 2.2
Image Size : 3264x2448
Megapixels : 8.0
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed : 1/20
Create Date : 2020:09:02 15:10:21.727
Date/Time Original : 2020:09:02 15:10:21.727
Thumbnail Image : (Binary data 2311 bytes, use -b option
to extract)
GPS Altitude : 1638.8 m Above Sea Level
GPS Date/Time : 2020:09:02 21:10:20Z
GPS Latitude : 39 deg 53' 5.20" N
GPS Longitude : 105 deg 5' 38.87" W
Circle Of Confusion : 0.004 mm

```

Field Of View	: 63.7 deg
Focal Length	: 4.2 mm (35 mm equivalent: 29.0 mm)
GPS Position	: 39 deg 53' 5.20" N, 105 deg 5' 38.87" W
Hyperfocal Distance	: 1.82 m
Light Value	: 5.3

Selfie Non-Destructive (Google Drive)

ExifTool Version Number	: 11.65
File Name	: IMG-0220-copy.jpg
Directory	: .
File Size	: 311 kB
File Modification Date/Time	: 2020:10:13 17:58:50-06:00
File Access Date/Time	: 2020:10:26 13:43:08-06:00
File Creation Date/Time	: 2020:10:13 18:01:57-06:00
File Permissions	: rw-rw-rw-
File Type	: JPEG
File Type Extension	: jpg
MIME Type	: image/jpeg
Exif Byte Order	: Big-endian (Motorola, MM)
Make	: Apple
Camera Model Name	: iPhone 5s
Orientation	: Rotate 90 CW
X Resolution	: 72
Y Resolution	: 72
Resolution Unit	: inches
Software	: 12.4.8
Modify Date	: 2020:09:02 12:01:32
Y Cb Cr Positioning	: Centered
Exposure Time	: 1/15
F Number	: 2.4
Exposure Program	: Program AE
ISO	: 800
Exif Version	: 0221
Date/Time Original	: 2020:09:02 12:01:32
Create Date	: 2020:09:02 12:01:32
Components Configuration	: Y, Cb, Cr, -
Shutter Speed Value	: 1/15
Aperture Value	: 2.4
Brightness Value	: -1.241659445
Exposure Compensation	: 0
Metering Mode	: Multi-segment
Flash	: No flash function
Focal Length	: 2.1 mm
Run Time Flags	: Valid
Run Time Value	: 493796424333750
Run Time Scale	: 1000000000
Run Time Epoch	: 0
Acceleration Vector	: 0.0231898222 -1.002990604 -0.04394700005
HDR Image Type	: Original Image

Image Unique ID : 2FD5B6E0-A18B-4333-9671-FDA8422CC52D
 Sub Sec Time Original : 942
 Sub Sec Time Digitized : 942
 Flashpix Version : 0100
 Color Space : sRGB
 Exif Image Width : 1280
 Exif Image Height : 960
 Sensing Method : One-chip color area
 Scene Type : Directly photographed
 Custom Rendered : Original (for HDR)
 Exposure Mode : Auto
 White Balance : Auto
 Focal Length In 35mm Format : 31 mm
 Scene Capture Type : Standard
 Lens Info : 2.15mm f/2.4
 Lens Make : Apple
 Lens Model : iPhone 5s front camera 2.15mm f/2.4
 GPS Latitude Ref : North
 GPS Longitude Ref : West
 GPS Altitude Ref : Above Sea Level
 GPS Time Stamp : 18:01:32
 GPS Speed Ref : km/h
 GPS Speed : 0
 GPS Img Direction Ref : True North
 GPS Img Direction : 9.783767702
 GPS Dest Bearing Ref : True North
 GPS Dest Bearing : 189.7837678
 GPS Date Stamp : 2020:09:02
 GPS Horizontal Positioning Error: 10 m
 Compression : JPEG (old-style)
 Thumbnail Offset : 1580
 Thumbnail Length : 8113
 Image Width : 1280
 Image Height : 960
 Encoding Process : Baseline DCT, Huffman coding
 Bits Per Sample : 8
 Color Components : 3
 Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
 Run Time Since Power Up : 5 days 17:09:56
 Aperture : 2.4
 Image Size : 1280x960
 Megapixels : 1.2
 Scale Factor To 35 mm Equivalent: 14.4
 Shutter Speed : 1/15
 Create Date : 2020:09:02 12:01:32.942
 Date/Time Original : 2020:09:02 12:01:32.942
 Thumbnail Image : (Binary data 8113 bytes, use -b option
 to extract)
 GPS Altitude : 1634.9 m Above Sea Level
 GPS Date/Time : 2020:09:02 18:01:32Z
 GPS Latitude : 39 deg 53' 5.38" N
 GPS Longitude : 105 deg 5' 38.74" W
 Circle Of Confusion : 0.002 mm
 Field Of View : 60.3 deg

Focal Length	: 2.1 mm (35 mm equivalent: 31.0 mm)
GPS Position	: 39 deg 53' 5.38" N, 105 deg 5' 38.74" W
Hyperfocal Distance	: 0.92 m
Light Value	: 3.4

Selfie Destructive (iMessage)

ExifTool Version Number	: 11.65
File Name	: IMG-0220-copy.JPG
Directory	: .
File Size	: 311 kB
File Modification Date/Time	: 2020:10:22 15:15:39-06:00
File Access Date/Time	: 2020:10:26 13:45:52-06:00
File Creation Date/Time	: 2020:10:26 13:45:52-06:00
File Permissions	: rw-rw-rw-
File Type	: JPEG
File Type Extension	: jpg
MIME Type	: image/jpeg
Exif Byte Order	: Big-endian (Motorola, MM)
Make	: Apple
Camera Model Name	: iPhone 5s
Orientation	: Rotate 90 CW
X Resolution	: 72
Y Resolution	: 72
Resolution Unit	: inches
Software	: 12.4.8
Modify Date	: 2020:09:02 12:01:32
Y Cb Cr Positioning	: Centered
Exposure Time	: 1/15
F Number	: 2.4
Exposure Program	: Program AE
ISO	: 800
Exif Version	: 0221
Date/Time Original	: 2020:09:02 12:01:32
Create Date	: 2020:09:02 12:01:32
Components Configuration	: Y, Cb, Cr, -
Shutter Speed Value	: 1/15
Aperture Value	: 2.4
Brightness Value	: -1.241659445
Exposure Compensation	: 0
Metering Mode	: Multi-segment
Flash	: No flash function
Focal Length	: 2.1 mm
Run Time Flags	: Valid
Run Time Value	: 493796424333750
Run Time Scale	: 1000000000
Run Time Epoch	: 0
Acceleration Vector	: 0.0231898222 -1.002990604 -0.04394700005
HDR Image Type	: Original Image
Image Unique ID	: 2FD5B6E0-A18B-4333-9671-FDA8422CC52D

```

Sub Sec Time Original : 942
Sub Sec Time Digitized : 942
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 1280
Exif Image Height : 960
Sensing Method : One-chip color area
Scene Type : Directly photographed
Custom Rendered : Original (for HDR)
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 31 mm
Scene Capture Type : Standard
Lens Info : 2.15mm f/2.4
Lens Make : Apple
Lens Model : iPhone 5s front camera 2.15mm f/2.4
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Time Stamp : 18:01:32
GPS Speed Ref : km/h
GPS Speed : 0
GPS Img Direction Ref : True North
GPS Img Direction : 9.783767702
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 189.7837678
GPS Date Stamp : 2020:09:02
GPS Horizontal Positioning Error: 10 m
Compression : JPEG (old-style)
Thumbnail Offset : 1580
Thumbnail Length : 8113
Image Width : 1280
Image Height : 960
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 5 days 17:09:56
Aperture : 2.4
Image Size : 1280x960
Megapixels : 1.2
Scale Factor To 35 mm Equivalent: 14.4
Shutter Speed : 1/15
Create Date : 2020:09:02 12:01:32.942
Date/Time Original : 2020:09:02 12:01:32.942
Thumbnail Image : (Binary data 8113 bytes, use -b option
to extract)
GPS Altitude : 1634.9 m Above Sea Level
GPS Date/Time : 2020:09:02 18:01:32Z
GPS Latitude : 39 deg 53' 5.38" N
GPS Longitude : 105 deg 5' 38.74" W
Circle Of Confusion : 0.002 mm
Field Of View : 60.3 deg
Focal Length : 2.1 mm (35 mm equivalent: 31.0 mm)

```

GPS Position	: 39 deg 53' 5.38" N, 105 deg 5' 38.74" W
Hyperfocal Distance	: 0.92 m
Light Value	: 3.4

FILE STRUCTURE

White Wall Non-Destructive (Google Drive) White Wall Destructive (iMessage)

File: IMG-0231-copy.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 2 -> FFE1 = APP
 Offset: 6 -> Exif
 Offset: 9E -> Apple
 Offset: A4 -> iPhone
 Offset: 2C8 -> Apple
 Offset: 67E -> Apple
 Offset: 684 -> iPhone
 Offset: 68E -> back camera
 Offset: 83C -> FFD8 = JPEG Start [83D]
 Offset: 83E -> FFDB = Quantization Table
 Offset: 8CA -> FFC0 = Baseline DCT
 Offset: 8DD -> FFC4 = Huffman Table
 Offset: A81 -> FFDA = Start of Scan (SOS)
 Offset: 1141 -> FFD9 = JPEG End [1142]
 Offset: 2002 -> FFDB = Quantization Table
 Offset: 208E -> FFC0 = Baseline DCT
 Offset: 20A1 -> FFC4 = Huffman Table
 Offset: 2245 -> FFDA = Start of Scan (SOS)
 Offset: F9B74 -> FFD9 = JPEG End [F9B75]

File: IMG-0231-copy.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 2 -> FFE1 = APP
 Offset: 6 -> Exif
 Offset: 9E -> Apple
 Offset: A4 -> iPhone
 Offset: 2C8 -> Apple
 Offset: 67E -> Apple
 Offset: 684 -> iPhone
 Offset: 68E -> back camera
 Offset: 83C -> FFD8 = JPEG Start [83D]
 Offset: 83E -> FFDB = Quantization Table
 Offset: 8CA -> FFC0 = Baseline DCT
 Offset: 8DD -> FFC4 = Huffman Table
 Offset: A81 -> FFDA = Start of Scan (SOS)
 Offset: 1141 -> FFD9 = JPEG End [1142]
 Offset: 2002 -> FFDB = Quantization Table
 Offset: 208E -> FFC0 = Baseline DCT
 Offset: 20A1 -> FFC4 = Huffman Table
 Offset: 2245 -> FFDA = Start of Scan (SOS)
 Offset: F9B74 -> FFD9 = JPEG End [F9B75]

Selfie Non-Destructive (Google Drive)

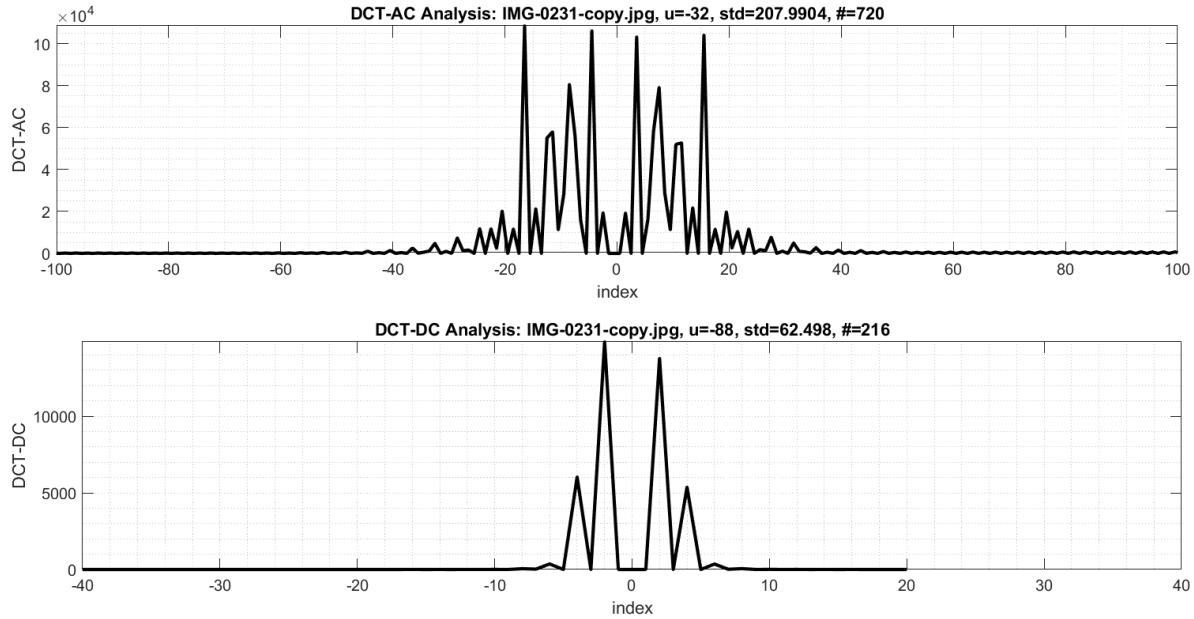
File: IMG-0220-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 2C0 -> Apple
Offset: 46E -> Apple
Offset: 474 -> iPhone
Offset: 62C -> FFD8 = JPEG Start [62D]
Offset: 62E -> FFDB = Quantization Table
Offset: 6BA -> FFC0 = Baseline DCT
Offset: 6CD -> FFC4 = Huffman Table
Offset: 871 -> FFDA = Start of Scan (SOS)
Offset: 25DB -> FFD9 = JPEG End [25DC]
Offset: 3002 -> FFDB = Quantization Table
Offset: 308E -> FFC0 = Baseline DCT
Offset: 30A1 -> FFC4 = Huffman Table
Offset: 3245 -> FFDA = Start of Scan (SOS)
Offset: 4DB3E -> FFD9 = JPEG End [4DB3F]

Selfie Destructive (iMessage)

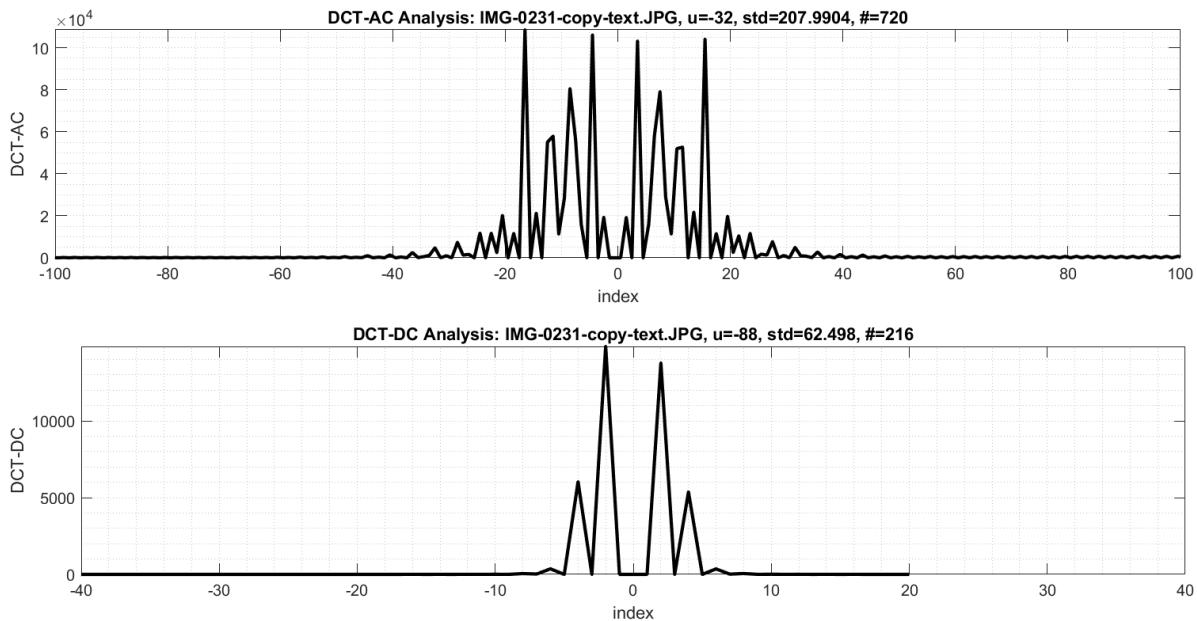
File: IMG-0220-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 2C0 -> Apple
Offset: 46E -> Apple
Offset: 474 -> iPhone
Offset: 62C -> FFD8 = JPEG Start [62D]
Offset: 62E -> FFDB = Quantization Table
Offset: 6BA -> FFC0 = Baseline DCT
Offset: 6CD -> FFC4 = Huffman Table
Offset: 871 -> FFDA = Start of Scan (SOS)
Offset: 25DB -> FFD9 = JPEG End [25DC]
Offset: 3002 -> FFDB = Quantization Table
Offset: 308E -> FFC0 = Baseline DCT
Offset: 30A1 -> FFC4 = Huffman Table
Offset: 3245 -> FFDA = Start of Scan (SOS)
Offset: 4DB3E -> FFD9 = JPEG End [4DB3F]

DCT COMPRESSION HISTOGRAMS

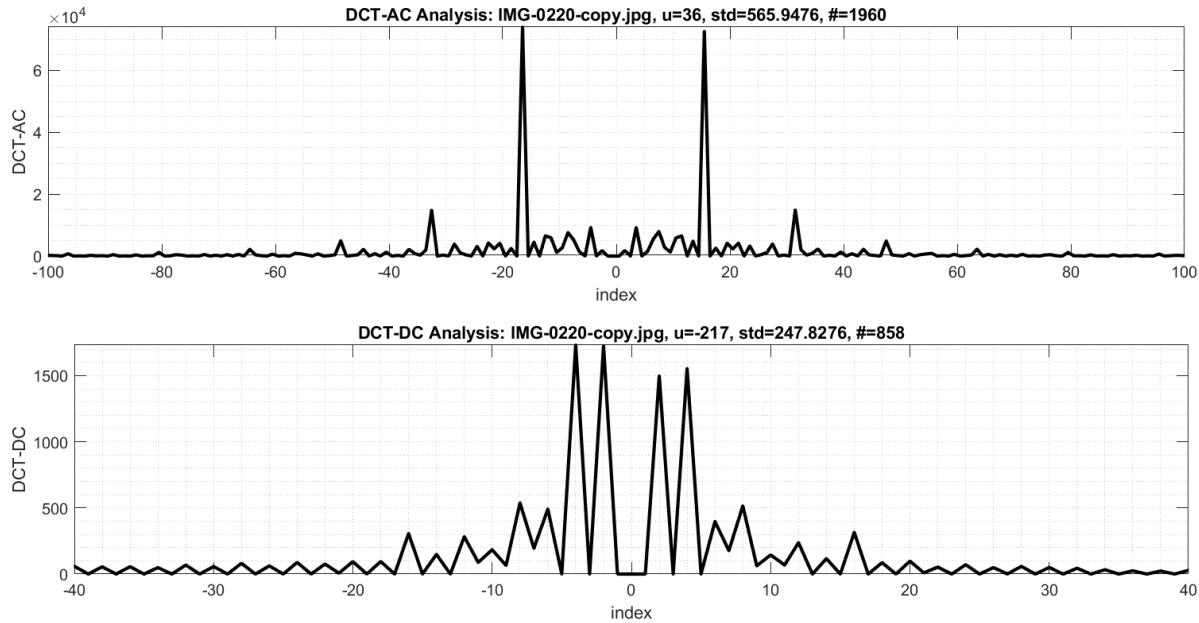
White Wall Non-Destructive (Google Drive)



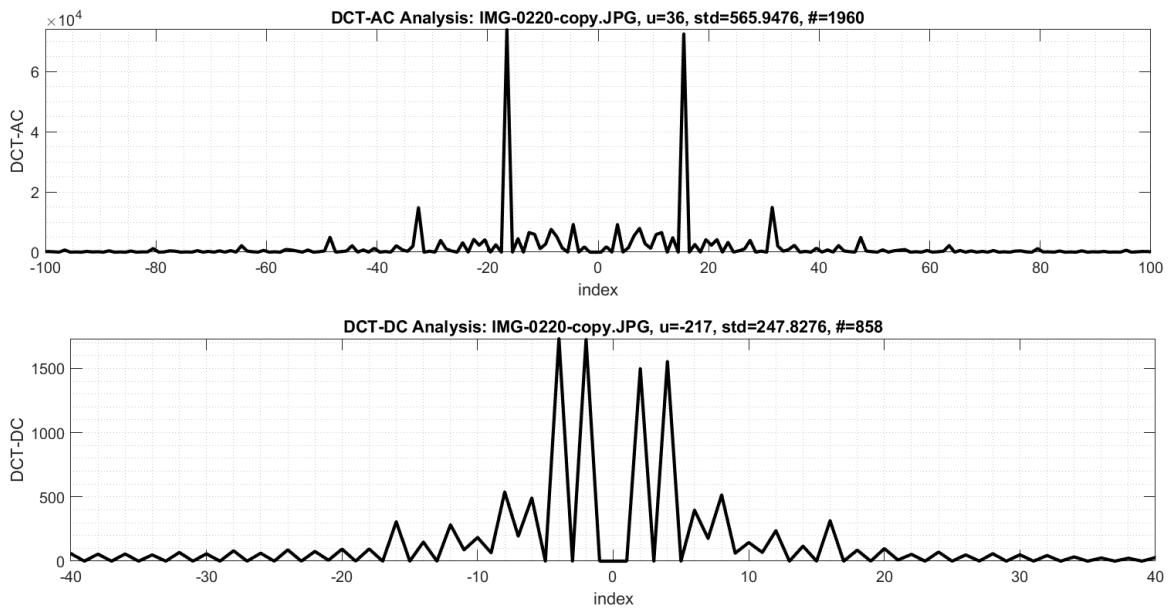
White Wall Destructive (iMessage)



Selfie Non Destructive (Google Drive)



Selfie Destructive (iMessage)



APPENDIX F

RAW DATA FROM IPHONE 6

EXIF DATA

White Wall Non-Destructive (Google Drive)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-3954-copy.jpg
Directory                   : .
File Size                   : 1346 kB
File Modification Date/Time : 2020:10:13 17:58:53-06:00
File Access Date/Time       : 2020:10:26 16:56:38-06:00
File Creation Date/Time    : 2020:10:26 16:56:38-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 6
Orientation                  : Rotate 90 CW
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 12.4.8
Modify Date                  : 2020:08:18 16:20:37
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/30
F Number                     : 2.2
Exposure Program             : Program AE
ISO                          : 32
Exif Version                 : 0221
Date/Time Original           : 2020:08:18 16:20:37
Create Date                  : 2020:08:18 16:20:37
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/30
Aperture Value               : 2.2
Brightness Value              : 4.312466458
Exposure Compensation        : 0
Metering Mode                : Multi-segment
Flash                        : Auto, Did not fire
Focal Length                 : 4.2 mm
Subject Area                  : 1631 1223 1795 1077
Run Time Flags                : Valid
Run Time Value                : 454551023071708
Run Time Scale                : 1000000000
```

```

Run Time Epoch : 0
Acceleration Vector : -0.01927440055 -0.952750742 -
0.1944019645
Sub Sec Time Original : 945
Sub Sec Time Digitized : 945
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3264
Exif Image Height : 2448
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type : Standard
Lens Info : 4.15mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6 back camera 4.15mm f/2.2
Compression : JPEG (old-style)
Thumbnail Offset : 1784
Thumbnail Length : 2699
Image Width : 3264
Image Height : 2448
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 5 days 6:15:51
Aperture : 2.2
Image Size : 3264x2448
Megapixels : 8.0
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed : 1/30
Create Date : 2020:08:18 16:20:37.945
Date/Time Original : 2020:08:18 16:20:37.945
Thumbnail Image : (Binary data 2699 bytes, use -b option
to extract)
Circle Of Confusion : 0.004 mm
Field Of View : 63.7 deg
Focal Length : 4.2 mm (35 mm equivalent: 29.0 mm)
Hyperfocal Distance : 1.82 m
Light Value : 8.8

```

White Wall Destructive (E-mail)

```

ExifTool Version Number : 11.65
File Name : IMG-3954-copy-text.jpg
Directory :
File Size : 1346 kB
File Modification Date/Time : 2020:10:22 15:15:14-06:00

```

File Access Date/Time : 2020:10:26 17:02:59-06:00
File Creation Date/Time : 2020:10:22 15:15:34-06:00
File Permissions : rw-rw-rw-
File Type : JPEG
File Type Extension : jpg
MIME Type : image/jpeg
Exif Byte Order : Big-endian (Motorola, MM)
Make : Apple
Camera Model Name : iPhone 6
Orientation : Rotate 90 CW
X Resolution : 72
Y Resolution : 72
Resolution Unit : inches
Software : 12.4.8
Modify Date : 2020:08:18 16:20:37
Y Cb Cr Positioning : Centered
Exposure Time : 1/30
F Number : 2.2
Exposure Program : Program AE
ISO : 32
Exif Version : 0221
Date/Time Original : 2020:08:18 16:20:37
Create Date : 2020:08:18 16:20:37
Components Configuration : Y, Cb, Cr, -
Shutter Speed Value : 1/30
Aperture Value : 2.2
Brightness Value : 4.312466458
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : Auto, Did not fire
Focal Length : 4.2 mm
Subject Area : 1631 1223 1795 1077
Run Time Flags : Valid
Run Time Value : 454551023071708
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : -0.01927440055 -0.952750742 -0.1944019645
Sub Sec Time Original : 945
Sub Sec Time Digitized : 945
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 3264
Exif Image Height : 2448
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type : Standard
Lens Info : 4.15mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6 back camera 4.15mm f/2.2
Compression : JPEG (old-style)

```

Thumbnail Offset          : 1784
Thumbnail Length         : 2699
Image Width              : 3264
Image Height             : 2448
Encoding Process         : Baseline DCT, Huffman coding
Bits Per Sample          : 8
Color Components          : 3
Y Cb Cr Sub Sampling    : YCbCr4:2:0 (2 2)
Run Time Since Power Up  : 5 days 6:15:51
Aperture                 : 2.2
Image Size               : 3264x2448
Megapixels                : 8.0
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed             : 1/30
Create Date               : 2020:08:18 16:20:37.945
Date/Time Original        : 2020:08:18 16:20:37.945
Thumbnail Image           : (Binary data 2699 bytes, use -b option
to extract)
Circle Of Confusion       : 0.004 mm
Field Of View             : 63.7 deg
Focal Length              : 4.2 mm (35 mm equivalent: 29.0 mm)
Hyperfocal Distance        : 1.82 m
Light Value                : 8.8

```

Selfie Non-Destructive (Google Drive)

```

ExifTool Version Number      : 11.65
File Name                   : IMG-3958-copy.jpg
Directory                  : .
File Size                   : 396 kB
File Modification Date/Time : 2020:10:13 17:58:59-06:00
File Access Date/Time       : 2020:10:26 17:04:48-06:00
File Creation Date/Time     : 2020:10:26 17:04:48-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                        : Apple
Camera Model Name           : iPhone 6
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit             : inches
Software                     : 12.4.8
Modify Date                 : 2020:08:18 17:33:12
Y Cb Cr Positioning         : Centered
Exposure Time               : 1/30
F Number                     : 2.2
Exposure Program             : Program AE

```

```

ISO : 32
Exif Version : 0221
Date/Time Original : 2020:08:18 17:33:12
Create Date : 2020:08:18 17:33:12
Components Configuration : Y, Cb, Cr, -
Shutter Speed Value : 1/30
Aperture Value : 2.2
Brightness Value : 4.366768673
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : No flash function
Focal Length : 2.6 mm
Run Time Flags : Valid
Run Time Value : 457483452964000
Run Time Scale : 10000000000
Run Time Epoch : 0
Acceleration Vector : 0.04391089824 -0.9706613422 0.1430604161
Sub Sec Time Original : 931
Sub Sec Time Digitized : 931
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 1280
Exif Image Height : 960
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 31 mm
Scene Capture Type : Standard
Lens Info : 2.65mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6 front camera 2.65mm f/2.2
Compression : JPEG (old-style)
Thumbnail Offset : 1184
Thumbnail Length : 12237
XMP Toolkit : XMP Core 5.4.0
Region Area Y : 0.5200000000000002
Region Area W : 0.1769999999999994
Region Area X : 0.4484999999999995
Region Area H : 0.252
Region Area Unit : normalized
Region Type : Face
Region Extensions Angle Info Yaw: 0
Region Extensions Angle Info Roll: 270
Region Extensions Confidence Level: 1000
Region Extensions Time Stamp : 10979602871478
Region Extensions Face ID : 11
Region Applied To Dimensions H : 960
Region Applied To Dimensions W : 1280
Region Applied To Dimensions Unit: pixel
Image Width : 1280
Image Height : 960
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8

```

```

Color Components           : 3
Y Cb Cr Sub Sampling    : YCbCr4:2:0 (2 2)
Run Time Since Power Up  : 5 days 7:04:43
Aperture                 : 2.2
Image Size                : 1280x960
Megapixels               : 1.2
Scale Factor To 35 mm Equivalent: 11.7
Shutter Speed             : 1/30
Create Date               : 2020:08:18 17:33:12.931
Date/Time Original        : 2020:08:18 17:33:12.931
Thumbnail Image           : (Binary data 12237 bytes, use -b option
to extract)
Circle Of Confusion       : 0.003 mm
Field Of View              : 60.3 deg
Focal Length               : 2.6 mm (35 mm equivalent: 31.0 mm)
Hyperfocal Distance        : 1.24 m
Light Value                : 8.8

```

Selfie Destructive (E-mail)

```

ExifTool Version Number      : 11.65
File Name                   : IMG-3958-copy.JPG
Directory                  : .
File Size                   : 396 kB
File Modification Date/Time : 2020:10:22 15:15:18-06:00
File Access Date/Time       : 2020:10:26 17:06:37-06:00
File Creation Date/Time     : 2020:10:26 17:06:37-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name            : iPhone 6
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit              : inches
Software                     : 12.4.8
Modify Date                  : 2020:08:18 17:33:12
Y Cb Cr Positioning          : Centered
Exposure Time                : 1/30
F Number                     : 2.2
Exposure Program              : Program AE
ISO                          : 32
Exif Version                 : 0221
Date/Time Original            : 2020:08:18 17:33:12
Create Date                   : 2020:08:18 17:33:12
Components Configuration       : Y, Cb, Cr, -
Shutter Speed Value           : 1/30

```

Aperture Value : 2.2
Brightness Value : 4.366768673
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : No flash function
Focal Length : 2.6 mm
Run Time Flags : Valid
Run Time Value : 457483452964000
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : 0.04391089824 -0.9706613422 0.1430604161
Sub Sec Time Original : 931
Sub Sec Time Digitized : 931
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 1280
Exif Image Height : 960
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 31 mm
Scene Capture Type : Standard
Lens Info : 2.65mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6 front camera 2.65mm f/2.2
Compression : JPEG (old-style)
Thumbnail Offset : 1184
Thumbnail Length : 12237
XMP Toolkit : XMP Core 5.4.0
Region Area Y : 0.52000000000000002
Region Area W : 0.17699999999999994
Region Area X : 0.44849999999999995
Region Area H : 0.252
Region Area Unit : normalized
Region Type : Face
Region Extensions Angle Info Yaw: 0
Region Extensions Angle Info Roll: 270
Region Extensions Confidence Level: 1000
Region Extensions Time Stamp : 10979602871478
Region Extensions Face ID : 11
Region Applied To Dimensions H : 960
Region Applied To Dimensions W : 1280
Region Applied To Dimensions Unit: pixel
Image Width : 1280
Image Height : 960
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 5 days 7:04:43
Aperture : 2.2
Image Size : 1280x960
Megapixels : 1.2

```

Scale Factor To 35 mm Equivalent: 11.7
Shutter Speed : 1/30
Create Date : 2020:08:18 17:33:12.931
Date/Time Original : 2020:08:18 17:33:12.931
Thumbnail Image : (Binary data 12237 bytes, use -b option
to extract)
Circle Of Confusion : 0.003 mm
Field Of View : 60.3 deg
Focal Length : 2.6 mm (35 mm equivalent: 31.0 mm)
Hyperfocal Distance : 1.24 m
Light Value : 8.8

```

FILE STRUCTURES

White Wall Non-Destructive (Google Drive)

File: IMG-3954-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2BC -> Apple
Offset: 672 -> Apple
Offset: 678 -> iPhone
Offset: 681 -> back camera
Offset: 6F8 -> FFD8 = JPEG Start [6F9]
Offset: 6FA -> FFDB = Quantization Table
Offset: 786 -> FFC0 = Baseline DCT
Offset: 799 -> FFC4 = Huffman Table
Offset: 93D -> FFDA = Start of Scan (SOS)
Offset: 1181 -> FFD9 = JPEG End [1182]
Offset: 2002 -> FFDB = Quantization Table
Offset: 208E -> FFC0 = Baseline DCT
Offset: 20A1 -> FFC4 = Huffman Table
Offset: 2245 -> FFDA = Start of Scan (SOS)
Offset: 15095C -> FFD9 = JPEG End [15095D]

White Wall Destructive (E-mail)

File: IMG-3954_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2BC -> Apple
Offset: 672 -> Apple
Offset: 678 -> iPhone
Offset: 681 -> back camera
Offset: 6F8 -> FFD8 = JPEG Start [6F9]
Offset: 6FA -> FFDB = Quantization Table
Offset: 786 -> FFC0 = Baseline DCT
Offset: 799 -> FFC4 = Huffman Table
Offset: 93D -> FFDA = Start of Scan (SOS)
Offset: 1181 -> FFD9 = JPEG End [1182]
Offset: 2002 -> FFDB = Quantization Table
Offset: 208E -> FFC0 = Baseline DCT
Offset: 20A1 -> FFC4 = Huffman Table
Offset: 2245 -> FFDA = Start of Scan (SOS)
Offset: 15095C -> FFD9 = JPEG End [15095D]

Selfie Non-Destructive (Google Drive)

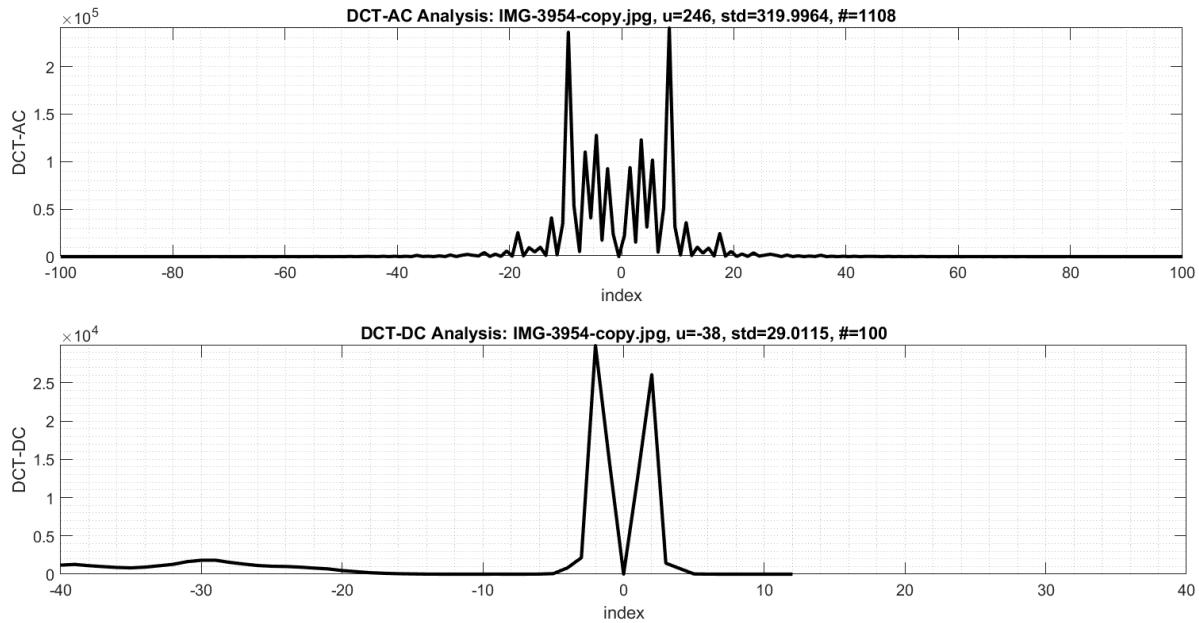
File: IMG-3958-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2A8 -> Apple
Offset: 418 -> Apple
Offset: 41E -> iPhone
Offset: 4A0 -> FFD8 = JPEG Start [4A1]
Offset: 4A2 -> FFDB = Quantization Table
Offset: 52E -> FFC0 = Baseline DCT
Offset: 541 -> FFC4 = Huffman Table
Offset: 6E5 -> FFDA = Start of Scan (SOS)
Offset: 346B -> FFD9 = JPEG End [346C]
Offset: 346F -> FFE1 = APP
Offset: 3473 -> <http://ns.adobe.com>
Offset: 3473 -> <http://ns.adobe.com/xap/>
Offset: 34E5 -> <http://www.w3.org>
Offset: 35A1 -> <http://ns.adobe.com>
Offset: 361E -> <http://ns.adobe.com>
Offset: 361E -> <http://ns.adobe.com/xap/>
Offset: 3C26 -> FFDB = Quantization Table
Offset: 3CB2 -> FFC0 = Baseline DCT
Offset: 3CC5 -> FFC4 = Huffman Table
Offset: 3E69 -> FFDA = Start of Scan (SOS)
Offset: 62EF7 -> FFD9 = JPEG End [62EF8]

Selfie Destructive (E-mail)

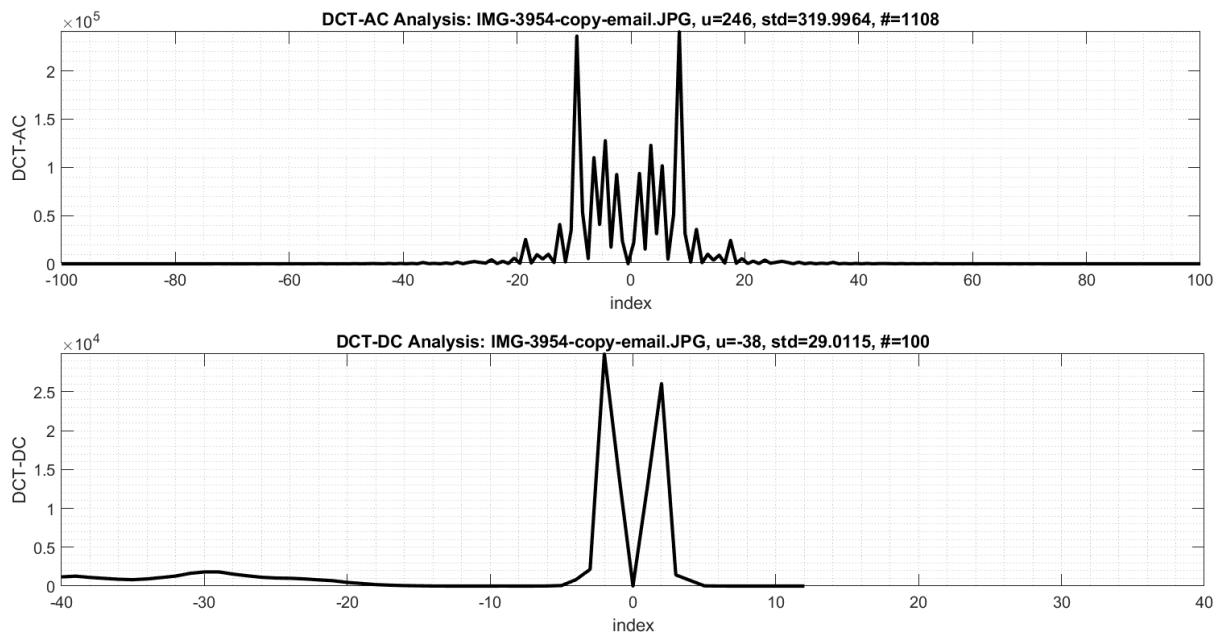
File: IMG-3958-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2A8 -> Apple
Offset: 418 -> Apple
Offset: 41E -> iPhone
Offset: 4A0 -> FFD8 = JPEG Start [4A1]
Offset: 4A2 -> FFDB = Quantization Table
Offset: 52E -> FFC0 = Baseline DCT
Offset: 541 -> FFC4 = Huffman Table
Offset: 6E5 -> FFDA = Start of Scan (SOS)
Offset: 346B -> FFD9 = JPEG End [346C]
Offset: 346F -> FFE1 = APP
Offset: 3473 -> <http://ns.adobe.com>
Offset: 3473 -> <http://ns.adobe.com/xap/>
Offset: 34E5 -> <http://www.w3.org>
Offset: 35A1 -> <http://ns.adobe.com>
Offset: 361E -> <http://ns.adobe.com>
Offset: 361E -> <http://ns.adobe.com/xap/>
Offset: 3C26 -> FFDB = Quantization Table
Offset: 3CB2 -> FFC0 = Baseline DCT
Offset: 3CC5 -> FFC4 = Huffman Table
Offset: 3E69 -> FFDA = Start of Scan (SOS)
Offset: 62EF7 -> FFD9 = JPEG End [62EF8]

DCT COMPRESSION HISTOGRAMS

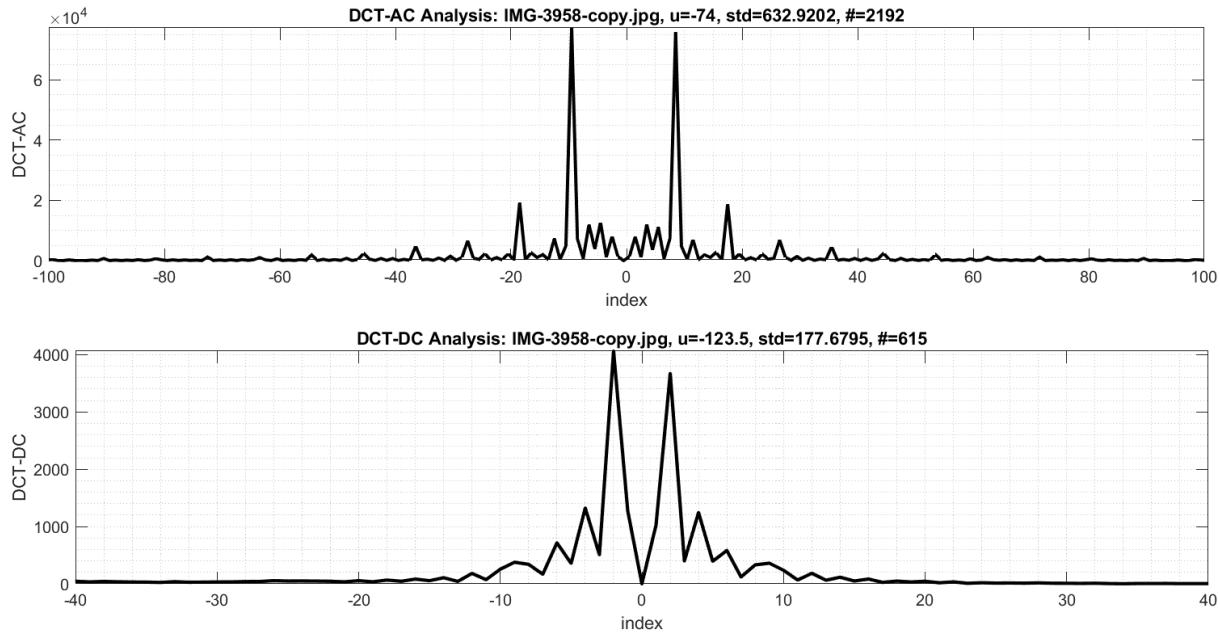
White Wall Non-Destructive (Google Drive)



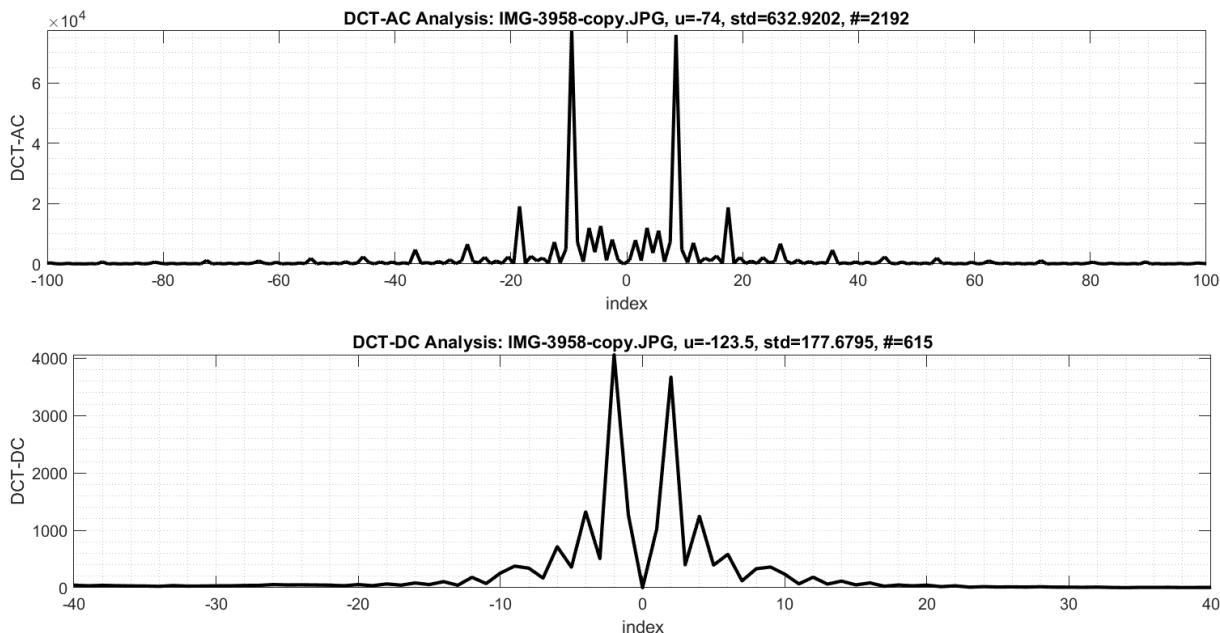
White Wall Destructive (E-mail)



Selfie Non-Destructive (Google Drive)



Selfie Destructive (E-mail)



APPENDIX G

RAW DATA FROM IPHONE 6S PLUS

White Wall Non-Destructive (Google Drive)

```
ExifTool Version Number      : 11.65
File Name                  : IMG-0642-copy.jpg
Directory                  : .
File Size                   : 1577 kB
File Modification Date/Time : 2020:10:13 17:58:52-06:00
File Access Date/Time       : 2020:10:28 11:27:52-06:00
File Creation Date/Time    : 2020:10:13 18:02:39-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                  : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                        : Apple
Camera Model Name           : iPhone 6s Plus
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit             : inches
Software                     : 13.6
Modify Date                 : 2020:08:21 12:59:53
Y Cb Cr Positioning        : Centered
Exposure Time               : 1/40
F Number                     : 2.2
Exposure Program             : Program AE
ISO                          : 25
Exif Version                : 0231
Date/Time Original          : 2020:08:21 12:59:53
Create Date                  : 2020:08:21 12:59:53
Offset Time                 : -07:00
Offset Time Original         : -07:00
Offset Time Digitized       : -07:00
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/40
Aperture Value               : 2.2
Brightness Value             : 5.034807554
Exposure Compensation        : 0
Metering Mode                : Spot
Flash                        : Off, Did not fire
Focal Length                 : 4.2 mm
Subject Area                  : 2335 2646 753 756
Run Time Flags                : Valid
Run Time Value                : 78831147290875
```

Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : -0.01405259595 -1.006911755
0.008169654752
Sub Sec Time Original : 855
Sub Sec Time Digitized : 855
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 4032
Exif Image Height : 3024
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type : Standard
Lens Info : 4.15mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6s Plus back camera 4.15mm f/2.2
Compression : JPEG (old-style)
Thumbnail Offset : 2030
Thumbnail Length : 3671
Image Width : 4032
Image Height : 3024
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 21:53:51
Aperture : 2.2
Image Size : 4032x3024
Megapixels : 12.2
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed : 1/40
Create Date : 2020:08:21 12:59:53.855-07:00
Date/Time Original : 2020:08:21 12:59:53.855-07:00
Modify Date : 2020:08:21 12:59:53-07:00
Thumbnail Image : (Binary data 3671 bytes, use -b option
to extract)
Circle Of Confusion : 0.004 mm
Field Of View : 63.7 deg
Focal Length : 4.2 mm (35 mm equivalent: 29.0 mm)
Hyperfocal Distance : 1.82 m
Light Value : 9.6

White Wall Destructive (E-mail)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-0642-copy-email.JPG
Directory                   : .
File Size                    : 1577 kB
File Modification Date/Time : 2020:10:22 15:15:10-06:00
File Access Date/Time       : 2020:10:28 11:29:50-06:00
File Creation Date/Time    : 2020:10:28 11:29:50-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 6s Plus
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit             : inches
Software                     : 13.6
Modify Date                 : 2020:08:21 12:59:53
Y Cb Cr Positioning        : Centered
Exposure Time               : 1/40
F Number                     : 2.2
Exposure Program            : Program AE
ISO                          : 25
Exif Version                : 0231
Date/Time Original          : 2020:08:21 12:59:53
Create Date                  : 2020:08:21 12:59:53
Offset Time                 : -07:00
Offset Time Original         : -07:00
Offset Time Digitized       : -07:00
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value          : 1/40
Aperture Value              : 2.2
Brightness Value             : 5.034807554
Exposure Compensation        : 0
Metering Mode               : Spot
Flash                        : Off, Did not fire
Focal Length                 : 4.2 mm
Subject Area                 : 2335 2646 753 756
Run Time Flags               : Valid
Run Time Value               : 78831147290875
Run Time Scale               : 1000000000
Run Time Epoch               : 0
Acceleration Vector          : -0.01405259595 -1.006911755
0.008169654752
Sub Sec Time Original        : 855
Sub Sec Time Digitized       : 855
Flashpix Version             : 0100
```

```

Color Space           : sRGB
Exif Image Width    : 4032
Exif Image Height   : 3024
Sensing Method      : One-chip color area
Scene Type          : Directly photographed
Exposure Mode       : Auto
White Balance        : Auto
Focal Length In 35mm Format : 29 mm
Scene Capture Type  : Standard
Lens Info            : 4.15mm f/2.2
Lens Make            : Apple
Lens Model           : iPhone 6s Plus back camera 4.15mm f/2.2
Compression          : JPEG (old-style)
Thumbnail Offset     : 2030
Thumbnail Length     : 3671
Image Width          : 4032
Image Height         : 3024
Encoding Process     : Baseline DCT, Huffman coding
Bits Per Sample      : 8
Color Components     : 3
Y Cb Cr Sub Sampling: YCbCr4:2:0 (2 2)
Run Time Since Power Up: 21:53:51
Aperture             : 2.2
Image Size            : 4032x3024
Megapixels           : 12.2
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed         : 1/40
Create Date           : 2020:08:21 12:59:53.855-07:00
Date/Time Original   : 2020:08:21 12:59:53.855-07:00
Modify Date           : 2020:08:21 12:59:53-07:00
Thumbnail Image       : (Binary data 3671 bytes, use -b option
to extract)
Circle Of Confusion  : 0.004 mm
Field Of View         : 63.7 deg
Focal Length          : 4.2 mm (35 mm equivalent: 29.0 mm)
Hyperfocal Distance   : 1.82 m
Light Value            : 9.6

```

Selfie Non-Destructive (Google Drive)

```

ExifTool Version Number : 11.65
File Name               : IMG-0652-copy.jpg
Directory              : .
File Size               : 811 kB
File Modification Date/Time: 2020:10:13 17:58:55-06:00
File Access Date/Time   : 2020:10:28 11:31:00-06:00
File Creation Date/Time: 2020:10:28 11:31:00-06:00
File Permissions        : rw-rw-rw-
File Type               : JPEG
File Type Extension     : jpg

```

MIME Type	:	image/jpeg
Exif Byte Order	:	Big-endian (Motorola, MM)
Make	:	Apple
Camera Model Name	:	iPhone 6s Plus
Orientation	:	Rotate 90 CW
X Resolution	:	72
Y Resolution	:	72
Resolution Unit	:	inches
Software	:	13.6
Modify Date	:	2020:08:21 13:33:10
Y Cb Cr Positioning	:	Centered
Exposure Time	:	1/1111
F Number	:	2.2
Exposure Program	:	Program AE
ISO	:	32
Exif Version	:	0231
Date/Time Original	:	2020:08:21 13:33:10
Create Date	:	2020:08:21 13:33:10
Offset Time	:	-07:00
Offset Time Original	:	-07:00
Offset Time Digitized	:	-07:00
Components Configuration	:	Y, Cb, Cr, -
Shutter Speed Value	:	1/1111
Aperture Value	:	2.2
Brightness Value	:	9.730951414
Exposure Compensation	:	0
Metering Mode	:	Multi-segment
Flash	:	Off, Did not fire
Focal Length	:	2.6 mm
Run Time Flags	:	Valid
Run Time Value	:	80721346781291
Run Time Scale	:	1000000000
Run Time Epoch	:	0
Acceleration Vector	:	0.0136006549 -0.8819293976 -0.3609178067
HDR Image Type	:	HDR Image
Image Unique ID	:	4C3F5978-90E3-4590-A0B1-71AC72C6218B
Sub Sec Time Original	:	183
Sub Sec Time Digitized	:	183
Flashpix Version	:	0100
Color Space	:	sRGB
Exif Image Width	:	2576
Exif Image Height	:	1932
Sensing Method	:	One-chip color area
Scene Type	:	Directly photographed
Custom Rendered	:	HDR (original saved)
Exposure Mode	:	Auto
White Balance	:	Auto
Focal Length In 35mm Format	:	31 mm
Scene Capture Type	:	Standard
Lens Info	:	2.65mm f/2.2
Lens Make	:	Apple
Lens Model	:	iPhone 6s Plus front camera 2.65mm f/2.2
Compression	:	JPEG (old-style)
Thumbnail Offset	:	1440

```

Thumbnail Length          : 7663
Image Width              : 2576
Image Height             : 1932
Encoding Process         : Baseline DCT, Huffman coding
Bits Per Sample          : 8
Color Components          : 3
Y Cb Cr Sub Sampling    : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 22:25:21
Aperture                 : 2.2
Image Size               : 2576x1932
Megapixels               : 5.0
Scale Factor To 35 mm Equivalent: 11.7
Shutter Speed             : 1/1111
Create Date               : 2020:08:21 13:33:10.183-07:00
Date/Time Original        : 2020:08:21 13:33:10.183-07:00
Modify Date               : 2020:08:21 13:33:10-07:00
Thumbnail Image           : (Binary data 7663 bytes, use -b option
to extract)
Circle Of Confusion       : 0.003 mm
Field Of View              : 60.3 deg
Focal Length               : 2.6 mm (35 mm equivalent: 31.0 mm)
Hyperfocal Distance        : 1.24 m
Light Value                : 14.0

```

Selfie Destructive (E-mail)

```

ExifTool Version Number      : 11.65
File Name                   : IMG-0652-copy-email.JPG
Directory                  : .
File Size                   : 811 kB
File Modification Date/Time : 2020:10:22 15:15:01-06:00
File Access Date/Time       : 2020:10:28 11:32:14-06:00
File Creation Date/Time     : 2020:10:28 11:32:14-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 6s Plus
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit              : inches
Software                     : 13.6
Modify Date                  : 2020:08:21 13:33:10
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/1111
F Number                     : 2.2
Exposure Program             : Program AE

```

```

ISO : 32
Exif Version : 0231
Date/Time Original : 2020:08:21 13:33:10
Create Date : 2020:08:21 13:33:10
Offset Time : -07:00
Offset Time Original : -07:00
Offset Time Digitized : -07:00
Components Configuration : Y, Cb, Cr, -
Shutter Speed Value : 1/1111
Aperture Value : 2.2
Brightness Value : 9.730951414
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : Off, Did not fire
Focal Length : 2.6 mm
Run Time Flags : Valid
Run Time Value : 80721346781291
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : 0.0136006549 -0.8819293976 -0.3609178067
HDR Image Type : HDR Image
Image Unique ID : 4C3F5978-90E3-4590-A0B1-71AC72C6218B
Sub Sec Time Original : 183
Sub Sec Time Digitized : 183
Flashpix Version : 0100
Color Space : sRGB
Exif Image Width : 2576
Exif Image Height : 1932
Sensing Method : One-chip color area
Scene Type : Directly photographed
Custom Rendered : HDR (original saved)
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 31 mm
Scene Capture Type : Standard
Lens Info : 2.65mm f/2.2
Lens Make : Apple
Lens Model : iPhone 6s Plus front camera 2.65mm f/2.2
Compression : JPEG (old-style)
Thumbnail Offset : 1440
Thumbnail Length : 7663
Image Width : 2576
Image Height : 1932
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
YCbCr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 22:25:21
Aperture : 2.2
Image Size : 2576x1932
Megapixels : 5.0
Scale Factor To 35 mm Equivalent : 11.7
Shutter Speed : 1/1111
Create Date : 2020:08:21 13:33:10.183-07:00

```

Date/Time Original	:	2020:08:21 13:33:10.183-07:00
Modify Date	:	2020:08:21 13:33:10-07:00
Thumbnail Image to extract)	:	(Binary data 7663 bytes, use -b option
Circle Of Confusion	:	0.003 mm
Field Of View	:	60.3 deg
Focal Length	:	2.6 mm (35 mm equivalent: 31.0 mm)
Hyperfocal Distance	:	1.24 m
Light Value	:	14.0

FILE STRUCTURES

White Wall Non-Destructive (Google Drive)

File: IMG-0642-copy.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 2 -> FFE1 = APP
 Offset: 6 -> Exif
 Offset: 92 -> Apple
 Offset: 98 -> iPhone
 Offset: 2FC -> Apple
 Offset: 762 -> Apple
 Offset: 768 -> iPhone
 Offset: 777 -> back camera
 Offset: 7EE -> FFD8 = JPEG Start [7EF]
 Offset: 7F0 -> FFDB = Quantization Table
 Offset: 87C -> FFC0 = Baseline DCT
 Offset: 88F -> FFC4 = Huffman Table
 Offset: A33 -> FFDA = Start of Scan (SOS)
 Offset: 1643 -> FFD9 = JPEG End [1644]
 Offset: 2002 -> FFDB = Quantization Table
 Offset: 208E -> FFC0 = Baseline DCT
 Offset: 20A1 -> FFC4 = Huffman Table
 Offset: 2245 -> FFDA = Start of Scan (SOS)
 Offset: 83A9B -> ACD
 Offset: 18A51D -> FFD9 = JPEG End [18A51E]

White Wall Destructive (E-mail)

File: IMG-0642_email-copy.jpg
 Offset: 0 -> FFD8 = JPEG Start [1]
 Offset: 2 -> FFE1 = APP
 Offset: 6 -> Exif
 Offset: 92 -> Apple
 Offset: 98 -> iPhone
 Offset: 2FC -> Apple
 Offset: 762 -> Apple
 Offset: 768 -> iPhone
 Offset: 777 -> back camera
 Offset: 7EE -> FFD8 = JPEG Start [7EF]
 Offset: 7F0 -> FFDB = Quantization Table
 Offset: 87C -> FFC0 = Baseline DCT
 Offset: 88F -> FFC4 = Huffman Table
 Offset: A33 -> FFDA = Start of Scan (SOS)
 Offset: 1643 -> FFD9 = JPEG End [1644]
 Offset: 2002 -> FFDB = Quantization Table
 Offset: 208E -> FFC0 = Baseline DCT
 Offset: 20A1 -> FFC4 = Huffman Table
 Offset: 2245 -> FFDA = Start of Scan (SOS)
 Offset: 83A9B -> ACD
 Offset: 18A51D -> FFD9 = JPEG End [18A51E]

Selfie Non-Destructive (Google Drive)

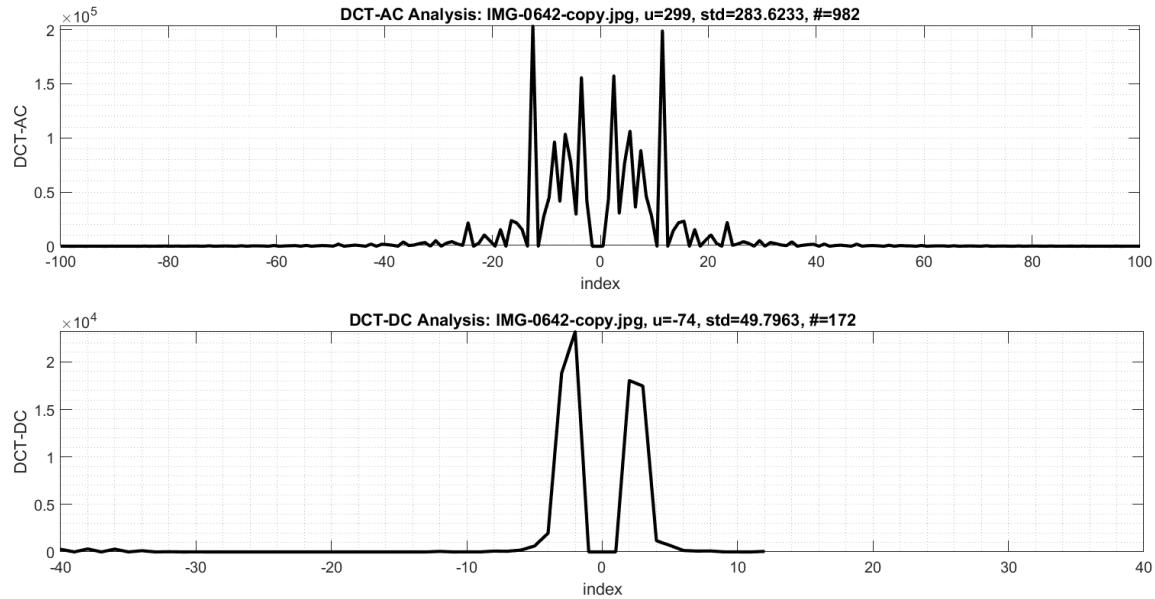
File: IMG-0652-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2F4 -> Apple
Offset: 512 -> Apple
Offset: 518 -> iPhone
Offset: 5A0 -> FFD8 = JPEG Start [5A1]
Offset: 5A2 -> FFDB = Quantization Table
Offset: 62E -> FFC0 = Baseline DCT
Offset: 641 -> FFC4 = Huffman Table
Offset: 7E5 -> FFDA = Start of Scan (SOS)
Offset: 238D -> FFD9 = JPEG End [238E]
Offset: 3002 -> FFDB = Quantization Table
Offset: 308E -> FFC0 = Baseline DCT
Offset: 30A1 -> FFC4 = Huffman Table
Offset: 3245 -> FFDA = Start of Scan (SOS)
Offset: CABD7 -> FFD9 = JPEG End [CABD8]

Selfie Destructive (E-mail)

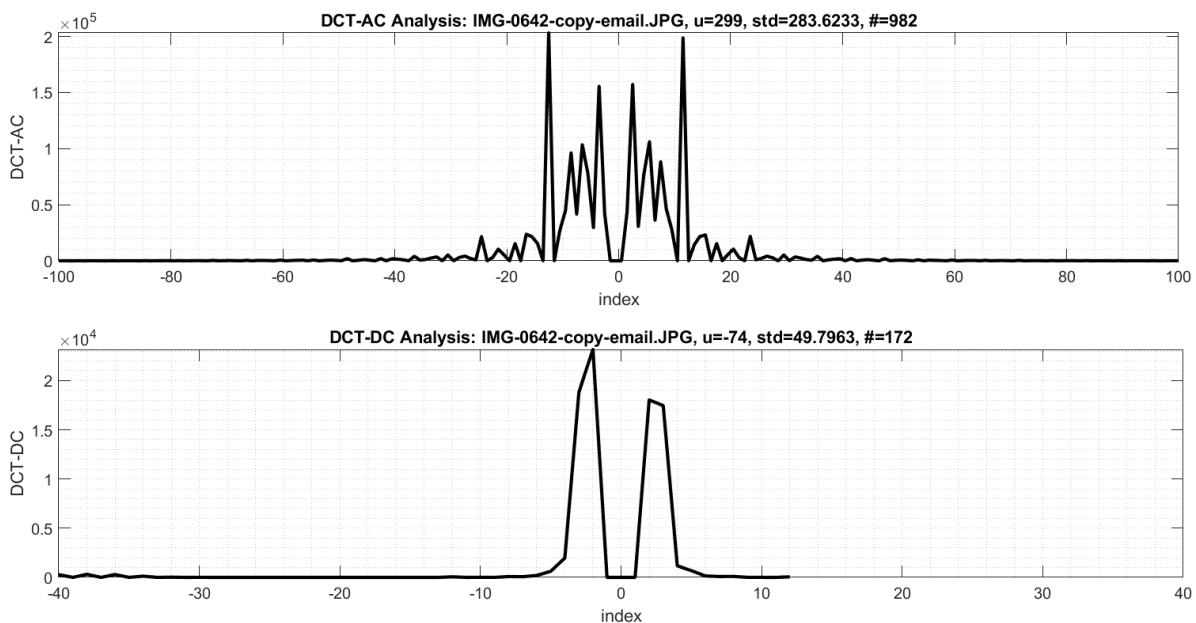
File: IMG-0652_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 92 -> Apple
Offset: 98 -> iPhone
Offset: 2F4 -> Apple
Offset: 512 -> Apple
Offset: 518 -> iPhone
Offset: 5A0 -> FFD8 = JPEG Start [5A1]
Offset: 5A2 -> FFDB = Quantization Table
Offset: 62E -> FFC0 = Baseline DCT
Offset: 641 -> FFC4 = Huffman Table
Offset: 7E5 -> FFDA = Start of Scan (SOS)
Offset: 238D -> FFD9 = JPEG End [238E]
Offset: 3002 -> FFDB = Quantization Table
Offset: 308E -> FFC0 = Baseline DCT
Offset: 30A1 -> FFC4 = Huffman Table
Offset: 3245 -> FFDA = Start of Scan (SOS)
Offset: CABD7 -> FFD9 = JPEG End [CABD8]

DCT COMPRESSION HISTOGRAMS

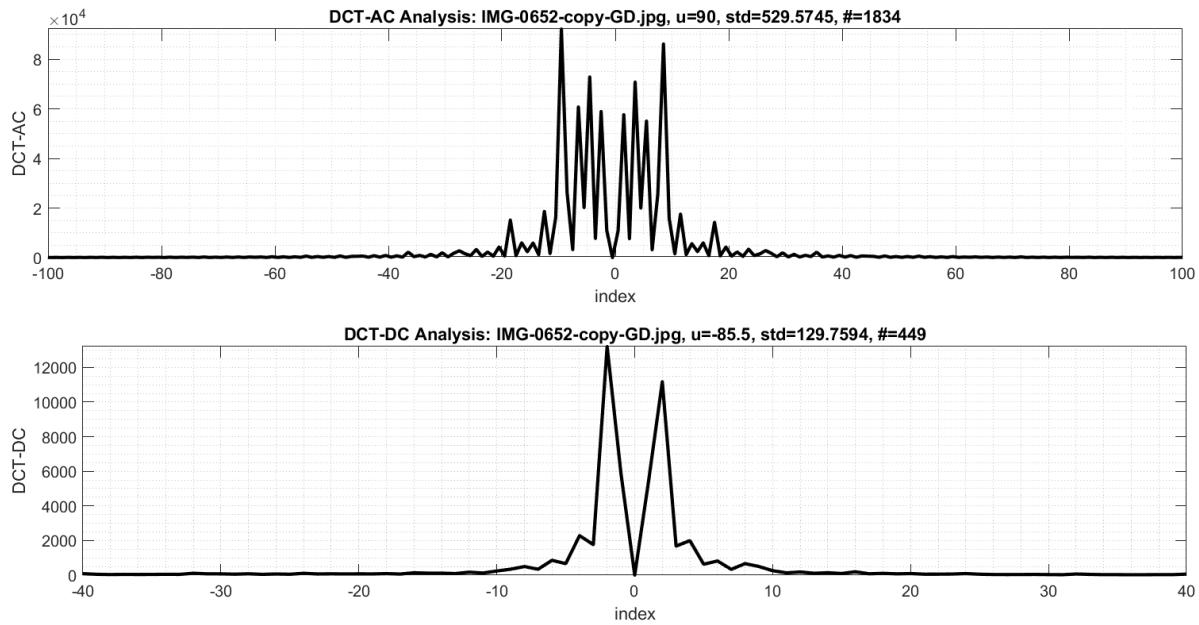
White Wall Non-Destructive (Google Drive)



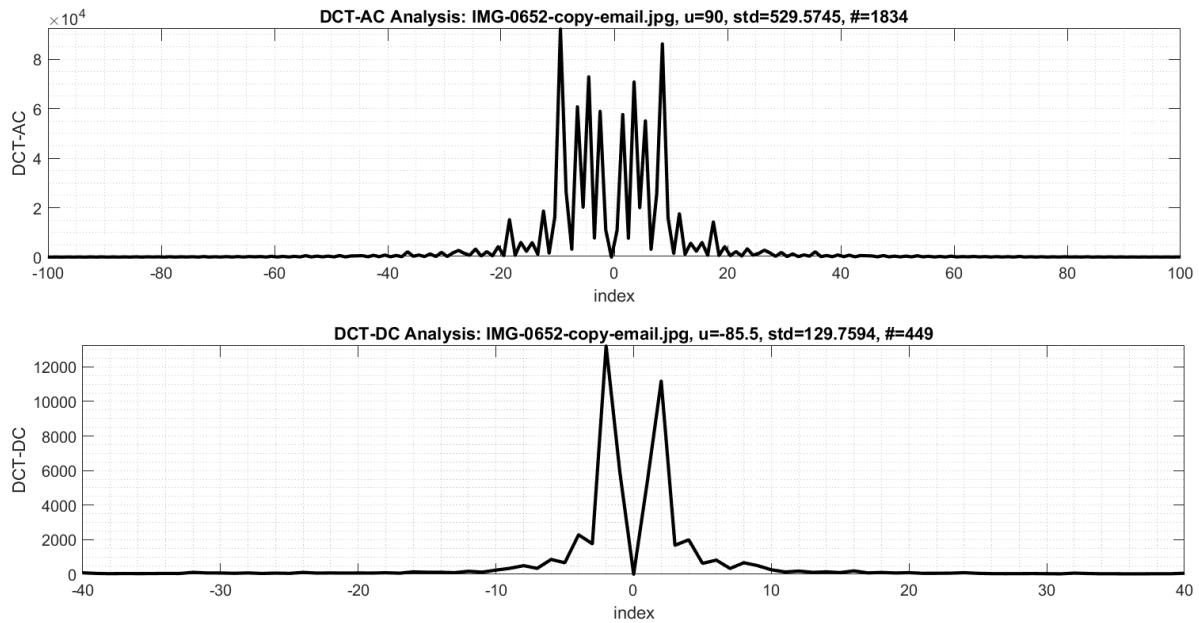
White Wall Destructive (E-mail)



Selfie Non Destructive (Google Drive)



Selfie Destructive (E-mail)



APPENDIX H

RAW DATA FROM IPHONE 7

EXIF DATA

White Wall Non-Destructive (Google Drive)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-3534-copy.jpg
Directory                   : .
File Size                   : 1442 kB
File Modification Date/Time : 2020:10:13 17:59:02-06:00
File Access Date/Time       : 2020:10:28 12:10:30-06:00
File Creation Date/Time    : 2020:10:28 12:10:30-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 7
Orientation                  : Rotate 90 CW
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 13.6.1
Modify Date                  : 2020:09:02 12:03:06
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/15
F Number                      : 1.8
Exposure Program              : Program AE
ISO                           : 50
Exif Version                 : 0231
Date/Time Original           : 2020:09:02 12:03:06
Create Date                   : 2020:09:02 12:03:06
Offset Time                   : -06:00
Offset Time Original          : -06:00
Offset Time Digitized        : -06:00
Components Configuration      : Y, Cb, Cr, -
Shutter Speed Value           : 1/15
Aperture Value                : 1.8
Brightness Value              : 2.345759291
Exposure Compensation         : 0
Metering Mode                 : Spot
Flash                         : Off, Did not fire
```

Focal Length : 4.0 mm
Subject Area : 2492 1127 753 756
Run Time Flags : Valid
Run Time Value : 16651881270166
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : 0.002544809831 -1.000033379 -0.002396658528
Sub Sec Time Original : 690
Sub Sec Time Digitized : 690
Flashpix Version : 0100
Color Space : Uncalibrated
Exif Image Width : 4032
Exif Image Height : 3024
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 28 mm
Scene Capture Type : Standard
Lens Info : 3.99000001mm f/1.8
Lens Make : Apple
Lens Model : iPhone 7 back camera 3.99mm f/1.8
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Speed Ref : km/h
GPS Speed : 0.2993952632
GPS Img Direction Ref : True North
GPS Img Direction : 143.0973358
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 143.0973358
GPS Horizontal Positioning Error : 16.00241655 m
Compression : JPEG (old-style)
Thumbnail Offset : 2318
Thumbnail Length : 2822
Profile CMM Type : Apple Computer Inc.
Profile Version : 4.0.0
Profile Class : Display Device Profile
Color Space Data : RGB
Profile Connection Space : XYZ
Profile Date Time : 2017:07:07 13:22:32
Profile File Signature : acsp
Primary Platform : Apple Computer Inc.
CMM Flags : Not Embedded, Independent
Device Manufacturer : Apple Computer Inc.
Device Model :
Device Attributes : Reflective, Glossy, Positive, Color
Rendering Intent : Perceptual
Connection Space Illuminant : 0.9642 1 0.82491
Profile Creator : Apple Computer Inc.
Profile ID : cala9582257f104d389913d5d1ea1582
Profile Description : Display P3
Profile Copyright : Copyright Apple Inc., 2017

Media White Point : 0.95045 1 1.08905
 Red Matrix Column : 0.51512 0.2412 -0.00105
 Green Matrix Column : 0.29198 0.69225 0.04189
 Blue Matrix Column : 0.1571 0.06657 0.78407
 Red Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Chromatic Adaptation : 1.04788 0.02292 -0.0502 0.02959 0.99048
 -0.01706 -0.00923 0.01508 0.75168
 Blue Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Green Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Image Width : 4032
 Image Height : 3024
 Encoding Process : Baseline DCT, Huffman coding
 Bits Per Sample : 8
 Color Components : 3
 Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
 Run Time Since Power Up : 4:37:32
 Aperture : 1.8
 Image Size : 4032x3024
 Megapixels : 12.2
 Scale Factor To 35 mm Equivalent: 7.0
 Shutter Speed : 1/15
 Create Date : 2020:09:02 12:03:06.690-06:00
 Date/Time Original : 2020:09:02 12:03:06.690-06:00
 Modify Date : 2020:09:02 12:03:06-06:00
 Thumbnail Image : (Binary data 2822 bytes, use -b option to extract)
 GPS Altitude : 1632.9 m Above Sea Level
 GPS Latitude : 39 deg 53' 5.14" N
 GPS Longitude : 105 deg 5' 38.85" W
 Circle Of Confusion : 0.004 mm
 Field Of View : 65.5 deg
 Focal Length : 4.0 mm (35 mm equivalent: 28.0 mm)
 GPS Position : 39 deg 53' 5.14" N, 105 deg 5' 38.85" W
 Hyperfocal Distance : 2.07 m
 Light Value : 6.6

White Wall Destructive (E-mail)

ExifTool Version Number : 11.65
 File Name : IMG-3534-copy-email.jpg
 Directory : .
 File Size : 1442 kB
 File Modification Date/Time : 2020:10:22 15:15:23-06:00
 File Access Date/Time : 2020:10:28 12:12:27-06:00
 File Creation Date/Time : 2020:10:28 12:12:27-06:00

File Permissions	:	rw-rw-rw-
File Type	:	JPEG
File Type Extension	:	jpg
MIME Type	:	image/jpeg
Exif Byte Order	:	Big-endian (Motorola, MM)
Make	:	Apple
Camera Model Name	:	iPhone 7
Orientation	:	Rotate 90 CW
X Resolution	:	72
Y Resolution	:	72
Resolution Unit	:	inches
Software	:	13.6.1
Modify Date	:	2020:09:02 12:03:06
Y Cb Cr Positioning	:	Centered
Exposure Time	:	1/15
F Number	:	1.8
Exposure Program	:	Program AE
ISO	:	50
Exif Version	:	0231
Date/Time Original	:	2020:09:02 12:03:06
Create Date	:	2020:09:02 12:03:06
Offset Time	:	-06:00
Offset Time Original	:	-06:00
Offset Time Digitized	:	-06:00
Components Configuration	:	Y, Cb, Cr, -
Shutter Speed Value	:	1/15
Aperture Value	:	1.8
Brightness Value	:	2.345759291
Exposure Compensation	:	0
Metering Mode	:	Spot
Flash	:	Off, Did not fire
Focal Length	:	4.0 mm
Subject Area	:	2492 1127 753 756
Run Time Flags	:	Valid
Run Time Value	:	16651881270166
Run Time Scale	:	1000000000
Run Time Epoch	:	0
Acceleration Vector	:	0.002544809831 -1.000033379 -
0.002396658528	:	
Sub Sec Time Original	:	690
Sub Sec Time Digitized	:	690
Flashpix Version	:	0100
Color Space	:	Uncalibrated
Exif Image Width	:	4032
Exif Image Height	:	3024
Sensing Method	:	One-chip color area
Scene Type	:	Directly photographed
Exposure Mode	:	Auto
White Balance	:	Auto
Focal Length In 35mm Format	:	28 mm
Scene Capture Type	:	Standard
Lens Info	:	3.99000001mm f/1.8
Lens Make	:	Apple
Lens Model	:	iPhone 7 back camera 3.99mm f/1.8

GPS Latitude Ref : North
 GPS Longitude Ref : West
 GPS Altitude Ref : Above Sea Level
 GPS Speed Ref : km/h
 GPS Speed : 0.2993952632
 GPS Img Direction Ref : True North
 GPS Img Direction : 143.0973358
 GPS Dest Bearing Ref : True North
 GPS Dest Bearing : 143.0973358
 GPS Horizontal Positioning Error: 16.00241655 m
 Compression : JPEG (old-style)
 Thumbnail Offset : 2318
 Thumbnail Length : 2822
 Profile CMM Type : Apple Computer Inc.
 Profile Version : 4.0.0
 Profile Class : Display Device Profile
 Color Space Data : RGB
 Profile Connection Space : XYZ
 Profile Date Time : 2017:07:07 13:22:32
 Profile File Signature : acsp
 Primary Platform : Apple Computer Inc.
 CMM Flags : Not Embedded, Independent
 Device Manufacturer : Apple Computer Inc.
 Device Model :
 Device Attributes : Reflective, Glossy, Positive, Color
 Rendering Intent : Perceptual
 Connection Space Illuminant : 0.9642 1 0.82491
 Profile Creator : Apple Computer Inc.
 Profile ID : cala9582257f104d389913d5d1ea1582
 Profile Description : Display P3
 Profile Copyright : Copyright Apple Inc., 2017
 Media White Point : 0.95045 1 1.08905
 Red Matrix Column : 0.51512 0.2412 -0.00105
 Green Matrix Column : 0.29198 0.69225 0.04189
 Blue Matrix Column : 0.1571 0.06657 0.78407
 Red Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Chromatic Adaptation : 1.04788 0.02292 -0.0502 0.02959 0.99048
 -0.01706 -0.00923 0.01508 0.75168
 Blue Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Green Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
 Image Width : 4032
 Image Height : 3024
 Encoding Process : Baseline DCT, Huffman coding
 Bits Per Sample : 8
 Color Components : 3
 Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
 Run Time Since Power Up : 4:37:32
 Aperture : 1.8
 Image Size : 4032x3024
 Megapixels : 12.2
 Scale Factor To 35 mm Equivalent: 7.0

```

Shutter Speed           : 1/15
Create Date             : 2020:09:02 12:03:06.690-06:00
Date/Time Original      : 2020:09:02 12:03:06.690-06:00
Modify Date              : 2020:09:02 12:03:06-06:00
Thumbnail Image          : (Binary data 2822 bytes, use -b option
to extract)
GPS Altitude            : 1632.9 m Above Sea Level
GPS Latitude             : 39 deg 53' 5.14" N
GPS Longitude            : 105 deg 5' 38.85" W
Circle Of Confusion       : 0.004 mm
Field Of View             : 65.5 deg
Focal Length              : 4.0 mm (35 mm equivalent: 28.0 mm)
GPS Position              : 39 deg 53' 5.14" N, 105 deg 5' 38.85" W
Hyperfocal Distance        : 2.07 m
Light Value                : 6.6

```

Selfie Non-Destructive (E-mail)

```

ExifTool Version Number      : 11.65
File Name                   : IMG-3550-copy.jpg
Directory                   : .
File Size                   : 1056 kB
File Modification Date/Time : 2020:10:13 17:58:58-06:00
File Access Date/Time       : 2020:10:28 12:15:41-06:00
File Creation Date/Time     : 2020:10:13 18:04:55-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 7
Orientation                  : Rotate 90 CW
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 13.6.1
Modify Date                  : 2020:09:02 12:06:32
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/15
F Number                      : 2.2
Exposure Program              : Program AE
ISO                           : 800
Exif Version                  : 0231
Date/Time Original            : 2020:09:02 12:06:32
Create Date                   : 2020:09:02 12:06:32
Offset Time                   : -06:00
Offset Time Original          : -06:00
Offset Time Digitized        : -06:00
Components Configuration       : Y, Cb, Cr, -

```

Shutter Speed Value : 1/15
Aperture Value : 2.2
Brightness Value : -1.557083014
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : Off, Did not fire
Focal Length : 2.9 mm
Run Time Flags : Valid
Run Time Value : 16850667791500
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : 0.02551322617 -0.7974678272 0.5913489462
Sub Sec Time Original : 812
Sub Sec Time Digitized : 812
Flashpix Version : 0100
Color Space : Uncalibrated
Exif Image Width : 3088
Exif Image Height : 2320
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 32 mm
Scene Capture Type : Standard
Lens Info : 2.869999885mm f/2.2
Lens Make : Apple
Lens Model : iPhone 7 front camera 2.87mm f/2.2
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Speed Ref : km/h
GPS Speed : 0.5989133119
GPS Img Direction Ref : True North
GPS Img Direction : 191.0187521
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 11.01875209
GPS Horizontal Positioning Error: 48 m
Compression : JPEG (old-style)
Thumbnail Offset : 2236
Thumbnail Length : 9763
Profile CMM Type : Apple Computer Inc.
Profile Version : 4.0.0
Profile Class : Display Device Profile
Color Space Data : RGB
Profile Connection Space : XYZ
Profile Date Time : 2017:07:07 13:22:32
Profile File Signature : acsp
Primary Platform : Apple Computer Inc.
CMM Flags : Not Embedded, Independent
Device Manufacturer : Apple Computer Inc.
Device Model :
Device Attributes : Reflective, Glossy, Positive, Color
Rendering Intent : Perceptual
Connection Space Illuminant : 0.9642 1 0.82491

```

Profile Creator : Apple Computer Inc.
Profile ID : cala9582257f104d389913d5d1ea1582
Profile Description : Display P3
Profile Copyright : Copyright Apple Inc., 2017
Media White Point : 0.95045 1 1.08905
Red Matrix Column : 0.51512 0.2412 -0.00105
Green Matrix Column : 0.29198 0.69225 0.04189
Blue Matrix Column : 0.1571 0.06657 0.78407
Red Tone Reproduction Curve : (Binary data 32 bytes, use -b option to
extract)
Chromatic Adaptation : 1.04788 0.02292 -0.0502 0.02959 0.99048
-0.01706 -0.00923 0.01508 0.75168
Blue Tone Reproduction Curve : (Binary data 32 bytes, use -b option to
extract)
Green Tone Reproduction Curve : (Binary data 32 bytes, use -b option to
extract)
Image Width : 3088
Image Height : 2320
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 4:40:51
Aperture : 2.2
Image Size : 3088x2320
Megapixels : 7.2
Scale Factor To 35 mm Equivalent: 11.1
Shutter Speed : 1/15
Create Date : 2020:09:02 12:06:32.812-06:00
Date/Time Original : 2020:09:02 12:06:32.812-06:00
Modify Date : 2020:09:02 12:06:32-06:00
Thumbnail Image : (Binary data 9763 bytes, use -b option
to extract)
GPS Altitude : 1471.4 m Above Sea Level
GPS Latitude : 39 deg 53' 5.12" N
GPS Longitude : 105 deg 5' 39.75" W
Circle Of Confusion : 0.003 mm
Field Of View : 58.7 deg
Focal Length : 2.9 mm (35 mm equivalent: 32.0 mm)
GPS Position : 39 deg 53' 5.12" N, 105 deg 5' 39.75" W
Hyperfocal Distance : 1.39 m
Light Value : 3.2

```

Selfie Destructive (E-mail)

```
ExifTool Version Number      : 11.65
File Name                  : IMG-3550-email-copy.jpg
Directory                  : .
File Size                   : 1056 kB
File Modification Date/Time : 2020:10:22 15:14:57-06:00
File Access Date/Time       : 2020:10:28 12:17:18-06:00
File Creation Date/Time     : 2020:10:28 12:17:18-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                  : image/jpeg
Exif Byte Order             : Big-endian (Motorola, MM)
Make                        : Apple
Camera Model Name          : iPhone 7
Orientation                 : Rotate 90 CW
X Resolution                : 72
Y Resolution                : 72
Resolution Unit             : inches
Software                     : 13.6.1
Modify Date                 : 2020:09:02 12:06:32
Y Cb Cr Positioning        : Centered
Exposure Time               : 1/15
F Number                     : 2.2
Exposure Program            : Program AE
ISO                          : 800
Exif Version                : 0231
Date/Time Original          : 2020:09:02 12:06:32
Create Date                 : 2020:09:02 12:06:32
Offset Time                 : -06:00
Offset Time Original         : -06:00
Offset Time Digitized       : -06:00
Components Configuration    : Y, Cb, Cr, -
Shutter Speed Value          : 1/15
Aperture Value              : 2.2
Brightness Value             : -1.557083014
Exposure Compensation        : 0
Metering Mode               : Multi-segment
Flash                        : Off, Did not fire
Focal Length                 : 2.9 mm
Run Time Flags               : Valid
Run Time Value               : 16850667791500
Run Time Scale               : 1000000000
Run Time Epoch                : 0
Acceleration Vector          : 0.02551322617 -0.7974678272 0.5913489462
Sub Sec Time Original        : 812
Sub Sec Time Digitized       : 812
Flashpix Version             : 0100
Color Space                  : Uncalibrated
Exif Image Width             : 3088
```

```

Exif Image Height          : 2320
Sensing Method            : One-chip color area
Scene Type                : Directly photographed
Exposure Mode             : Auto
White Balance              : Auto
Focal Length In 35mm Format: 32 mm
Scene Capture Type        : Standard
Lens Info                 : 2.869999885mm f/2.2
Lens Make                 : Apple
Lens Model                : iPhone 7 front camera 2.87mm f/2.2
GPS Latitude Ref          : North
GPS Longitude Ref         : West
GPS Altitude Ref          : Above Sea Level
GPS Speed Ref              : km/h
GPS Speed                 : 0.5989133119
GPS Img Direction Ref     : True North
GPS Img Direction          : 191.0187521
GPS Dest Bearing Ref      : True North
GPS Dest Bearing           : 11.01875209
GPS Horizontal Positioning Error: 48 m
Compression               : JPEG (old-style)
Thumbnail Offset           : 2236
Thumbnail Length           : 9763
Profile CMM Type          : Apple Computer Inc.
Profile Version            : 4.0.0
Profile Class              : Display Device Profile
Color Space Data           : RGB
Profile Connection Space   : XYZ
Profile Date Time          : 2017:07:07 13:22:32
Profile File Signature     : acsp
Primary Platform            : Apple Computer Inc.
CMM Flags                  : Not Embedded, Independent
Device Manufacturer        : Apple Computer Inc.
Device Model               :
Device Attributes          : Reflective, Glossy, Positive, Color
Rendering Intent            : Perceptual
Connection Space Illuminant: 0.9642 1 0.82491
Profile Creator             : Apple Computer Inc.
Profile ID                 : cala9582257f104d389913d5d1ea1582
Profile Description         : Display P3
Profile Copyright           : Copyright Apple Inc., 2017
Media White Point           : 0.95045 1 1.08905
Red Matrix Column           : 0.51512 0.2412 -0.00105
Green Matrix Column          : 0.29198 0.69225 0.04189
Blue Matrix Column          : 0.1571 0.06657 0.78407
Red Tone Reproduction Curve: (Binary data 32 bytes, use -b option to extract)
Chromatic Adaptation       : 1.04788 0.02292 -0.0502 0.02959 0.99048
-0.01706 -0.00923 0.01508 0.75168
Blue Tone Reproduction Curve: (Binary data 32 bytes, use -b option to extract)
Green Tone Reproduction Curve: (Binary data 32 bytes, use -b option to extract)
Image Width                 : 3088

```

Image Height : 2320
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 4:40:51
Aperture : 2.2
Image Size : 3088x2320
Megapixels : 7.2
Scale Factor To 35 mm Equivalent: 11.1
Shutter Speed : 1/15
Create Date : 2020:09:02 12:06:32.812-06:00
Date/Time Original : 2020:09:02 12:06:32.812-06:00
Modify Date : 2020:09:02 12:06:32-06:00
Thumbnail Image : (Binary data 9763 bytes, use -b option
to extract)
GPS Altitude : 1471.4 m Above Sea Level
GPS Latitude : 39 deg 53' 5.12" N
GPS Longitude : 105 deg 5' 39.75" W
Circle Of Confusion : 0.003 mm
Field Of View : 58.7 deg
Focal Length : 2.9 mm (35 mm equivalent: 32.0 mm)
GPS Position : 39 deg 53' 5.12" N, 105 deg 5' 39.75" W
Hyperfocal Distance : 1.39 m
Light Value : 3.2

FILE STRUCTURES

White Wall Non-Destructive (Google Drive)

File: IMG-3534-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 304 -> Apple
Offset: 78E -> Apple
Offset: 794 -> iPhone
Offset: 79D -> back camera
Offset: 90E -> FFD8 = JPEG Start [90F]
Offset: 910 -> FFDB = Quantization Table
Offset: 99C -> FFC0 = Baseline DCT
Offset: 9AF -> FFC4 = Huffman Table
Offset: B53 -> FFDA = Start of Scan (SOS)
Offset: 1412 -> FFD9 = JPEG End [1413]
Offset: 159E -> Apple
Offset: 194A -> FFDB = Quantization Table
Offset: 19D6 -> FFC0 = Baseline DCT
Offset: 19E9 -> FFC4 = Huffman Table
Offset: 1B8D -> FFDA = Start of Scan (SOS)
Offset: 1686EF -> FFD9 = JPEG End [1686F0]

White Wall Destructive (E-mail)

File: IMG-3534_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 304 -> Apple
Offset: 78E -> Apple
Offset: 794 -> iPhone
Offset: 79D -> back camera
Offset: 90E -> FFD8 = JPEG Start [90F]
Offset: 910 -> FFDB = Quantization Table
Offset: 99C -> FFC0 = Baseline DCT
Offset: 9AF -> FFC4 = Huffman Table
Offset: B53 -> FFDA = Start of Scan (SOS)
Offset: 1412 -> FFD9 = JPEG End [1413]
Offset: 159E -> Apple
Offset: 194A -> FFDB = Quantization Table
Offset: 19D6 -> FFC0 = Baseline DCT
Offset: 19E9 -> FFC4 = Huffman Table
Offset: 1B8D -> FFDA = Start of Scan (SOS)
Offset: 1686EF -> FFD9 = JPEG End [1686F0]

Selfie Non-Destructive (Google Drive)

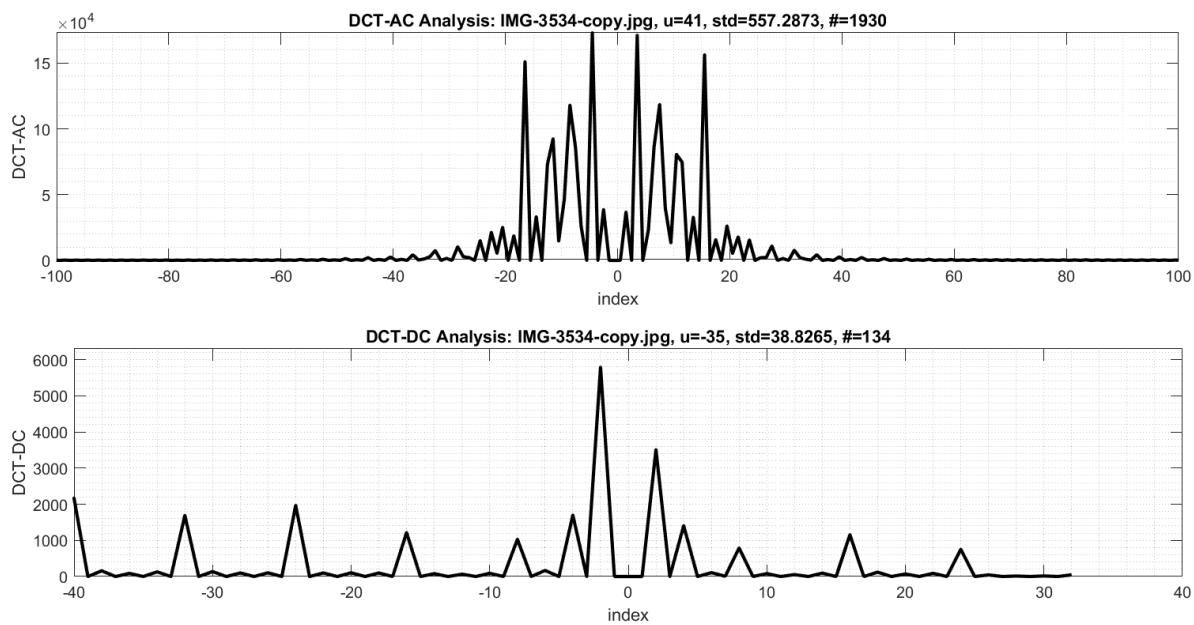
File: IMG-3550-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 2F0 -> Apple
Offset: 73A -> Apple
Offset: 740 -> iPhone
Offset: 8BC -> FFD8 = JPEG Start [8BD]
Offset: 8BE -> FFDB = Quantization Table
Offset: 94A -> FFC0 = Baseline DCT
Offset: 95D -> FFC4 = Huffman Table
Offset: B01 -> FFDA = Start of Scan (SOS)
Offset: 2EDD -> FFD9 = JPEG End [2EDE]
Offset: 3069 -> Apple
Offset: 3365 -> FFDB = Quantization Table
Offset: 33F1 -> FFC0 = Baseline DCT
Offset: 3404 -> FFC4 = Huffman Table
Offset: 35A8 -> FFDA = Start of Scan (SOS)
Offset: 10801B -> FFD9 = JPEG End [10801C]

Selfie Destructive (E-mail)

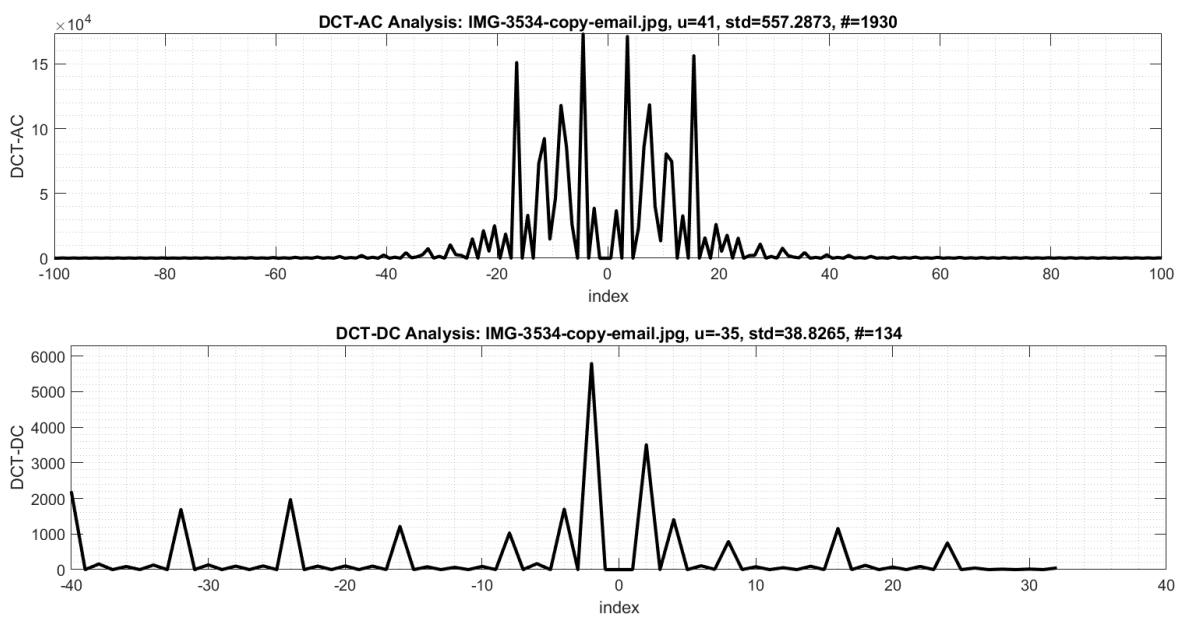
File: IMG-3550_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 2F0 -> Apple
Offset: 73A -> Apple
Offset: 740 -> iPhone
Offset: 8BC -> FFD8 = JPEG Start [8BD]
Offset: 8BE -> FFDB = Quantization Table
Offset: 94A -> FFC0 = Baseline DCT
Offset: 95D -> FFC4 = Huffman Table
Offset: B01 -> FFDA = Start of Scan (SOS)
Offset: 2EDD -> FFD9 = JPEG End [2EDE]
Offset: 3069 -> Apple
Offset: 3365 -> FFDB = Quantization Table
Offset: 33F1 -> FFC0 = Baseline DCT
Offset: 3404 -> FFC4 = Huffman Table
Offset: 35A8 -> FFDA = Start of Scan (SOS)
Offset: 10801B -> FFD9 = JPEG End [10801C]

DCT COMPRESSION HISTOGRAMS

White Wall Non-Destructive (Google Drive)



White Wall Destructive (E-mail)



APPENDIX I

RAW DATA FROM IPHONE 8

Note – No data available for Non-destructive images Google Drive (HEIC files)

EXIF DATA

White Wall Destructive (E-mail)

```
ExifTool Version Number      : 11.65
File Name                   : IMG-1918-copy-email.jpg
Directory                   : .
File Size                   : 1274 kB
File Modification Date/Time : 2020:10:22 15:15:17-06:00
File Access Date/Time       : 2020:10:29 15:35:17-06:00
File Creation Date/Time    : 2020:10:29 15:35:17-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
Exif Byte Order              : Big-endian (Motorola, MM)
Make                         : Apple
Camera Model Name           : iPhone 8
Orientation                  : Rotate 90 CW
X Resolution                 : 72
Y Resolution                 : 72
Resolution Unit              : inches
Software                     : 13.5.1
Modify Date                  : 2020:08:22 17:46:21
Y Cb Cr Positioning         : Centered
Exposure Time                : 1/24
F Number                      : 1.8
Exposure Program             : Program AE
ISO                          : 40
Exif Version                 : 0231
Date/Time Original           : 2020:08:22 17:46:21
Create Date                   : 2020:08:22 17:46:21
Offset Time                   : -06:00
Offset Time Original          : -06:00
Offset Time Digitized        : -06:00
Components Configuration     : Y, Cb, Cr, -
Shutter Speed Value           : 1/24
```

Aperture Value : 1.8
Brightness Value : 3.084159839
Exposure Compensation : 0
Metering Mode : Multi-segment
Flash : Auto, Did not fire
Focal Length : 4.0 mm
Subject Area : 2015 1511 2217 1330
Run Time Flags : Valid
Run Time Value : 77392717559375
Run Time Scale : 1000000000
Run Time Epoch : 0
Acceleration Vector : 0.001934705186 -1.000737429 -0.05722175169
Sub Sec Time Original : 659
Sub Sec Time Digitized : 659
Flashpix Version : 0100
Color Space : Uncalibrated
Exif Image Width : 4032
Exif Image Height : 3024
Sensing Method : One-chip color area
Scene Type : Directly photographed
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 28 mm
Scene Capture Type : Standard
Lens Info : 3.99000001mm f/1.8
Lens Make : Apple
Lens Model : iPhone 8 back camera 3.99mm f/1.8
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Speed Ref : km/h
GPS Speed : 0
GPS Img Direction Ref : True North
GPS Img Direction : 205.9738465
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 205.9738465
GPS Horizontal Positioning Error : 5 m
Compression : JPEG (old-style)
Thumbnail Offset : 2338
Thumbnail Length : 2009
Profile CMM Type : Apple Computer Inc.
Profile Version : 4.0.0
Profile Class : Display Device Profile
Color Space Data : RGB
Profile Connection Space : XYZ
Profile Date Time : 2017:07:07 13:22:32
Profile File Signature : acsp
Primary Platform : Apple Computer Inc.
CMM Flags : Not Embedded, Independent
Device Manufacturer : Apple Computer Inc.
Device Model :
Device Attributes : Reflective, Glossy, Positive, Color
Rendering Intent : Perceptual

Connection Space Illuminant : 0.9642 1 0.82491
Profile Creator : Apple Computer Inc.
Profile ID : cala9582257f104d389913d5d1ea1582
Profile Description : Display P3
Profile Copyright : Copyright Apple Inc., 2017
Media White Point : 0.95045 1 1.08905
Red Matrix Column : 0.51512 0.2412 -0.00105
Green Matrix Column : 0.29198 0.69225 0.04189
Blue Matrix Column : 0.1571 0.06657 0.78407
Red Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
Chromatic Adaptation : 1.04788 0.02292 -0.0502 0.02959 0.99048
-0.01706 -0.00923 0.01508 0.75168
Blue Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
Green Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
Image Width : 4032
Image Height : 3024
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 21:29:53
Aperture : 1.8
Image Size : 4032x3024
Megapixels : 12.2
Scale Factor To 35 mm Equivalent: 7.0
Shutter Speed : 1/24
Create Date : 2020:08:22 17:46:21.659-06:00
Date/Time Original : 2020:08:22 17:46:21.659-06:00
Modify Date : 2020:08:22 17:46:21-06:00
Thumbnail Image : (Binary data 2009 bytes, use -b option to extract)
GPS Altitude : 928.6 m Above Sea Level
GPS Latitude : 48 deg 13' 28.66" N
GPS Longitude : 114 deg 19' 45.86" W
Circle Of Confusion : 0.004 mm
Field Of View : 65.5 deg
Focal Length : 4.0 mm (35 mm equivalent: 28.0 mm)
GPS Position : 48 deg 13' 28.66" N, 114 deg 19' 45.86" W
Hyperfocal Distance : 2.07 m
Light Value : 7.6

Selfie Destructive

```
ExifTool Version Number          : 11.65
File Name                       : IMG-1925-email-copy.jpg
Directory                        : .
File Size                        : 1302 kB
File Modification Date/Time     : 2020:10:22 15:15:29-06:00
File Access Date/Time           : 2020:10:29 15:32:52-06:00
File Creation Date/Time         : 2020:10:29 15:32:52-06:00
File Permissions                 : rw-rw-rw-
File Type                        : JPEG
File Type Extension             : jpg
MIME Type                        : image/jpeg
Exif Byte Order                  : Big-endian (Motorola, MM)
Make                             : Apple
Camera Model Name                : iPhone 8
Orientation                       : Rotate 90 CW
X Resolution                      : 72
Y Resolution                      : 72
Resolution Unit                  : inches
Software                          : 13.5.1
Modify Date                      : 2020:08:22 17:51:17
Y Cb Cr Positioning             : Centered
Exposure Time                    : 1/120
F Number                          : 2.2
Exposure Program                 : Program AE
ISO                              : 125
Exif Version                     : 0231
Date/Time Original               : 2020:08:22 17:51:17
Create Date                       : 2020:08:22 17:51:17
Offset Time                       : -06:00
Offset Time Original              : -06:00
Offset Time Digitized            : -06:00
Components Configuration          : Y, Cb, Cr, -
Shutter Speed Value              : 1/120
Aperture Value                   : 2.2
Brightness Value                 : 4.29459851
Exposure Compensation            : 0
Metering Mode                     : Spot
Flash                            : Auto, Did not fire
Focal Length                      : 2.9 mm
Run Time Flags                   : Valid
Run Time Value                   : 77679577900458
Run Time Scale                   : 1000000000
Run Time Epoch                   : 0
Acceleration Vector              : -0.0614958927 -0.9955891362
0.04607308286
HDR Image Type                   : Unknown (2)
Sub Sec Time Original            : 104
Sub Sec Time Digitized          : 104
Flashpix Version                 : 0100
```

```

Color Space : Uncalibrated
Exif Image Width : 3088
Exif Image Height : 2320
Sensing Method : One-chip color area
Scene Type : Directly photographed
Custom Rendered : HDR (no original saved)
Exposure Mode : Auto
White Balance : Auto
Focal Length In 35mm Format : 32 mm
Scene Capture Type : Standard
Lens Info : 2.869999885mm f/2.2
Lens Make : Apple
Lens Model : iPhone 8 front camera 2.87mm f/2.2
GPS Latitude Ref : North
GPS Longitude Ref : West
GPS Altitude Ref : Above Sea Level
GPS Speed Ref : km/h
GPS Speed : 0
GPS Img Direction Ref : True North
GPS Img Direction : 199.9733506
GPS Dest Bearing Ref : True North
GPS Dest Bearing : 19.97335053
GPS Horizontal Positioning Error: 5 m
Compression : JPEG (old-style)
Thumbnail Offset : 2280
Thumbnail Length : 9992
Profile CMM Type : Apple Computer Inc.
Profile Version : 4.0.0
Profile Class : Display Device Profile
Color Space Data : RGB
Profile Connection Space : XYZ
Profile Date Time : 2017:07:07 13:22:32
Profile File Signature : acsp
Primary Platform : Apple Computer Inc.
CMM Flags : Not Embedded, Independent
Device Manufacturer : Apple Computer Inc.
Device Model :
Device Attributes : Reflective, Glossy, Positive, Color
Rendering Intent : Perceptual
Connection Space Illuminant : 0.9642 1 0.82491
Profile Creator : Apple Computer Inc.
Profile ID : cala9582257f104d389913d5d1ea1582
Profile Description : Display P3
Profile Copyright : Copyright Apple Inc., 2017
Media White Point : 0.95045 1 1.08905
Red Matrix Column : 0.51512 0.2412 -0.00105
Green Matrix Column : 0.29198 0.69225 0.04189
Blue Matrix Column : 0.1571 0.06657 0.78407
Red Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
Chromatic Adaptation : 1.04788 0.02292 -0.0502 0.02959 0.99048
-0.01706 -0.00923 0.01508 0.75168
Blue Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)

```

Green Tone Reproduction Curve : (Binary data 32 bytes, use -b option to extract)
Image Width : 3088
Image Height : 2320
Encoding Process : Baseline DCT, Huffman coding
Bits Per Sample : 8
Color Components : 3
Y Cb Cr Sub Sampling : YCbCr4:2:0 (2 2)
Run Time Since Power Up : 21:34:40
Aperture : 2.2
Image Size : 3088x2320
Megapixels : 7.2
Scale Factor To 35 mm Equivalent: 11.1
Shutter Speed : 1/120
Create Date : 2020:08:22 17:51:17.104-06:00
Date/Time Original : 2020:08:22 17:51:17.104-06:00
Modify Date : 2020:08:22 17:51:17-06:00
Thumbnail Image : (Binary data 9992 bytes, use -b option to extract)
GPS Altitude : 928.5 m Above Sea Level
GPS Latitude : 48 deg 13' 28.65" N
GPS Longitude : 114 deg 19' 45.64" W
Circle Of Confusion : 0.003 mm
Field Of View : 58.7 deg
Focal Length : 2.9 mm (35 mm equivalent: 32.0 mm)
GPS Position : 48 deg 13' 28.65" N, 114 deg 19' 45.64" W
Hyperfocal Distance : 1.39 m
Light Value : 8.9

FILE STRUCTURES

White Wall Destructive (Email)

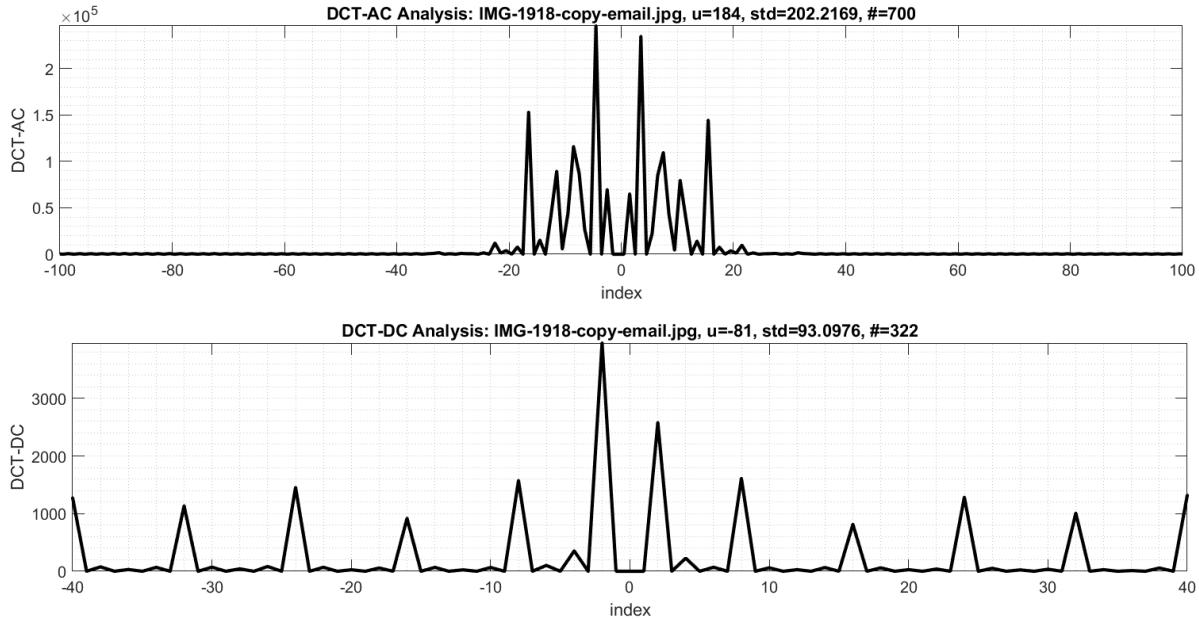
File: IMG-1918_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 304 -> Apple
Offset: 7A2 -> Apple
Offset: 7A8 -> iPhone
Offset: 7B1 -> back camera
Offset: 922 -> FFD8 = JPEG Start [923]
Offset: 924 -> FFDB = Quantization Table
Offset: 9B0 -> FFC0 = Baseline DCT
Offset: 9C3 -> FFC4 = Huffman Table
Offset: B67 -> FFDA = Start of Scan (SOS)
Offset: 10F9 -> FFD9 = JPEG End [10FA]
Offset: 1285 -> Apple
Offset: 1631 -> FFDB = Quantization Table
Offset: 16BD -> FFC0 = Baseline DCT
Offset: 16D0 -> FFC4 = Huffman Table
Offset: 1874 -> FFDA = Start of Scan (SOS)
Offset: 13E9EE -> FFD9 = JPEG End [13E9EF]

Selfie Destructive (E-mail)

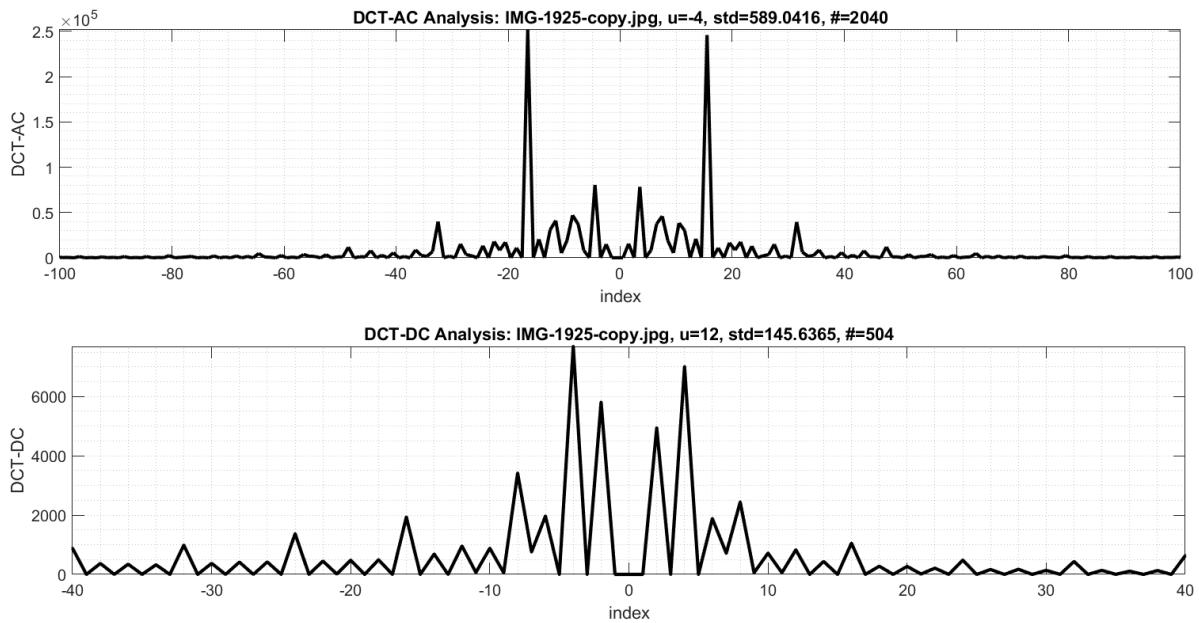
File: IMG-1925_email-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 2 -> FFE1 = APP
Offset: 6 -> Exif
Offset: 9E -> Apple
Offset: A4 -> iPhone
Offset: 2FC -> Apple
Offset: 766 -> Apple
Offset: 76C -> iPhone
Offset: 8E8 -> FFD8 = JPEG Start [8E9]
Offset: 8EA -> FFDB = Quantization Table
Offset: 976 -> FFC0 = Baseline DCT
Offset: 989 -> FFC4 = Huffman Table
Offset: B2D -> FFDA = Start of Scan (SOS)
Offset: 2FEE -> FFD9 = JPEG End [2FEF]
Offset: 317A -> Apple
Offset: 3476 -> FFDB = Quantization Table
Offset: 3502 -> FFC0 = Baseline DCT
Offset: 3515 -> FFC4 = Huffman Table
Offset: 36B9 -> FFDA = Start of Scan (SOS)
Offset: 145938 -> FFD9 = JPEG End [145939]

DCT COMPRESSION HISTOGRAMS

White Wall Destructive (E-mail)



Selfie Destructive (E-mail)



APPENDIX J

RAW DATA FROM IPHONE XR

Note – No data available for Non-Destructive Images AirDrop (HEIC Files)

EXIF DATA

White Wall Destructive (Facebook Messenger)

```
ExifTool Version Number      : 11.65
File Name                  : 118405288-2722970871311885-
5097772612966926109-n-copy.jpg
Directory                  : .
File Size                   : 9.2 kB
File Modification Date/Time : 2020:10:22 15:15:19-06:00
File Access Date/Time       : 2020:10:29 16:09:03-06:00
File Creation Date/Time     : 2020:10:29 16:09:03-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                  : image/jpeg
JFIF Version               : 1.02
Resolution Unit             : None
X Resolution                : 1
Y Resolution                : 1
Current IPTC Digest        : 95d48c1844d7e2503e2e4e639f3eeef03
Special Instructions         :
FBMD01000a80010000d80a0000330b0000550b00007b0b0000b00b0000380c000057120000
b51200003f130000b2240000
Image Width                 : 828
Image Height                : 621
Encoding Process            : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components             : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                   : 828x621
Megapixels                  : 0.514
```

Selfie Destructive (Facebook Messenger)

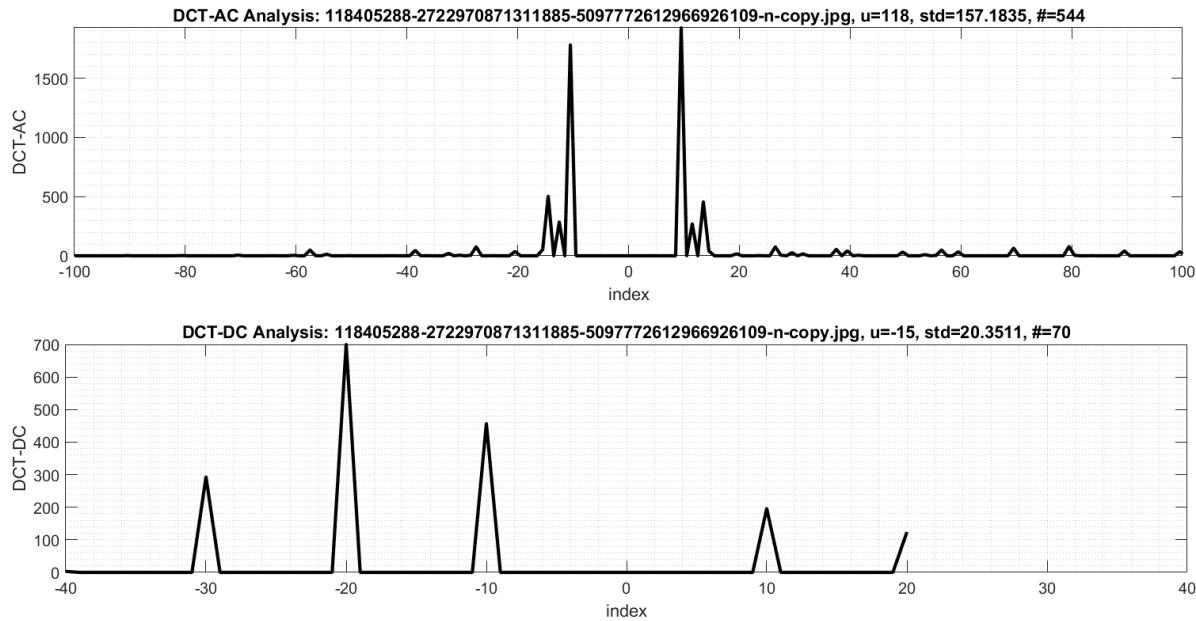
```
ExifTool Version Number      : 11.65
File Name                   : 118401899-680854952514444-
3292131666374840539-n-copy.jpg
Directory                   : .
File Size                   : 83 kB
File Modification Date/Time : 2020:10:22 15:15:32-06:00
File Access Date/Time       : 2020:10:29 16:10:56-06:00
File Creation Date/Time    : 2020:10:29 16:10:56-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
JFIF Version                : 1.02
Resolution Unit              : None
X Resolution                 : 1
Y Resolution                 : 1
Current IPTC Digest        : dd62cf3231aedd47bcd41c4ceb522a77
Special Instructions          :
FBMD01000a8a010000a5260000af4e0000d751000062560000896e0000ceb200008fb0000
59c400008dcc0000104a0100
Image Width                  : 828
Image Height                 : 1104
Encoding Process             : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components              : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                   : 828x1104
Megapixels                   : 0.914
```

FILE STRUCTURES

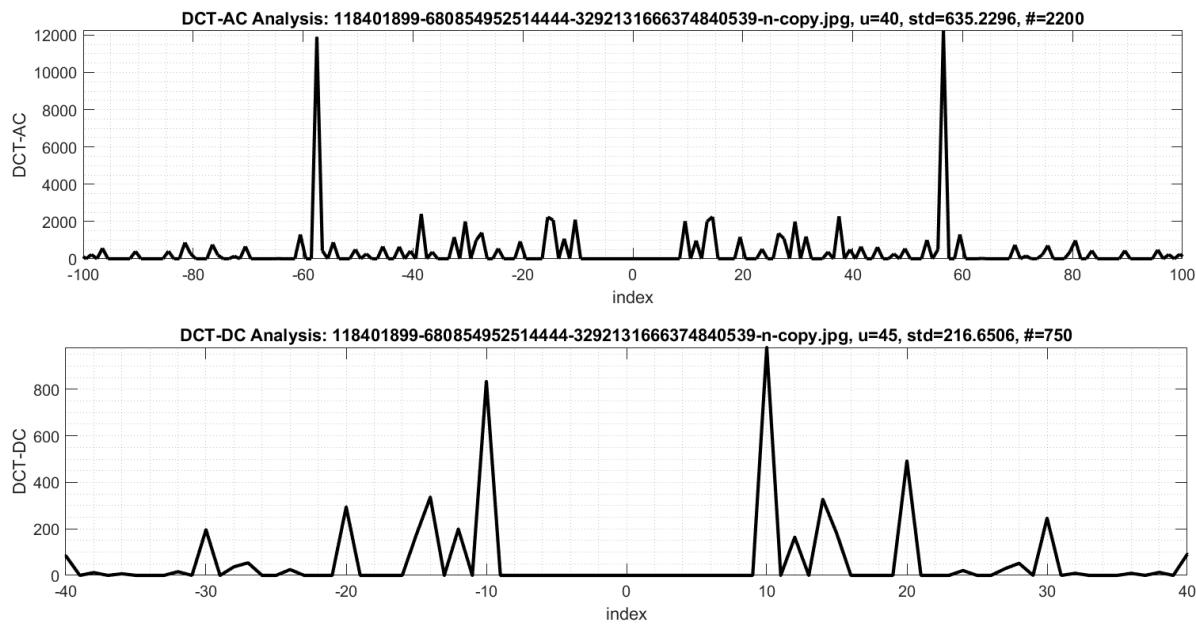
White Wall Destructive (Facebook Msg.)	Selfie Destructive (Facebook Msg.)
File: 118405288-2722970871311885-50 97772612966926109-n-copy.jpg	File: 118401899-680854952514444 -3292131666374840539-n-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]	Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 6 -> JFIF	Offset: 6 -> JFIF
Offset: 18 -> Photoshop	Offset: 18 -> Photoshop
Offset: 22 -> 3.0 8BIM	Offset: 22 -> 3.0 8BIM
Offset: 9A -> FFDB = Quantization Table	Offset: 9A -> FFDB = Quantization Table
Offset: DF -> FFDB = Quantization Table	Offset: DF -> FFDB = Quantization Table
Offset: 124 -> FFC2 = Progressive DCT	Offset: 124 -> FFC2 = Progressive DCT
Offset: 137 -> FFC4 = Huffman Table	Offset: 137 -> FFC4 = Huffman Table
Offset: 150 -> FFC4 = Huffman Table	Offset: 154 -> FFC4 = Huffman Table
Offset: 168 -> FFC4 = Huffman Table	Offset: 16F -> FFC4 = Huffman Table
Offset: 180 -> FFDA = Start of Scan (SOS)	Offset: 18A -> FFDA = Start of Scan (SOS)
Offset: AB9 -> FFC4 = Huffman Table	Offset: 2675 -> FFC4 = Huffman Table
Offset: AD8 -> FFDA = Start of Scan (SOS)	Offset: 26A5 -> FFDA = Start of Scan (SOS)
Offset: B1D -> FFC4 = Huffman Table	Offset: 4E83 -> FFC4 = Huffman Table
Offset: B33 -> FFDA = Start of Scan (SOS)	Offset: 4EAF -> FFDA = Start of Scan (SOS)
Offset: B3F -> FFC4 = Huffman Table	Offset: 51AC -> FFC4 = Huffman Table
Offset: B55 -> FFDA = Start of Scan (SOS)	Offset: 51D7 -> FFDA = Start of Scan (SOS)
Offset: B61 -> FFC4 = Huffman Table	Offset: 5294 -> DxO
Offset: B7B -> FFDA = Start of Scan (SOS)	Offset: 5627 -> FFC4 = Huffman Table
Offset: B8E -> FFC4 = Huffman Table	Offset: 5662 -> FFDA = Start of Scan (SOS)
Offset: BB0 -> FFDA = Start of Scan (SOS)	Offset: 6E58 -> FFC4 = Huffman Table
Offset: C38 -> FFDA = Start of Scan (SOS)	Offset: 6E89 -> FFDA = Start of Scan (SOS)
Offset: 1238 -> FFC4 = Huffman Table	Offset: B2CE -> FFDA = Start of Scan (SOS)
Offset: 1257 -> FFDA = Start of Scan (SOS)	Offset: BD6C -> FFC4 = Huffman Table
Offset: 1295 -> FFC4 = Huffman Table	Offset: BD8F -> FFDA = Start of Scan (SOS)
Offset: 12B5 -> FFDA = Start of Scan (SOS)	Offset: C433 -> FFC4 = Huffman Table
Offset: 1315 -> FFC4 = Huffman Table	Offset: C459 -> FFDA = Start of Scan (SOS)
Offset: 133F -> FFDA = Start of Scan (SOS)	Offset: CC60 -> FFC4 = Huffman Table
Offset: 24B0 -> FFD9 = JPEG End [24B1]	Offset: CC8D -> FFDA = Start of Scan (SOS)
	Offset: 14A0E -> FFD9 = JPEG End [14A0F]

DCT COMPRESSION HISTOGRAMS

White Wall Destructive (Facebook Messenger)



Selfie Destructive (Facebook Messenger)



APPENDIX K

RAW DATA FROM IPHONE 11 PRO

Note – No data available for Non-Destructive images AirDrop (HEIC files)

EXIF DATA

White Wall Destructive (Facebook Messenger)

```
ExifTool Version Number      : 11.65
File Name                  : 118600992-336035517579913-
2432185787447823780-n-copy.jpg
Directory                  : .
File Size                   : 49 kB
File Modification Date/Time : 2020:10:22 15:15:33-06:00
File Access Date/Time       : 2020:10:29 16:28:01-06:00
File Creation Date/Time    : 2020:10:29 16:28:01-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                  : image/jpeg
JFIF Version               : 1.02
Resolution Unit             : None
X Resolution                : 1
Y Resolution                : 1
Current IPTC Digest        : a7cc91e3c00940b009d9b7a37f7b860f
Special Instructions         :
FBMD01000a82010000461400008f170000b3170000e417000082180000393800006e430000
90430000c643000084c50000
Image Width                 : 1125
Image Height                : 844
Encoding Process            : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components             : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                  : 1125x844
Megapixels                  : 0.950
```

Selfie Destructive (Facebook Messenger)

```
ExifTool Version Number      : 11.65
File Name                   : 118309754-1716704271813773-
402271669008361732-n-copy.jpg
Directory                   : .
File Size                   : 97 kB
File Modification Date/Time : 2020:10:22 15:15:40-06:00
File Access Date/Time       : 2020:10:29 16:29:32-06:00
File Creation Date/Time    : 2020:10:29 16:29:32-06:00
File Permissions            : rw-rw-rw-
File Type                   : JPEG
File Type Extension         : jpg
MIME Type                   : image/jpeg
JFIF Version                : 1.02
Resolution Unit             : None
X Resolution                : 1
Y Resolution                : 1
Current IPTC Digest        : 51a2057fe945ac5d0c74faa9303d96af
Special Instructions          :
FBMD01000a8c010000093d0000c86600000a6a0000ff6d0000b67f0000e0c40000b2d80000
c1de0000b6e50000d4830100
Image Width                 : 1125
Image Height                : 1500
Encoding Process            : Progressive DCT, Huffman coding
Bits Per Sample              : 8
Color Components             : 3
Y Cb Cr Sub Sampling        : YCbCr4:2:0 (2 2)
Image Size                   : 1125x1500
Megapixels                  : 1.7
```

FILE STRUCTURES

White Wall Destructive (Facebook Msg.)

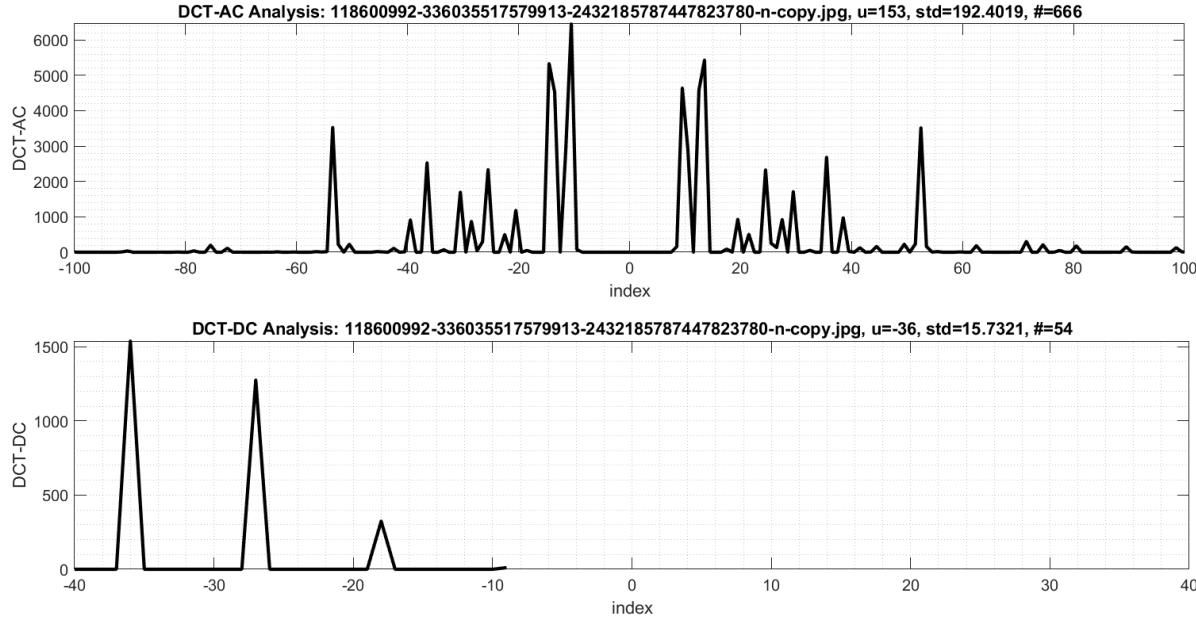
File: 118600992-336035517579913
-2432185787447823780-n-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 6 -> JFIF
Offset: 18 -> Photoshop
Offset: 22 -> 3.0 8BIM
Offset: 9A -> FFDB = Quantization Table
Offset: DF -> FFDB = Quantization Table
Offset: 124 -> FFC2 = Progressive DCT
Offset: 137 -> FFC4 = Huffman Table
Offset: 152 -> FFC4 = Huffman Table
Offset: 16A -> FFC4 = Huffman Table
Offset: 182 -> FFDA = Start of Scan (SOS)
Offset: 141F -> FFC4 = Huffman Table
Offset: 1446 -> FFDA = Start of Scan (SOS)
Offset: 1777 -> FFC4 = Huffman Table
Offset: 178F -> FFDA = Start of Scan (SOS)
Offset: 179D -> FFC4 = Huffman Table
Offset: 17B3 -> FFDA = Start of Scan (SOS)
Offset: 17BF -> FFC4 = Huffman Table
Offset: 17E4 -> FFDA = Start of Scan (SOS)
Offset: 1856 -> FFC4 = Huffman Table
Offset: 1882 -> FFDA = Start of Scan (SOS)
Offset: 3839 -> FFDA = Start of Scan (SOS)
Offset: 4358 -> FFC4 = Huffman Table
Offset: 436E -> FFDA = Start of Scan (SOS)
Offset: 437A -> FFC4 = Huffman Table
Offset: 4390 -> FFDA = Start of Scan (SOS)
Offset: 439C -> FFC4 = Huffman Table
Offset: 43C6 -> FFDA = Start of Scan (SOS)
Offset: C582 -> FFD9 = JPEG End [C583]

Selfie Destructive (Facebook Msg.)

File: 118309754-171670427181377
3-402271669008361732-n-copy.jpg
Offset: 0 -> FFD8 = JPEG Start [1]
Offset: 6 -> JFIF
Offset: 18 -> Photoshop
Offset: 22 -> 3.0 8BIM
Offset: 9A -> FFDB = Quantization Table
Offset: DF -> FFDB = Quantization Table
Offset: 124 -> FFC2 = Progressive DCT
Offset: 137 -> FFC4 = Huffman Table
Offset: 154 -> FFC4 = Huffman Table
Offset: 170 -> FFC4 = Huffman Table
Offset: 18C -> FFDA = Start of Scan (SOS)
Offset: 3CD7 -> FFC4 = Huffman Table
Offset: 3D09 -> FFDA = Start of Scan (SOS)
Offset: 669A -> FFC4 = Huffman Table
Offset: 66C8 -> FFDA = Start of Scan (SOS)
Offset: 69DD -> FFC4 = Huffman Table
Offset: 6A0A -> FFDA = Start of Scan (SOS)
Offset: 6DC8 -> FFC4 = Huffman Table
Offset: 6DFF -> FFDA = Start of Scan (SOS)
Offset: 7F89 -> FFC4 = Huffman Table
Offset: 7FB6 -> FFDA = Start of Scan (SOS)
Offset: C4E0 -> FFDA = Start of Scan (SOS)
Offset: D88D -> FFC4 = Huffman Table
Offset: D8B2 -> FFDA = Start of Scan (SOS)
Offset: DE9B -> FFC4 = Huffman Table
Offset: DEC1 -> FFDA = Start of Scan (SOS)
Offset: E58B -> FFC4 = Huffman Table
Offset: E5B6 -> FFDA = Start of Scan (SOS)
Offset: 183D2 -> FFD9 = JPEG End [183D3]

DCT COMPRESSION HISTOGRAMS

White Wall Destructive (Facebook Messenger)



Selfie Destructive (Facebook Messenger)

