DETECTING CLONED REGIONS IN DIGITAL IMAGES

BEFORE AND AFTER FACEBOOK RECOMPRESSION

by

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Detecting Cloned Regions in Digital Images Before and After Facebook Recompression

Thesis directed by Associate Professor Catalin Grigoras

ABSTRACT

This day and age it is becoming increasingly difficult to know if you can trust the images that you see on your Facebook feed. The ease of use and availability of tools such as Adobe Photoshop make manipulating images a relatively straightforward and simple process. One such method of image manipulation is cloning pixels. Cloning pixels in an image is a method to both create copies of content within an image and/or remove content from an image. Forensic tools exist that can detect these cloned regions and can identify an image as having been manipulated in this way. This thesis investigates the effects that JPEG compression and Facebook recompression has on the ability to detect cloned regions in digital images.

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

Approved: Catalin Grigoras

DEDICATION

I dedicate this to family. I would like to thank my wife, Kelly, my sons, Charlie and Max, and my mom, Pam, for their love, support, and encouragement during my time working on my Masters in Media Forensics. Thanks to both of my parents Pam and Doug Lemon, who instilled in me my curious nature and passion for lifelong learning. I wish you were still here dad!

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DCT – Discrete Cosine Transform

ELA – Error Level Analysis

EXIF – Exchangeable Image File Format

FIAS – Forensic Image Analysis System

FN – False Negative

FP – False Positive

JPEG – Joint Photographic Experts Group

MCC – Matthews Correlation Coefficient

QT – Quantization Table

TN – True Negative

TP – True Positive

CHAPTER I

INTRODUCTION

One of the most prolific image formats to date is the JPEG image format. This is due mostly to the JPEG's ability to maintain decent image quality while simultaneously reducing the size of the file greatly. This is made possible by efficient and clever compression techniques that were created by the group behind JPEG, the Joint Photographic Experts Group, created in 1992. [1] JPEG compression works by taking advantage of how the human eye perceives changes in brightness and changes in color differently. "The human retina contains about 120 million brightness-sensitive rod cells, but only about 6 million color-sensitive cone cells." [2] This means that your eye is more sensitive to changes in brightness and less sensitive to changes in color. JPEG compression takes advantage of this by converting the image from an RGB space to a YCbCr space with the Y channel representing the brightness and the Cb and Cr channels together representing all the color. With the channels split like this, the color data can be more heavily compressed without much noticeable change, while compressing the brightness data to a lesser extent, resulting in an image that is smaller in file size but still retains much of the perceivable quality. Because of the smaller file sizes that are possible with JPEG, the format is an obvious choice for social media sites such as Facebook who have hundreds of millions of images that get uploaded to their site each day, all needing to be stored on their servers.

One method of image editing/manipulation is referred to as cloning or clone stamping. Clone stamping is the process of making a copy of existing pixels from one region in an image to another. This does not always have to be a malicious edit as it can simply be used to remove distracting elements from an otherwise nice-looking photo. There are two main ways to think about using cloning in an image, subtractive and additive. Using cloning in a subtractive method

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would be used to remove an object or region from an image such as removing a sign or other people from the background of an image. Additive cloning can be thought of as creating a copy of an object or region in an image, such as duplicating a tree or a duck to make it look like there were more than there actually were. Both additive and subtractive cloning are using the same basic idea, copying pixels from one part of an image to another, but they have different intentions behind them. For this research, a set of 100 images were captured and then manipulated using the Adobe Photoshop clone stamp tool to remove objects or copying objects as discussed above.

In the research presented here, two tools were used to do the clone detection, AMPED Authenticate Revision 23481, and Forensic Image Analysis System (FIAS) v.2022.02.15. In Amped Authenticate only the "Clone Blocks" filter was used for ease of comparison across both tools as FIAS also uses a block-based detection algorithm. As this research is not aimed at assessing which tool is better than the other, the tools will be referred to from here on only as Tool 1 and Tool 2 which have been randomly assigned to one of the above tools. Both Tool 1 and Tool 2 use different but similar methods for identifying cloned regions. As a surface level explanation of how clone detection works, the tools look for blocks of similar pixels throughout the image, which is uncommon to find in an unedited image. There will be a few examples showing where similar pixel regions do occur naturally in an image. Using clone detection alone there is no way for the tools to identify which region was the original and which region is the clone but finding hits in an image can be an indicator that the image in question is not a camera original image and needs to be investigated further by a forensic expert.

Previous Research

Pippin's thesis "Digital Image Recompression Analysis: Facebook" [3] investigates the changes that take place to a digital image when uploading it to Facebook. The changes they found came in the form of changes to the metadata, changes to the resolution of the images and changes to the file name of the images. Pippin also considered what kind of device was responsible for the uploading and downloading of the images and observed changes in the type of encoding based on the device that the images were downloaded on.

Marrion's thesis "Digital Image Manipulation Detection on Facebook Images" [4] examined the ability to detect image manipulations using Discrete Cosine Transform Map (DCT Map) and Error Level Analysis (ELA) after the images have been uploaded to and process by Facebook. Marrion used Content Aware and Clone tools in Adobe Photoshop to make edits to the images before uploading them to Facebook. They found that either uploading the images to Facebook or saving them out of Adobe Photoshop with a lower quality level, both hinder the ability to detect the manipulation using DCT and ELA.

CHAPTER II

MATERIALS AND METHODS

For this research 100 images were captured using a Google Pixel 6 Pro running Android 12 SQ1D.220205.004) using the pre-installed Google Camera App (version 8.4.400.423370569.19). As this dataset may be shared in the future, the GPS metadata including latitude, longitude, and altitude were removed. To emulate a low sophistication actor, this metadata removal was done using the built-in Windows file properties manager.
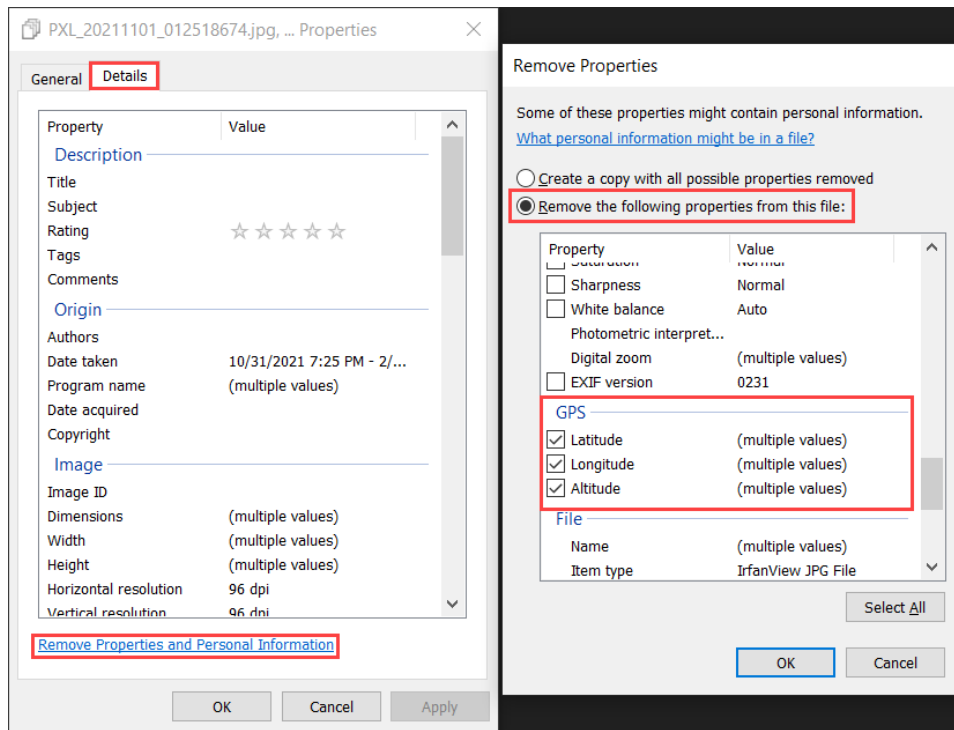
Figure 2.1 *Removing GPS Metadata*

Prior to performing any clone stamp edits, the images were resized by 50% with bilinear resampling using an Adobe Photoshop Action, saving out images as JPEG with level 12 quality. This was done to help with the efficiency of the clone detection at the end of the line.
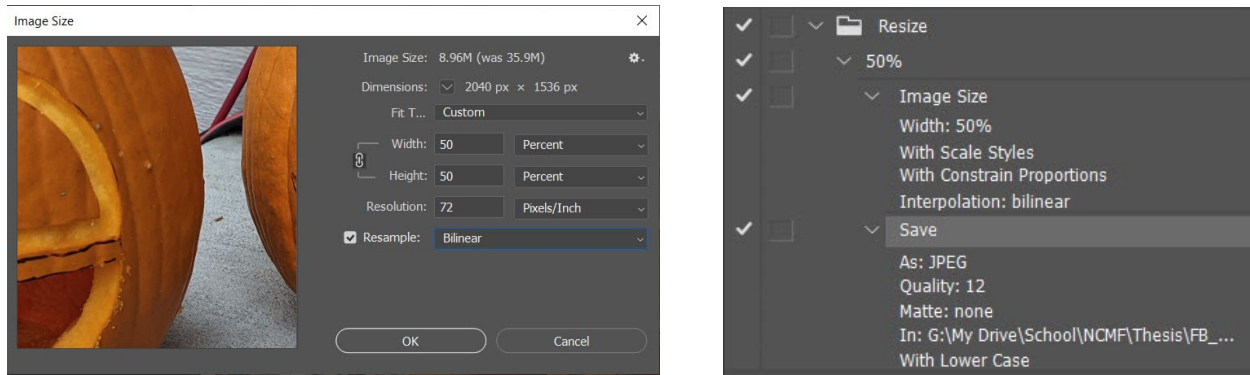
Figure 2.2 *50% Resize with Bilinear Resampling (left) and Photoshop Action Created for Batch Processing Entire Folder (right)*

Clone detection was run on the full-size images and compared to the 50% scaled images to see if the initial down scaling introduced any false positives. The scaling of the image did introduce some additional false positives, but also some were found on the originals and not on the 50% scaled images. This can be seen in the "Original" column in appendix A and appendix C. What is most important is the comparison between the different quality levels and the before and after Facebook comparisons.

All the clone stamping was done using Adobe Photoshop CC version 23.1 on an HP Z640 Workstation running Windows 10 21H2 19044.1526. It was originally considered to automatically clone a predetermined region in all images to another location in the image, but to try to emulate a "real world" scenario, all the images were manually cloned to try to hide or duplicate an object in the image. The only tool used was the Adobe Photoshop Clone Stamp tool with various brush hardness to help with blending in and making it harder for at least the human eye to spot the manipulation. To minimize variables, no rotation or scaling of the cloned region were performed. It is worth mentioning that in a real-life case, the manipulator would not be restricted to using only the clone stamp tool and could take further efforts to obfuscate the edits that they make.

Figure 2.3 *An Example Before and After of a Clone Stamp Manipulation. The Original Image (left) and the Manipulated Image (right) with Cloned Region Circled in Red.*

The un-manipulated images were exported from Adobe Photoshop as JPEG files at quality level 12, 6 and 0 (a higher number is better quality, less compressed) to serve as control cases for the various Photoshop compression levels when compared to the manipulated images at the same compression levels. The manipulated images were also exported from Adobe Photoshop as JPEG files at quality level 12, 6 and 0 for analysis on effects of initial JPEG compression.

Two separate Facebook accounts were used for this testing. One account was signed in to upload the images to Facebook and the second account was signed in during the download process. This step is important as the quality available for download may be different from the original uploader vs a Facebook friend/public user. Downloading from a separate account also more accurately emulates the real-world scenario where the images are being downloaded by an investigator who does not have access to the originals. All the unedited and cloned images, in all of their above-mentioned quality levels, were uploaded to Facebook while signed into the first account and then downloaded while signed into the second account. As discussed in Pippin's thesis [3] the name of the image file gets changed upon upload to Facebook. To keep the images

organized and easier to compare side by side, a software tool called Bulk Rename Utility was used to rename the downloaded images so that they all start with the original file name followed by abbreviated actions that have taken place.

Clone detection for Tool 1 and Tool 2 were both done using a Dell XPS 7760 AIO running Windows 10 21H2 19044.1526. Both tools have options for batch processing clone detection and output similar images to highlight where the clones were detected as can be seen in *Figure 2.4* below.

Figure 2.4 Example Output Highlighting Detected Cloned Region from Tool 1 and Tool 2

Evaluation Metrics

Each of the 100 images were exported from Adobe Photoshop at three different JPEG quality levels (0, 6, 12) before and after manipulation, uploaded to and downloaded from Facebook and then analyzed using two different forensic clone detection tools. This process created 600 non-manipulated and 600 manipulated images, a total of 1200 images to look at with each tool for a combined total of 2400 data points. Each of the tool analyzed output images as seen above in *Figure 2.4* were looked at and classified as using Matthews Correlation Coefficient (MCC)[5]. "MCC is a robust metric that summarizes the classifier performance in a

single value, if positive and negative cases are of equal importance." [6] In this research, the positive cases are the manipulated images, and the negative cases are the unmanipulated images exported at the same quality level. This helps to evaluate the ability of the clone detection tools to detect clones but also to correctly identify the negative, unmanipulated images as true negatives.

$$MCC = \frac{TP \times TN - FP \times FN}{\sqrt{(TP + FP)(TP + FN)(TN + FP)(TN + FN)}}$$

Figure 2.5 Matthews Correlation Coefficient Formula

Each of the images were assigned a value of True Positive (TP), False Positive (FP), True Negative (TN) or False Negative (FN) or one of two combinations, True Positive and False Positive (TP/FP) or False Positive and False Negative (FP/FN). True Positive (*Figure 2.6)* indicates that the clone detection tool accurately highlighted the cloned regions on a manipulated image. False Negative (*Figure 2.7)* indicates that the clone detection tool inaccurately shows no highlights on an image that has been manipulated. True Negative (*Figure 2.8)* indicates that the clone detection tool accurately did not highlight any regions on a non-manipulated image. False Positive (*Figure 2.9)* indicates that the clone detection tool inaccurately highlighted regions that were not manipulated on either a non-manipulated or manipulated image. The two combination classifications mentioned above were used to classify images where multiple conditions were true. True Positive and False Positive (*Figure 2.10)* was used to indicate when the clone detection tool accurately highlighted the cloned regions on a manipulated image but also inaccurately highlighted regions that were not manipulated. Lastly False Positive and False Negative (*Figure 2.11)* indicates that the clone detection tool inaccurately highlighted regions that were not manipulated and also inaccurately shows no highlights on manipulated regions.

Table 2.1 below shows a small preview of the image classification table used for each image at each quality level. The full tables are available in the appendix.

Table 2.1 *Image Classification Example Table*

Filename	Cloned Pixels	Manip. Size	Original	Unedited - Before Facebook			Cloned - Before Facebook		
				Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20211031_232916890	31763	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20211101_012518674	29285	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211102_224010950	44798	Medium	TN	TN	TN	TN	TP	TP/FP	TP
PXL_20211108_145346777	53027	Medium	TN	TN	FP	FP	FN	FN	TP/FP
PXL_20211112_155441302	36753	Small	TN	FP	TN	TN	FP	FN	TP
PXL_20211114_024220416	142236	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211115_020345079	340169	Large	TN	TN	TN	TN	TP	TP	TP

The occurrences of each classification were counted and summed at each quality level and can be seen in *Table 3.1* and *Table 3.2*. The sums were then plugged into the MCC formula shown in *Figure 2.5* to calculate the MCC score for each quality level. The MCC equation results in a value between -1.0 and +1.0 which details how well each tool correctly identified cloned regions within the manipulated images and correctly identified non-edited images as non-edited images. The closer the value is to 1.0, the better the tool performed overall. The MCC was calculated for each JPEG quality (0, 6, 12) before and after uploading to Facebook to determine what effect JPEG quality has and additionally what effect Facebook recompression has on the ability to detect cloned regions. The results can be seen graphed in *Figure 3.1*.

In addition to MCC, precision, accuracy, and fall-out were all calculated for each quality level and can be seen below in *Table 3.3* and *Table 3.4*. $Precision = TP/(TP + FP)$, graphed in *Figure 3.2* shows the number of True Positive classifications out of all the Positive classifications. $Accuracy = (TP + TN)/(P + N)$, graphed in *Figure 3.3* shows how well the tool correctly identified both positive and negative manipulations. $Fall\text{-}Out = FP/N$, graphed in *Figure 3.4* shows how many False Positive identifications there were.
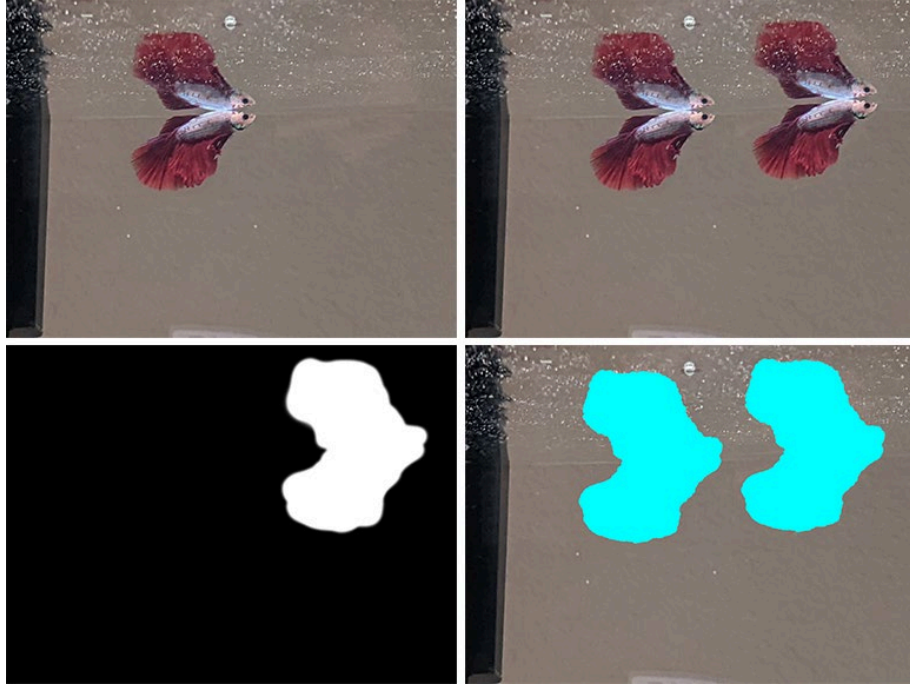
Figure 2.6 *True Positive Example. Original (top left), Manipulated (top right), Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)*

Figure 2.7 *False Negative Example. Original (top left), Manipulated (top right), Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)*

Figure 2.8 *True Negative Example. Original (left), Clone Detection (right)*

Figure 2.9 *False Positive Example. Original (left), Clone Detection (right)*

Figure 2.10 *True Positive/False Positive Example. Original (top left), Manipulated (top right), Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)*
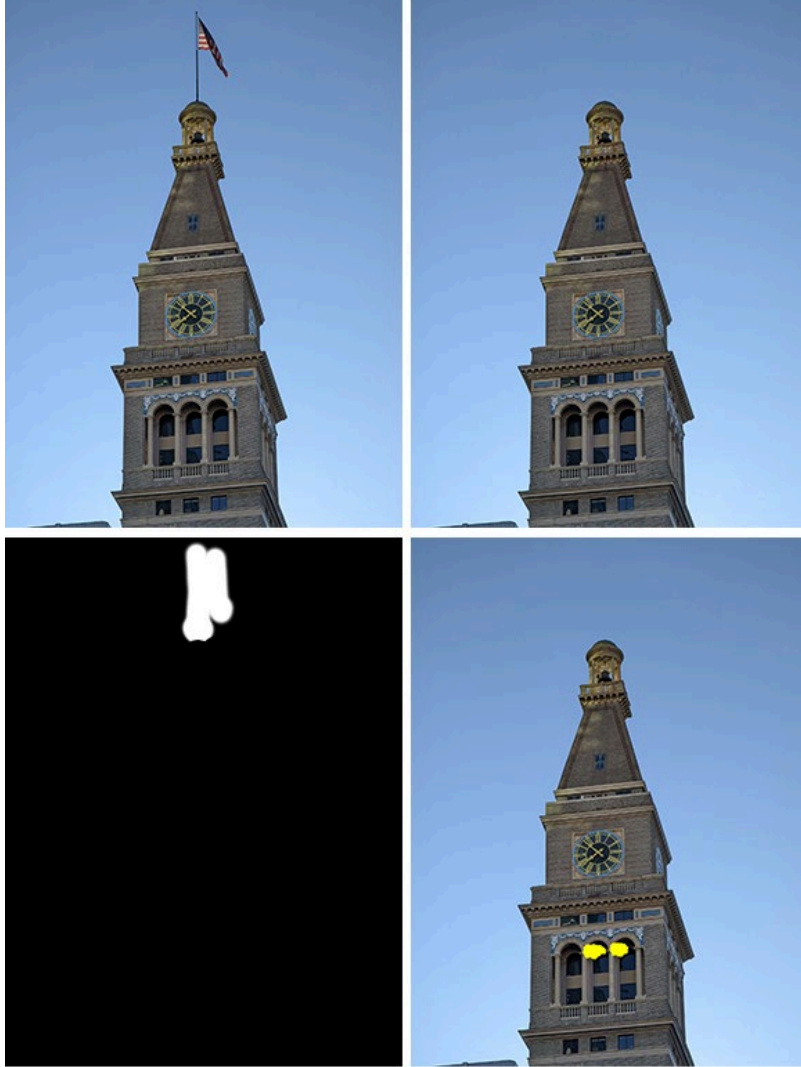
Figure 2.11 *False Positive/False Negative Example. Original (top left), Manipulated (top right),*
Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)

CHAPTER III

RESULTS

Table 3.1 *MCC Before Facebook (left), MCC After Facebook (right) for Tool 1*

	TP	TN	FP	FN	MCC
Quality 0	68	93	12	30	0.59
Quality 6	86	92	13	14	0.74
Quality 12	93	92	13	7	0.81

	TP	TN	FP	FN	MCC
Quality 0	69	93	11	30	0.60
Quality 6	86	94	14	14	0.73
Quality 12	87	93	16	12	0.73

Table 3.2 *MCC Before Facebook (left), MCC After Facebook (right) for Tool 2*

	TP	TN	FP	FN	MCC
Quality 0	55	87	25	38	0.38
Quality 6	64	91	18	34	0.50
Quality 12	69	91	18	29	0.55

	TP	TN	FP	FN	MCC
Quality 0	55	87	26	38	0.37
Quality 6	61	92	16	37	0.49
Quality 12	66	91	17	32	0.53
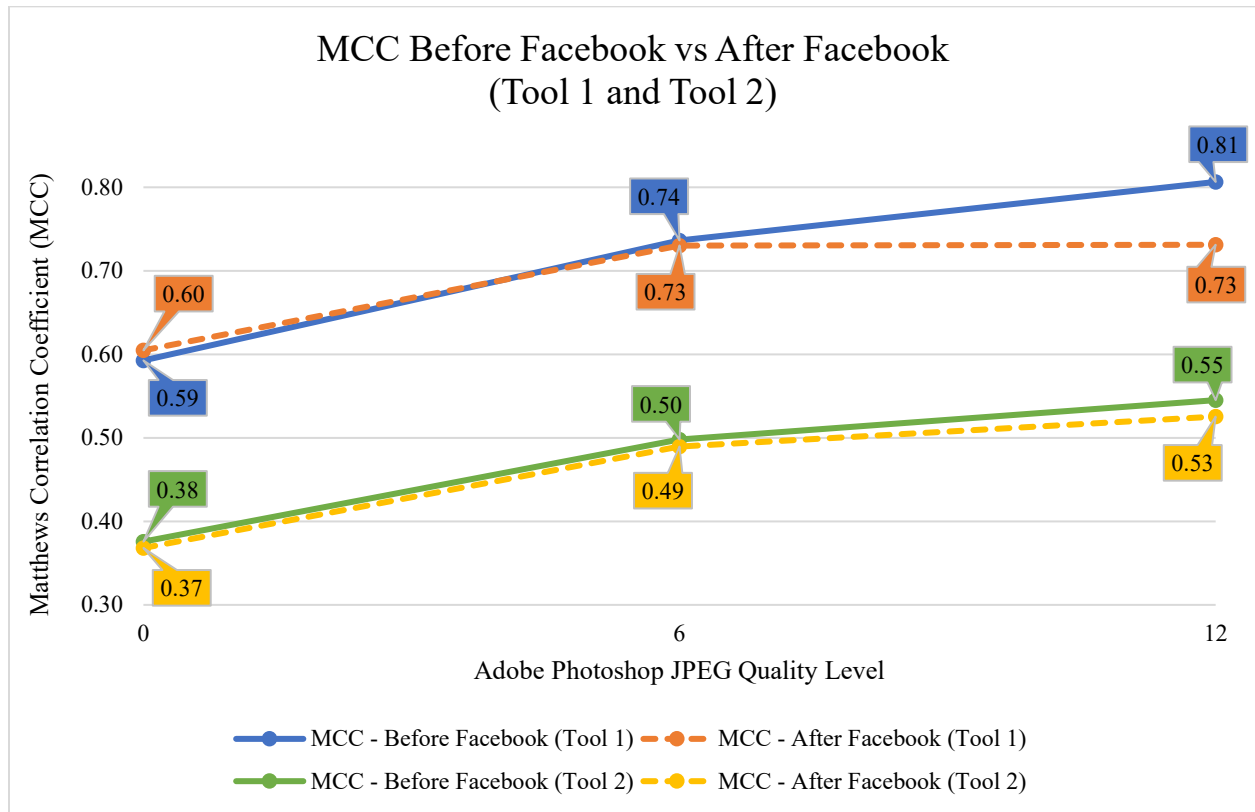
Figure 3.1 *MCC Before and After Facebook Graph*

Table 3.3 *Precision, Accuracy and Fall-Out Before Facebook (left)*
and After Facebook (right) for Tool 1

	Precision	Accuracy	Fall-Out			Precision	Accuracy	Fall-Out
Quality 0	0.85	0.81	0.12		**Quality 0**	0.86	0.81	0.11
Quality 6	0.87	0.89	0.13		**Quality 6**	0.86	0.90	0.14
Quality 12	0.88	0.93	0.13		**Quality 12**	0.84	0.90	0.16

Table 3.4 *Precision, Accuracy and Fall-Out Before Facebook (left)*
and After Facebook (right) for Tool 2

	Precision	Accuracy	Fall-Out			Precision	Accuracy	Fall-Out
Quality 0	0.69	0.71	0.25		**Quality 0**	0.68	0.71	0.26
Quality 6	0.78	0.78	0.18		**Quality 6**	0.79	0.77	0.16
Quality 12	0.79	0.80	0.18		**Quality 12**	0.80	0.79	0.17
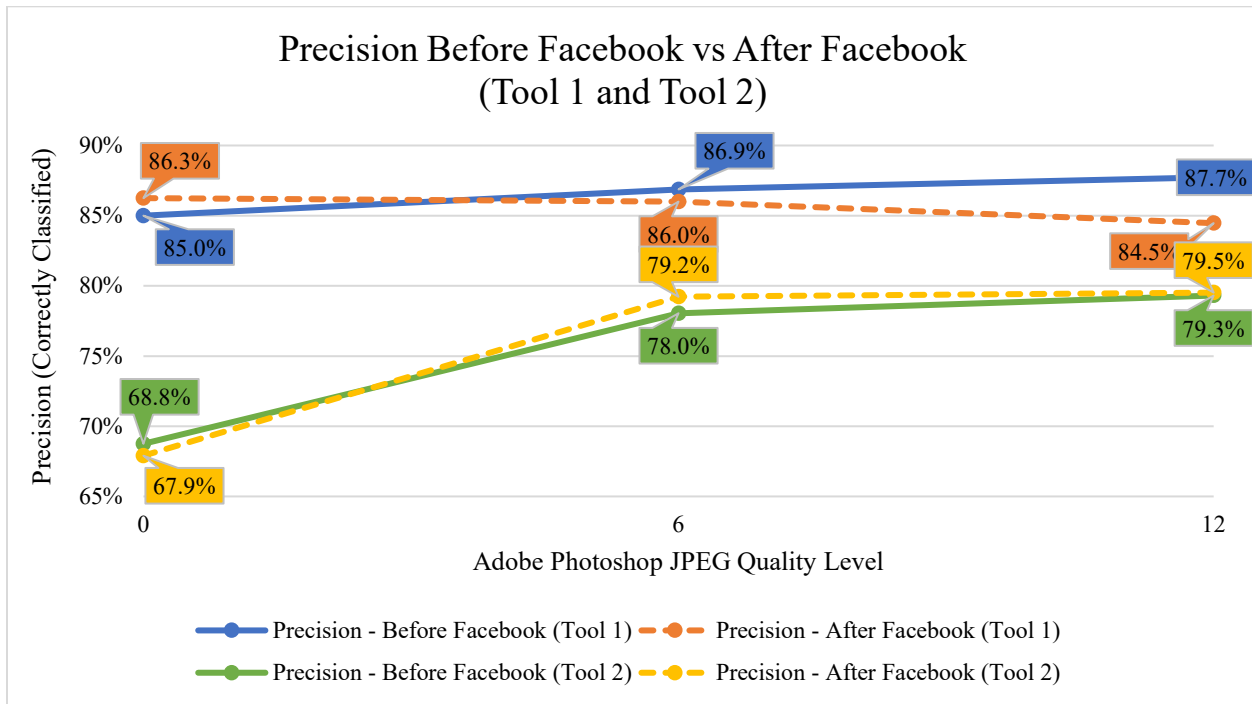
Figure 3.2 *Precision Before and After Facebook Graph*
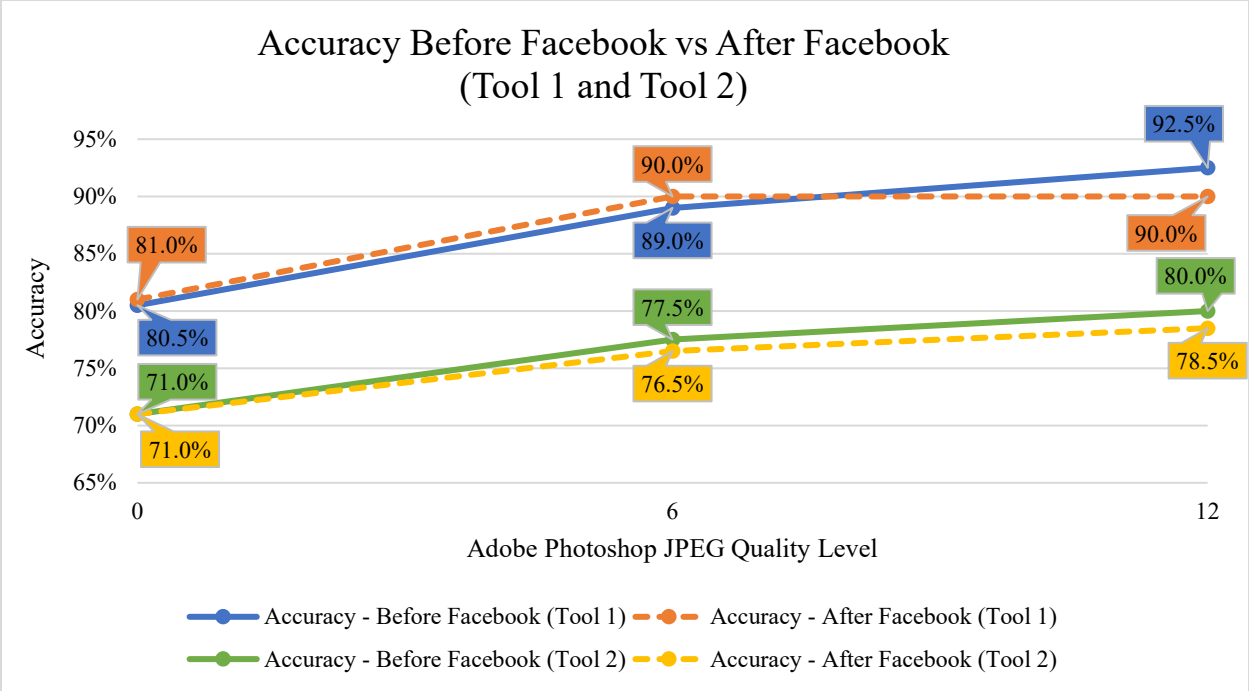
Figure 3.3 *Accuracy Before and After Facebook Graph*
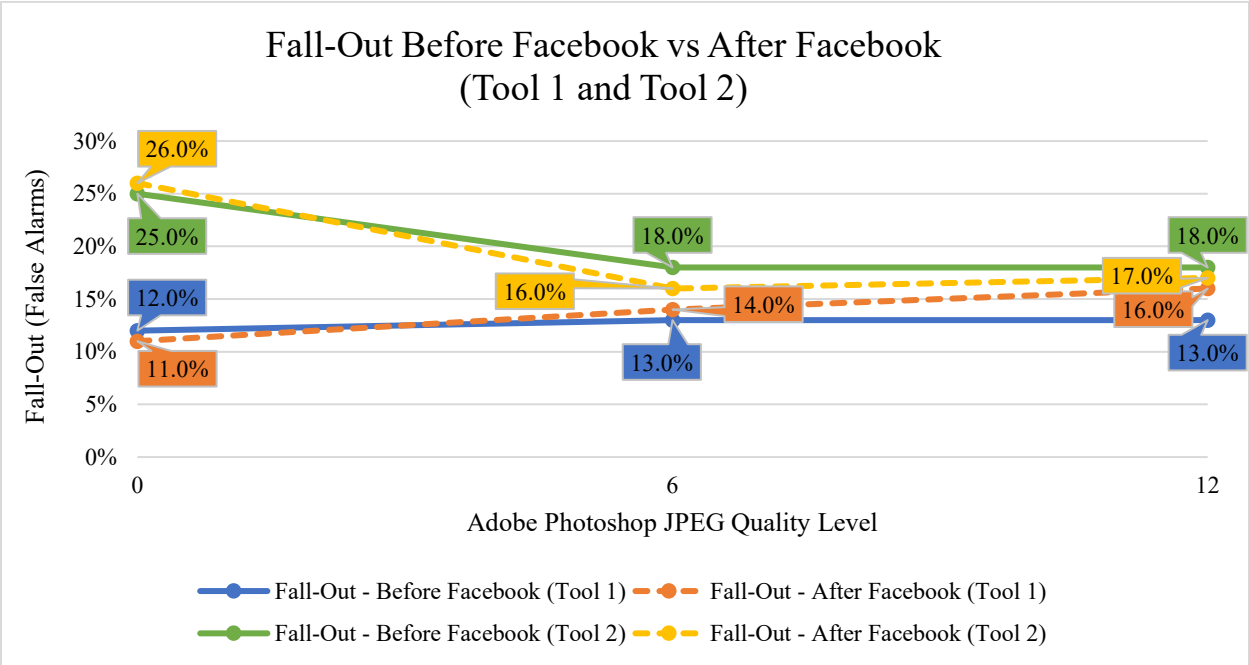
Figure 3.4 *Fall-Out Before and After Facebook Graph*

In order to more clearly see where the clone stamp detection was working and where it was falling short, each of the images was also classified with a size based on the number of pixels that were cloned. All the cloning was done on a separate Adobe Photoshop layer and was later exported as a black and white image with white representing where the cloned region was and black everywhere else. These images can be seen in all the clone stamp examples in this paper and below in *Figure 3.5*. A command line utility called ImageMagick was used to count the number of white pixels to get an approximate size of the cloned region. Each of the images was then divided into three evenly split groups and classified as small, medium, or large manipulations. The MCC score was calculated on each of the groups to identify how the size of the cloned region affects the ability to detect the clone, the results of which can be seen in *Table 3.5* and *Table 3.6* and graphed in *Figure 3.6* and *Figure 3.7*.

Figure 3.5 *Clone Stamp Mask Example*

Table 3.5 *MCC by Manipulation Size Before Facebook (left), After Facebook (right) for Tool 1*

Small	TP	TN	FP	FN	MCC
Quality 0	15	31	4	17	0.39
Quality 6	22	32	2	11	0.63
Quality 12	26	32	2	7	0.74

Small	TP	TN	FP	FN	MCC
Quality 0	14	31	3	19	0.39
Quality 6	22	32	3	11	0.60
Quality 12	24	32	3	9	0.66

Medium	TP	TN	FP	FN	MCC
Quality 0	22	31	5	11	0.54
Quality 6	32	29	8	2	0.73
Quality 12	34	30	7	0	0.82

Medium	TP	TN	FP	FN	MCC
Quality 0	24	31	5	9	0.60
Quality 6	32	31	7	2	0.76
Quality 12	31	30	9	2	0.71

Large	TP	TN	FP	FN	MCC
Quality 0	31	31	3	2	0.85
Quality 6	32	31	3	1	0.88
Quality 12	33	30	4	0	0.89

Large	TP	TN	FP	FN	MCC
Quality 0	31	31	3	2	0.85
Quality 6	32	31	4	1	0.86
Quality 12	32	31	4	1	0.86
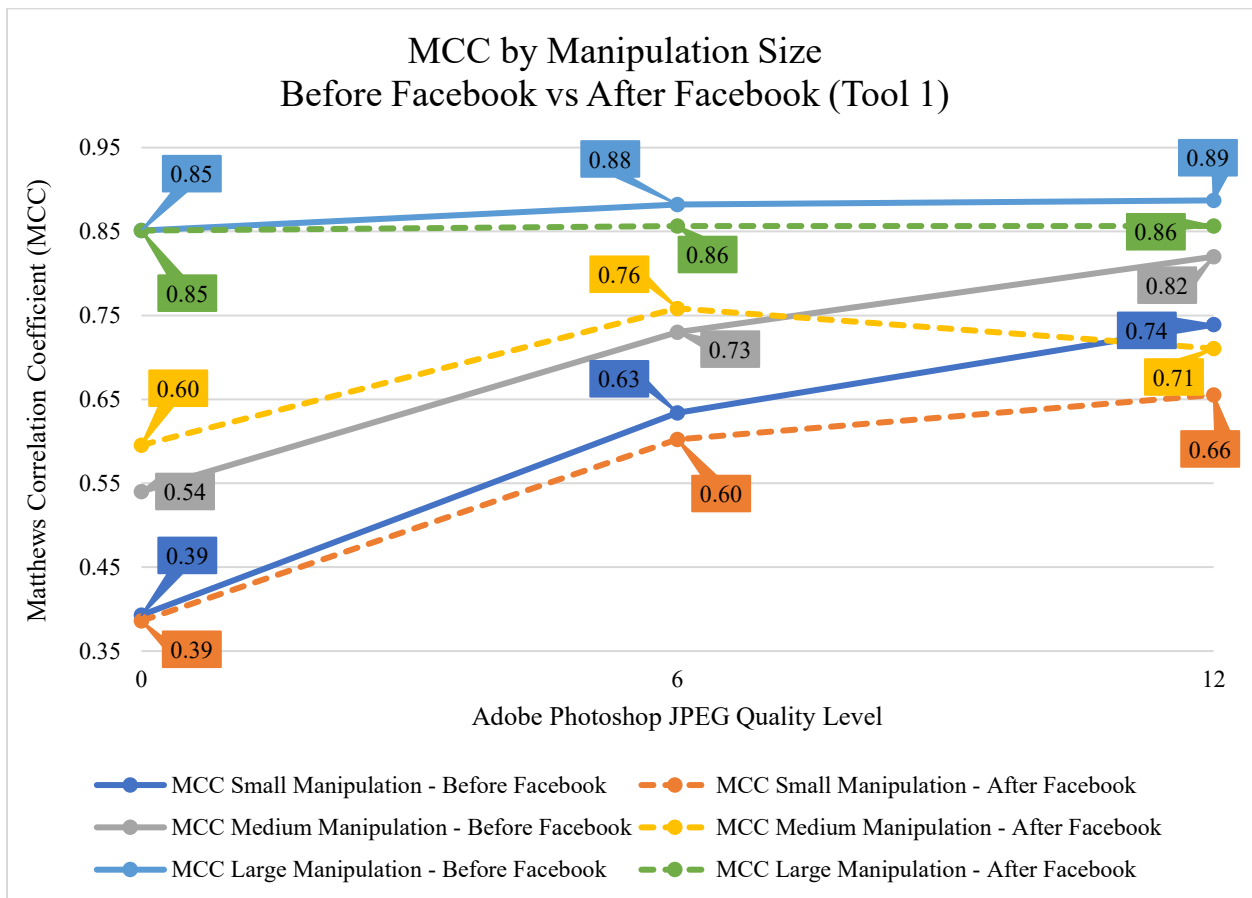
Figure 3.6 *MCC by Manipulation Size – Before and After Facebook Graph (Tool 1)*

Table 3.6 *MCC by Manipulation Size Before Facebook (left), After Facebook (right) for Tool 2*

Small	TP	TN	FP	FN	MCC
Quality 0	12	28	11	16	0.15
Quality 6	13	31	4	19	0.34
Quality 12	15	31	4	17	0.39

Small	TP	TN	FP	FN	MCC
Quality 0	12	28	11	16	0.15
Quality 6	12	31	4	20	0.31
Quality 12	14	31	4	18	0.36

Medium	TP	TN	FP	FN	MCC
Quality 0	16	30	8	16	0.30
Quality 6	22	29	10	11	0.41
Quality 12	24	29	10	9	0.47

Medium	TP	TN	FP	FN	MCC
Quality 0	16	30	8	16	0.30
Quality 6	20	30	8	13	0.40
Quality 12	23	29	9	10	0.46

Large	TP	TN	FP	FN	MCC
Quality 0	27	29	6	6	0.65
Quality 6	29	31	4	4	0.76
Quality 12	30	31	4	3	0.79

Large	TP	TN	FP	FN	MCC
Quality 0	27	29	7	6	0.62
Quality 6	29	31	4	4	0.76
Quality 12	29	31	4	4	0.76
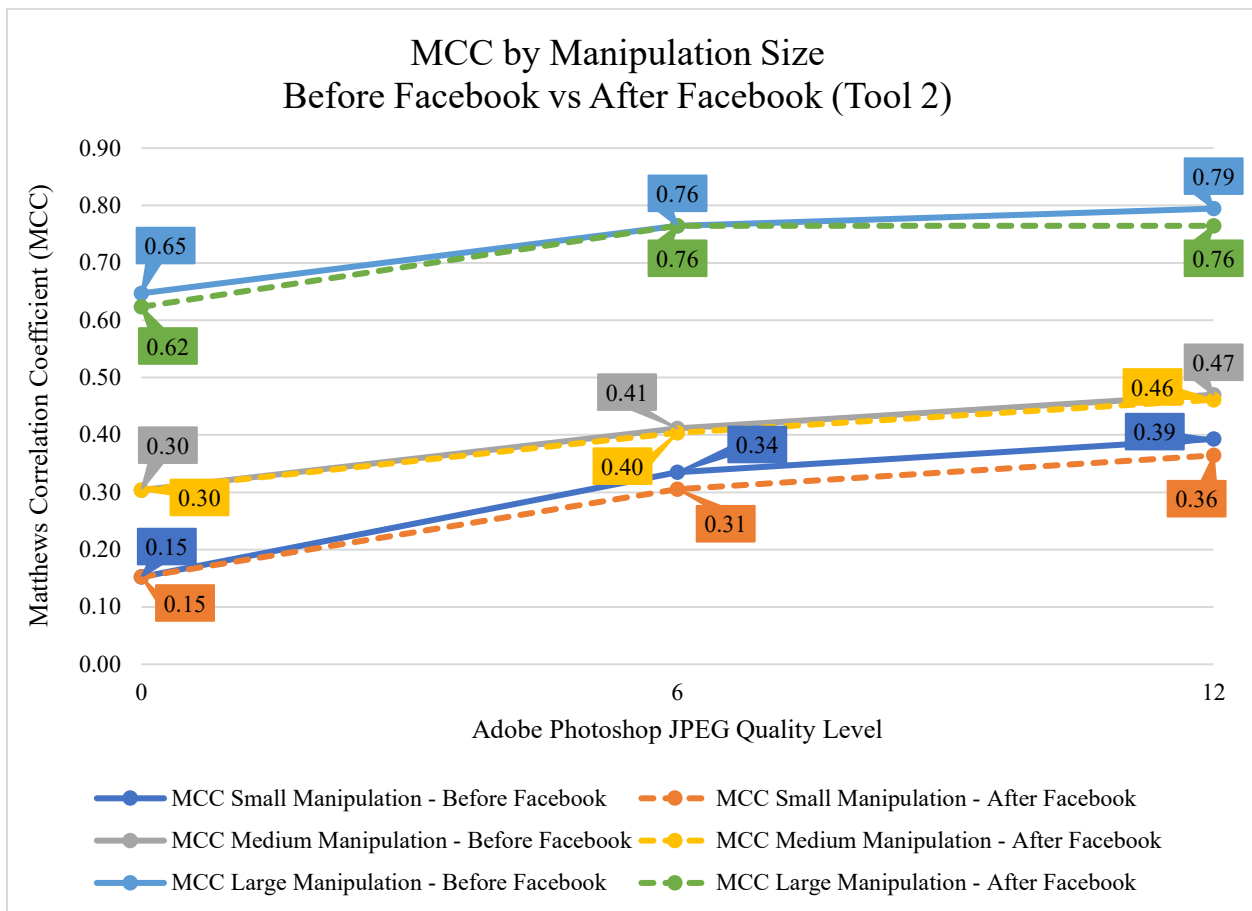
Figure 3.7 *MCC by Manipulation Size – Before and After Facebook Graph (Tool 2)*

CHAPTER IV

DISCUSSION

In conclusion, the more compressed a manipulated image is, the more difficult it is to detect the cloned regions. This was the expected result. When creating a clone, an exact copy of the pixels is being made in a second location within the image. If this image were saved out in a lossless format that has no compression, the clones would be trivial to detect. As explained in the introduction, when applying JPEG compression, data is being thrown away to achieve a smaller file size. In this process of averaging pixel data, the previously identical clones get less and less similar as the quality level decreases making it harder and harder to detect the cloned region. In this test, Tool 1 performed better than Tool 2 but they both show the same overall trend. At JPEG quality level 0 and 6, the MCC value is nearly identical before and after being uploaded to Facebook. At JPEG quality level 12 there is a larger difference in the MCC value before and after being uploaded to Facebook. While Tool 1 shows a larger difference than Tool 2, both again show a similar trend. Overall, the data shows that the Facebook recompression that is applied at upload does make it more difficult to detect the cloned regions but only when the uploaded image has a higher quality level to begin with. Looking at the output from JPEGsnoop in *Figure 4.1*, the Quantization Tables that dictate how compressed each frequency will be and the overall quality factor show that the compression that Facebook applies is similar to what Adobe Photoshop would call JPEG quality 5-6 regardless of the input quality.
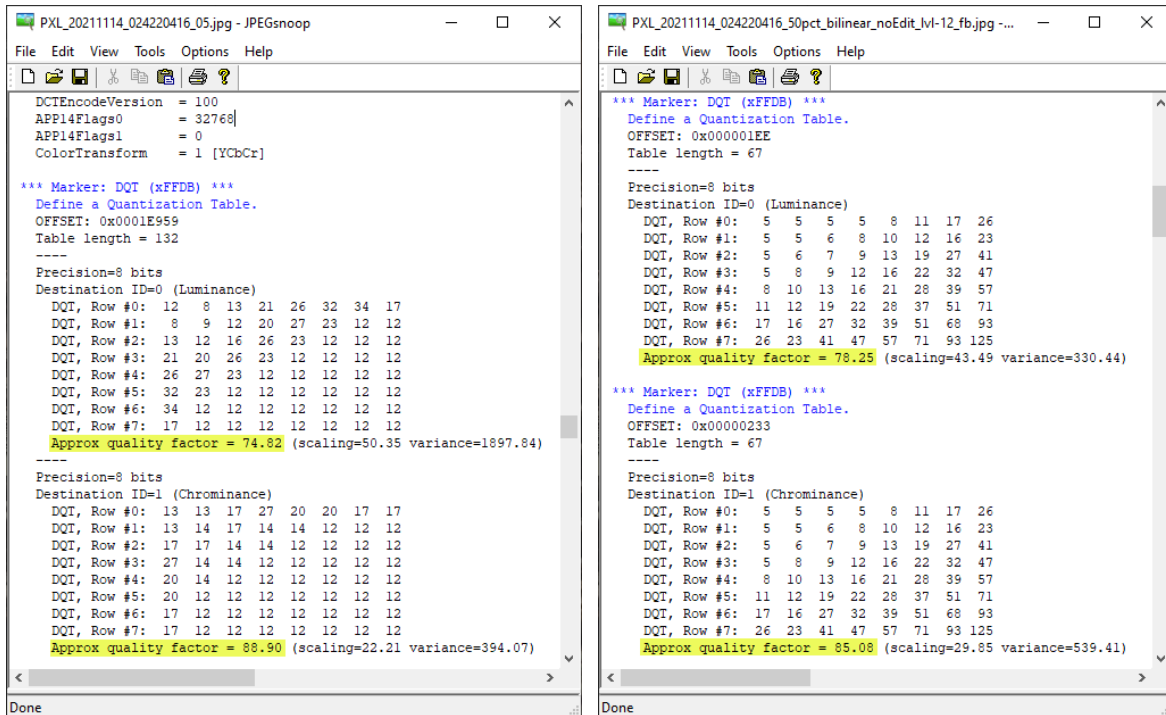
Figure 4.1 *Photoshop Quality Level 5 QT (left) vs Downloaded from Facebook QT (right)*

Uploading an image with better quality (12) will get crushed down to the lower quality

when uploading to Facebook but uploading a lower quality (6 or 0) image to begin with will not

get significantly worse after uploading to Facebook. While classifying all the images some

interesting observations were made about how some of the errors are introduced. One of the

main factors that would cause a False Positive were naturally occurring repeating patterns in the

image such as logos or fonts that are identical by design as seen in *Figure 4.2*.
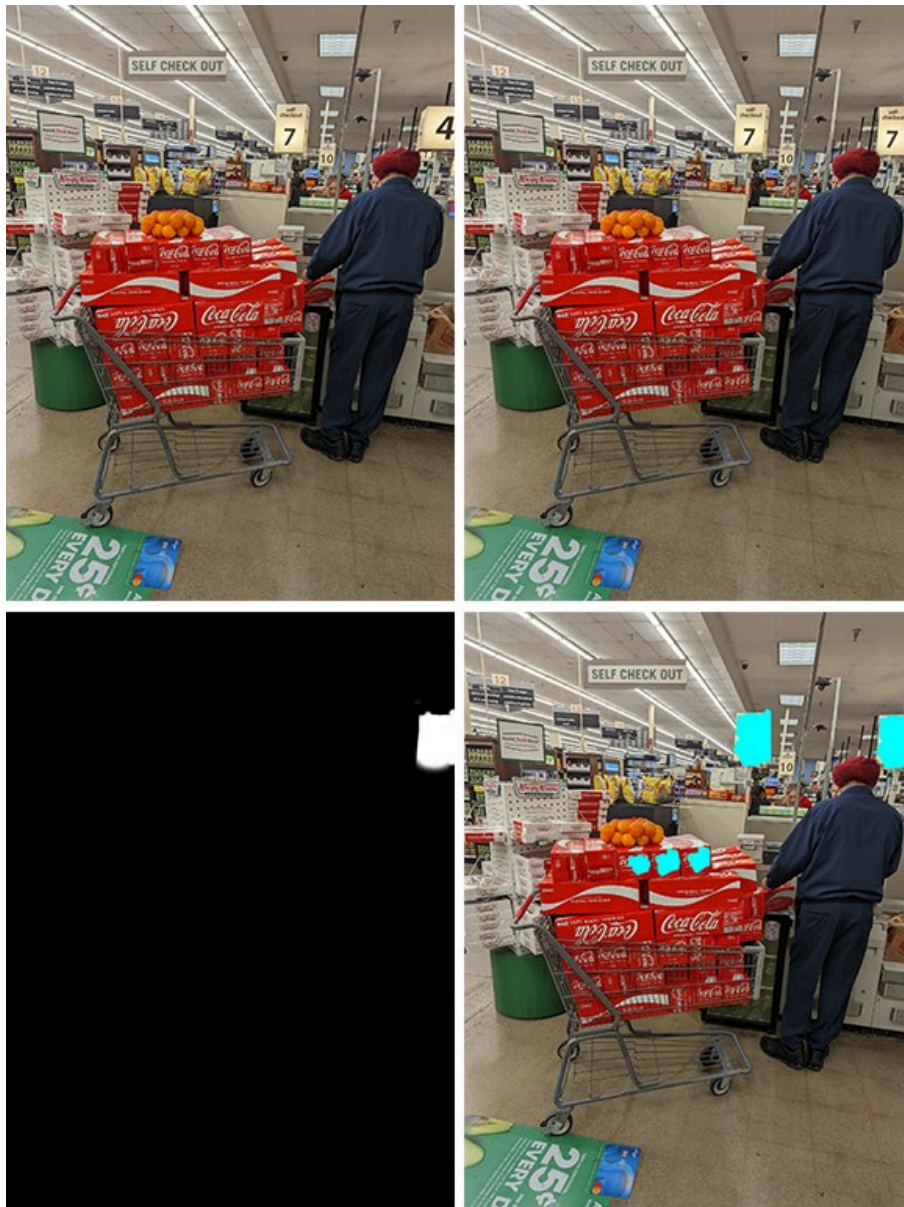
Figure 4.2 *Example Showing False Positive Hits on the Coca-Cola Logos. Original (top left), Manipulated (top right), Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)*
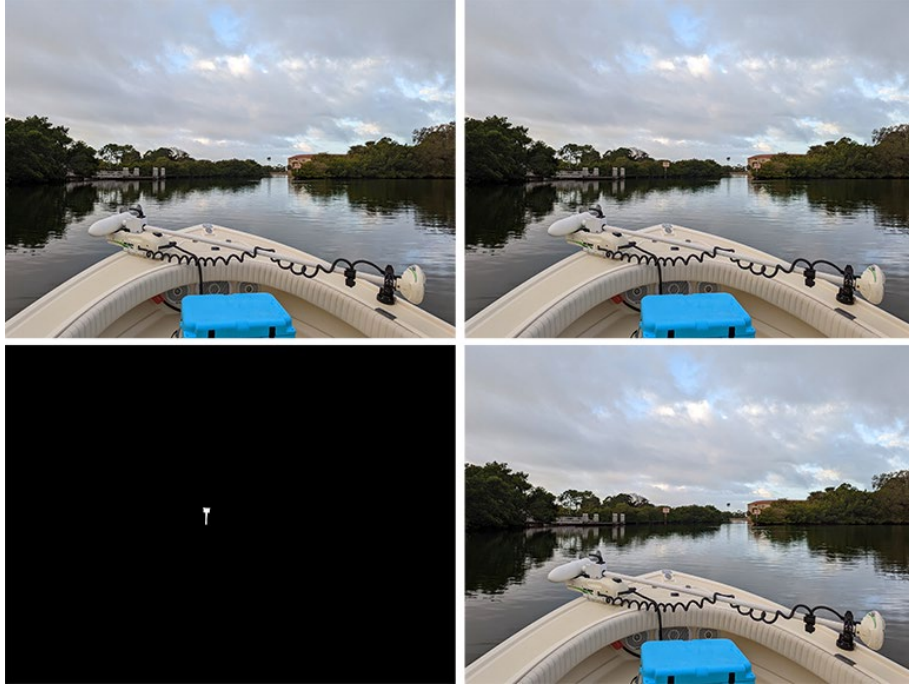
Figure 4.3 *Example Showing False Negative on a Very Small, Cloned Region. Original (top left), Manipulated (top right), Ground Truth Cloned Region (bottom left), Clone Detection (bottom right)*

Looking at the graphs in *Figure 3.6* and *Figure 3.7*, the size of the manipulation has a large effect on the ability to detect the cloned region. Both tools again show the same trend as they did globally. The larger the cloned region, the easier it will be to detect it. This makes sense as there will be more of the identical pixels that can be detected, and it will be more robust to JPEG compression. It can be seen directly above in *Figure 4.3*, when there are very small manipulations, the clone detection tools have a hard time detecting the cloned regions if they can detect them at all. This could potentially be remedied by using a smaller block size at the expense of more processing time. Smaller block size could also introduce more false positives.

Future Research

Future research in this area could include additional variables like rotating and or scaling the cloned region making it harder for the tools to detect as the resultant pixels are less similar than their source. A more granular study of Photoshop quality settings should show more specifically where the effects of uploading to Facebook start to have an effect. It would be great to have a larger dataset of input images from more than one camera. Pippin [3] discussed the fact that Facebook will change the resolution of uploaded images that are above a certain resolution. It would be interesting to see what effect this has on clone detection by using higher resolution input images. Lastly, it would be a good idea to evaluate the same dataset using the same clone detection tools with a smaller block size, giving them the ability to detect smaller cloned regions at the expense of more processing time.

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[5] Matthews, B. W. (1975). "Comparison of the predicted and observed secondary structure of T4 phage lysozyme." Biochimica et Biophysica Acta (BBA) - Protein Structure 405(2): 442-451.

[6] Chicco, D., et al. (2021). "The Matthews correlation coefficient (MCC) is more reliable than balanced accuracy, bookmaker informedness, and markedness in two-class confusion matrix evaluation." BioData Mining 14(1).

APPENDIX

Appendix A *Unedited vs Cloned - Before Facebook (Tool 1)*

Filename	Cloned Pixels	Manip. Size	Original	Unedited - Before Facebook			Cloned - Before Facebook		
				Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20220109_032542056	1237618	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220105_220907082	1049151	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220105_221053849	929494	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_014310666	860553	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220107_001751505	835144	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_200509038	640417	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211203_002343589	595043	Large	FP	TN	FP	FP	TP	TP	TP
PXL_20220122_235707149	585725	Large	FP	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220129_002835577	518930	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_215552465	508188	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_195107041	494820	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211115_213218317	482829	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211120_025012600	403545	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_151736693	382856	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211123_000135468	372048	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211115_020345079	340169	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220112_161838882	337349	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_211457598	323677	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220107_001742866	320779	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211208_001112507	299077	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211210_182128878	282296	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211220_042137350	279668	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220104_013022232	278043	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_203523709	277152	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211125_195530884	274631	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211130_024543915	255777	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_041450333	235067	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211123_075849670	212304	Large	TN	TN	TN	TN	FN	FN	TP
PXL_20220207_211543518	203786	Large	TN	TN	TN	TN	FN	TP	TP
PXL_20220110_211153569	195330	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220202_191451628	169369	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_202938471	161896	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211118_233802618	161121	Large	TN	FP	TN	FP	TP	TP	TP
PXL_20220202_021629209	152073	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211124_234835882	151210	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220123_172227166	148496	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20211117_192545379	144420	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211114_024220416	142236	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211208_231246726	130406	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220109_223245302	126879	Medium	FP	FP	FP	FP	FP	TP/FP	TP/FP
PXL_20211231_221719341	121865	Medium	FP	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211204_040746262	118553	Medium	TN	TN	TN	TN	FN	FN	TP
PXL_20220202_003812704	117856	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220101_231809947	107154	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220121_143546713	94797	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211204_183457116	91936	Medium	FP	FP	FP	FP	TP	TP	TP
PXL_20220119_163512268	91741	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220122_182736072	87464	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220203_194950797	86489	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220125_231758799	80752	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20211201_004234519	73759	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220128_190449804	72621	Medium	FP	TN	TN	TN	TP	TP	TP
PXL_20211223_145308256	70324	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20211130_022617175	68501	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220128_180933948	65045	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20211223_161103181	62265	Medium	TN	TN	TN	TN	FN	TP	TP

Appendix A cont'd

Filename	Cloned Pixels	Manip. Size	Original	Unedited - Before Facebook			Cloned - Before Facebook		
				Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20211118_150807317	61385	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220106_200910142	56327	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211130_152307787	53656	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211108_145346777	53027	Medium	TN	TN	FP	FP	FN	FN	TP/FP
PXL_20220103_022923925	50418	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220202_055706418	50089	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220205_155502780	47003	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211102_224010950	44798	Medium	TN	TN	TN	TN	TP	TP/FP	TP
PXL_20220121_215805508	42840	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220203_170250905	42002	Medium	TN	TN	FP	TN	FN	TP	TP
PXL_20220202_004959530	41282	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211203_192532020	41190	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211125_011030722	37632	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211112_155441302	36753	Small	TN	FP	TN	TN	FP	FN	TP
PXL_20211230_182319363	35529	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220207_210924601	35103	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211127_032653437	34698	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20211031_232916890	31763	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220130_220306079	30622	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211101_012518674	29285	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211230_175948761	28945	Small	TN	TN	TN	TN	FN	FN	TP
PXL_20211127_161543654	27981	Small	TN	TN	TN	TN	FN	FN	TP
PXL_20211203_192408677	27562	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220203_021456944	25326	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_193750034	25282	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220123_025449943	24256	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211227_002412122	22823	Small	FP	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211223_143207013	21125	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220122_234119635	20064	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220131_190941169	17204	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220204_163348941	15378	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211129_231243713	11604	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220123_000329973	10649	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211202_192936903	9606	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220112_172718498	8468	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211130_184109511	7712	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220112_171347858	7018	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211231_153858378	4745	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220127_193817530	4510	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220210_183619512	3429	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20220203_175537256	3387	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211224_011426278	3031	Small	TN	TN	TN	TN	FN	FN	TP
PXL_20220202_180720038	2456	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220204_125528620	997	Small	TN	TN	TN	TN	FN	FN	FN

	TP	TN	FP	FN	MCC
Quality 0	68	93	12	30	0.59
Quality 6	86	92	13	14	0.74
Quality 12	93	92	13	7	0.81

	Precision	Accuracy	Fall-Out
Quality 0	0.85	0.81	0.12
Quality 6	0.87	0.89	0.13
Quality 12	0.88	0.93	0.13

Appendix B *Unedited vs Cloned - After Facebook (Tool 1)*

Filename	Cloned Pixels	Manip. Size	Unedited - After Facebook			Cloned - After Facebook		
			Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20220109_032542056	1237618	Large	TN	TN	TN	TP	TP	TP
PXL_20220105_220907082	1049151	Large	TN	TN	TN	TP	TP	TP
PXL_20220105_221053849	929494	Large	TN	TN	TN	TP	TP	TP
PXL_20220127_014310666	860553	Large	TN	TN	TN	TP	TP	TP
PXL_20220107_001751505	835144	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_200509038	640417	Large	TN	TN	TN	TP	TP	TP
PXL_20211203_002343589	595043	Large	TN	FP	FP	TP	TP/FP	TP/FP
PXL_20220122_235707149	585725	Large	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220129_002835577	518930	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_215552465	508188	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_195107041	494820	Large	TN	TN	TN	TP	TP	TP
PXL_20211115_213218317	482829	Large	TN	TN	TN	TP	TP	TP
PXL_20211120_025012600	403545	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_151736693	382856	Large	TN	TN	TN	TP	TP	TP
PXL_20211123_000135468	372048	Large	TN	TN	TN	TP	TP	TP
PXL_20211115_020345079	340169	Large	TN	TN	TN	TP	TP	TP
PXL_20220112_161838882	337349	Large	TN	TN	TN	TP	TP	TP
PXL_20220127_211457598	323677	Large	TN	TN	TN	TP	TP	TP
PXL_20220107_001742866	320779	Large	TN	TN	TN	TP	TP	TP
PXL_20211208_001112507	299077	Large	TN	TN	TN	TP	TP	TP
PXL_20211210_182128878	282296	Large	TN	TN	TN	TP	TP	TP
PXL_20211220_042137350	279668	Large	TN	TN	TN	TP	TP	TP
PXL_20220104_013022232	278043	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_203523709	277152	Large	TN	TN	TN	TP	TP	TP
PXL_20211125_195530884	274631	Large	TN	TN	TN	TP	TP	TP
PXL_20211130_024543915	255777	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_041450333	235067	Large	TN	TN	TN	TP	TP	TP
PXL_20211123_075849670	212304	Large	TN	TN	TN	FN	FN	FN
PXL_20220207_211543518	203786	Large	TN	TN	TN	FN	TP	TP
PXL_20220110_211153569	195330	Large	TN	TN	TN	TP	TP	TP
PXL_20220202_191451628	169369	Large	TN	TN	TN	TP	TP	TP
PXL_20220127_202938471	161896	Large	TN	TN	TN	TP	TP	TP
PXL_20211118_233802618	161121	Large	FP	TN	TN	TP	TP	TP
PXL_20220202_021629209	152073	Medium	TN	TN	TN	TP	TP	TP
PXL_20211124_234835882	151210	Medium	TN	TN	TN	TP	TP	TP
PXL_20220123_172227166	148496	Medium	TN	TN	TN	FN	TP	TP
PXL_20211117_192545379	144420	Medium	TN	TN	TN	TP	TP	TP
PXL_20211114_024220416	142236	Medium	TN	TN	TN	TP	TP	TP
PXL_20211208_231246726	130406	Medium	TN	TN	TN	TP	TP	TP
PXL_20220109_223245302	126879	Medium	FP	FP	FP	FP	TP/FP	FP
PXL_20211231_221719341	121865	Medium	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211204_040746262	118553	Medium	TN	TN	TN	FN	FN	FN
PXL_20220202_003812704	117856	Medium	TN	TN	TN	FN	TP	TP
PXL_20220101_231809947	107154	Medium	TN	TN	TN	TP	TP	TP
PXL_20220121_143546713	94797	Medium	TN	TN	TN	TP	TP	TP
PXL_20211204_183457116	91936	Medium	FP	FP	FP	TP	TP	TP
PXL_20220119_163512268	91741	Medium	TN	TN	TN	TP	TP	TP
PXL_20220122_182736072	87464	Medium	TN	TN	TN	TP	TP	TP
PXL_20220203_194950797	86489	Medium	TN	TN	TN	TP	TP	TP
PXL_20220125_231758799	80752	Medium	TN	TN	TN	FN	TP	TP
PXL_20211201_004234519	73759	Medium	TN	TN	TN	TP	TP	TP
PXL_20220128_190449804	72621	Medium	TN	TN	TN	TP	TP	TP
PXL_20211223_145308256	70324	Medium	TN	TN	TN	FN	TP	TP
PXL_20211130_022617175	68501	Medium	TN	TN	TN	TP	TP	TP
PXL_20220128_180933948	65045	Medium	TN	TN	TN	TP	TP	TP
PXL_20211223_161103181	62265	Medium	TN	TN	TN	FN	TP	TP
PXL_20211118_150807317	61385	Medium	TN	TN	TN	TP	TP	TP
PXL_20220106_200910142	56327	Medium	TN	TN	TN	TP	TP	TP
PXL_20211130_152307787	53656	Medium	TN	TN	TN	TP	TP	TP

Appendix B cont'd

Filename	Cloned Pixels	Manip. Size	Unedited - After Facebook			Cloned - After Facebook		
			Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20211108_145346777	53027	Medium	TN	TN	TN	FN	FP/FN	FP/FN
PXL_20220103_022923925	50418	Medium	TN	TN	FP	TP	TP	TP
PXL_20220202_055706418	50089	Medium	TN	TN	TN	FN	TP	TP
PXL_20220205_155502780	47003	Medium	TN	TN	TN	TP	TP	TP
PXL_20211102_224010950	44798	Medium	TN	TN	TN	TP	TP/FP	TP/FP
PXL_20220121_215805508	42840	Medium	TN	TN	TN	TP	TP	TP
PXL_20220203_170250905	42002	Medium	TN	TN	TN	FN	TP	TP/FP
PXL_20220202_004959530	41282	Medium	TN	TN	TN	TP	TP	TP
PXL_20211203_192532020	41190	Small	TN	TN	TN	FN	TP	TP
PXL_20211125_011030722	37632	Small	TN	TN	TN	FN	FN	FN
PXL_20211112_155441302	36753	Small	FP	TN	TN	FN	FN	FN
PXL_20211230_182319363	35529	Small	TN	TN	TN	TP	TP	TP
PXL_20220207_210924601	35103	Small	TN	TN	TN	TP	TP	TP
PXL_20211127_032653437	34698	Small	TN	TN	TN	FN	TP	TP
PXL_20211031_232916890	31763	Small	TN	TN	TN	FN	TP	TP
PXL_20220130_220306079	30622	Small	TN	TN	TN	TP	TP	TP
PXL_20211101_012518674	29285	Small	TN	TN	TN	TP	TP	TP
PXL_20211230_175948761	28945	Small	TN	TN	TN	FN	FN	TP
PXL_20211127_161543654	27981	Small	TN	TN	TN	FN	FN	FN
PXL_20211203_192408677	27562	Small	TN	TN	TN	FN	TP	TP
PXL_20220203_021456944	25326	Small	TN	TN	TN	TP	TP	TP
PXL_20220127_193750034	25282	Small	TN	TN	TN	TP	TP	TP
PXL_20220123_025449943	24256	Small	TN	TN	TN	TP	TP	TP
PXL_20211227_002412122	22823	Small	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211223_143207013	21125	Small	TN	TN	TN	TP	TP	TP
PXL_20220122_234119635	20064	Small	TN	TN	TN	FN	TP	TP
PXL_20220131_190941169	17204	Small	TN	TN	TN	TP	TP	TP
PXL_20220204_163348941	15378	Small	TN	TN	TN	TP	TP	TP
PXL_20211129_231243713	11604	Small	TN	TN	TN	TP	TP	TP
PXL_20220123_000329973	10649	Small	TN	TN	TN	FN	FN	FN
PXL_20211202_192936903	9606	Small	TN	TN	TN	TP	TP	TP
PXL_20220112_172718498	8468	Small	TN	TN	TN	FN	FN	FN
PXL_20211130_184109511	7712	Small	TN	TN	TN	FN	FN	TP
PXL_20220112_171347858	7018	Small	TN	TN	TN	TP	TP/FP	TP/FP
PXL_20211231_153858378	4745	Small	TN	TN	TN	FN	TP	TP
PXL_20220127_193817530	4510	Small	TN	TN	TN	FN	FN	FN
PXL_20220210_183619512	3429	Small	TN	TN	TN	FN	TP	TP
PXL_20220203_175537256	3387	Small	TN	TN	TN	FN	FN	FN
PXL_20211224_011426278	3031	Small	TN	TN	TN	FN	TP	TP
PXL_20220202_180720038	2456	Small	TN	TN	TN	FN	FN	FN
PXL_20220204_125528620	997	Small	TN	TN	TN	FN	FN	FN

	TP	TN	FP	FN	MCC
Quality 0	69	93	11	30	0.60
Quality 6	86	94	14	14	0.73
Quality 12	87	93	16	12	0.73

	Precision	Accuracy	Fall-Out
Quality 0	0.86	0.81	0.11
Quality 6	0.86	0.90	0.14
Quality 12	0.84	0.90	0.16

Appendix C *Unedited vs Cloned - Before Facebook (Tool 2)*

Filename	Cloned Pixels	Manip. Size	Original	Unedited - Before Facebook			Cloned - Before Facebook		
				Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20220109_032542056	1237618	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220105_220907082	1049151	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220105_221053849	929494	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_014310666	860553	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220107_001751505	835144	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_200509038	640417	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211203_002343589	595043	Large	FP	FP	FP	FP	TP	TP/FP	TP/FP
PXL_20220122_235707149	585725	Large	TN	FP	TN	TN	TP	TP	TP
PXL_20220129_002835577	518930	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_215552465	508188	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_195107041	494820	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211115_213218317	482829	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211120_025012600	403545	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_151736693	382856	Large	TN	TN	TN	TN	FN	TP	TP
PXL_20211123_000135468	372048	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211115_020345079	340169	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220112_161838882	337349	Large	TN	TN	TN	TN	FN	FN	FN
PXL_20220127_211457598	323677	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220107_001742866	320779	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211208_001112507	299077	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211210_182128878	282296	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211220_042137350	279668	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220104_013022232	278043	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20220106_203523709	277152	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211125_195530884	274631	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211130_024543915	255777	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211225_041450333	235067	Large	TN	TN	TN	TN	TP	TP	TP
PXL_20211123_075849670	212304	Large	TN	FP	FP	FP	FN	FN	TP
PXL_20220207_211543518	203786	Large	TN	TN	TN	TN	FN	TP	TP
PXL_20220110_211153569	195330	Large	TN	TN	TN	TN	FN	FN	FN
PXL_20220202_191451628	169369	Large	TN	FP	TN	TN	TP/FP	TP	TP
PXL_20220127_202938471	161896	Large	TN	TN	TN	TN	FN	FN	FN
PXL_20211118_233802618	161121	Large	TN	TN	TN	TN	TP/FP	TP/FP	TP/FP
PXL_20220202_021629209	152073	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211124_234835882	151210	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220123_172227166	148496	Medium	TN	TN	TN	TN	FN	FN	TP
PXL_20211117_192545379	144420	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20211114_024220416	142236	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211208_231246726	130406	Medium	TN	FP	FP	FP	TP	TP/FP	TP/FP
PXL_20220109_223245302	126879	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20211231_221719341	121865	Medium	FP	TN	TN	TN	FN	FN	FN
PXL_20211204_040746262	118553	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220202_003812704	117856	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220101_231809947	107154	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220121_143546713	94797	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211204_183457116	91936	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220119_163512268	91741	Medium	TN	TN	FP	FP	TP	TP/FP	TP/FP
PXL_20220122_182736072	87464	Medium	TN	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220203_194950797	86489	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220125_231758799	80752	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20211201_004234519	73759	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20220128_190449804	72621	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211223_145308256	70324	Medium	FP	TN	TN	TN	FN	TP	TP
PXL_20211130_022617175	68501	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20220128_180933948	65045	Medium	TN	TN	TN	TN	FN	TP	TP
PXL_20211223_161103181	62265	Medium	TN	TN	TN	TN	FN	FN	TP
PXL_20211118_150807317	61385	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20220106_200910142	56327	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20211130_152307787	53656	Medium	TN	TN	TN	TN	FN	TP	TP

Appendix C cont'd

Filename	Cloned Pixels	Manip. Size	Original	Unedited - Before Facebook			Cloned - Before Facebook		
				Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20211108_145346777	53027	Medium	FP	TN	FP	FP	FP	FP	FP
PXL_20220103_022923925	50418	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20220202_055706418	50089	Medium	TN	TN	TN	TN	FN	FN	FN
PXL_20220205_155502780	47003	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211102_224010950	44798	Medium	TN	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220121_215805508	42840	Medium	TN	TN	TN	TN	FP	FN	FN
PXL_20220203_170250905	42002	Medium	TN	FP	TN	TN	TP	TP	TP
PXL_20220202_004959530	41282	Medium	TN	TN	TN	TN	TP	TP	TP
PXL_20211203_192532020	41190	Small	TN	TN	TN	TN	FP	FN	FN
PXL_20211125_011030722	37632	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211112_155441302	36753	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211230_182319363	35529	Small	TN	FP	TN	TN	TP	TP	TP
PXL_20220207_210924601	35103	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211127_032653437	34698	Small	TN	TN	TN	TN	FN	TP	TP
PXL_20211031_232916890	31763	Small	TN	TN	TN	TN	FN	FN	TP
PXL_20220130_220306079	30622	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211101_012518674	29285	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211230_175948761	28945	Small	TN	TN	TN	TN	FP	FN	TP
PXL_20211127_161543654	27981	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211203_192408677	27562	Small	TN	TN	TN	TN	FP	FN	FN
PXL_20220203_021456944	25326	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220127_193750034	25282	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220123_025449943	24256	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211227_002412122	22823	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211223_143207013	21125	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220122_234119635	20064	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220131_190941169	17204	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220204_163348941	15378	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20211129_231243713	11604	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220123_000329973	10649	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211202_192936903	9606	Small	TN	TN	TN	TN	TP	TP	TP
PXL_20220112_172718498	8468	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211130_184109511	7712	Small	TN	FP	TN	TN	FP	FN	FN
PXL_20220112_171347858	7018	Small	FP	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211231_153858378	4745	Small	TN	FP	TN	TN	FN	FN	FN
PXL_20220127_193817530	4510	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220210_183619512	3429	Small	FP	FP	FP	FP	FP	FP	FP
PXL_20220203_175537256	3387	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20211224_011426278	3031	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220202_180720038	2456	Small	TN	TN	TN	TN	FN	FN	FN
PXL_20220204_125528620	997	Small	TN	TN	TN	TN	FN	FN	FN

	TP	TN	FP	FN	MCC
Quality 0	55	87	25	38	0.38
Quality 6	64	91	18	34	0.50
Quality 12	69	91	18	29	0.55

	Precision	Accuracy	Fall-Out
Quality 0	0.69	0.71	0.25
Quality 6	0.78	0.78	0.18
Quality 12	0.79	0.80	0.18

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Appendix D *Unedited vs Cloned - After Facebook (Tool 2)*

Filename	Cloned Pixels	Manip. Size	Unedited - After Facebook			Cloned - After Facebook		
			Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20220109_032542056	1237618	Large	TN	TN	TN	TP	TP	TP
PXL_20220105_220907082	1049151	Large	TN	TN	TN	TP	TP	TP
PXL_20220105_221053849	929494	Large	TN	TN	TN	TP	TP	TP
PXL_20220127_014310666	860553	Large	TN	TN	TN	TP	TP	TP
PXL_20220107_001751505	835144	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_200509038	640417	Large	TN	TN	TN	TP	TP	TP
PXL_20211203_002343589	595043	Large	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220122_235707149	585725	Large	FP	TN	TN	TP	TP	TP
PXL_20220129_002835577	518930	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_215552465	508188	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_195107041	494820	Large	TN	TN	TN	TP	TP	TP
PXL_20211115_213218317	482829	Large	TN	TN	TN	TP	TP	TP
PXL_20211120_025012600	403545	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_151736693	382856	Large	TN	TN	TN	FN	TP	TP
PXL_20211123_000135468	372048	Large	TN	TN	TN	TP	TP	TP
PXL_20211115_020345079	340169	Large	TN	TN	TN	TP	TP	TP
PXL_20220112_161838882	337349	Large	TN	TN	TN	FN	FN	FN
PXL_20220127_211457598	323677	Large	TN	TN	TN	TP	TP	TP
PXL_20220107_001742866	320779	Large	TN	TN	TN	TP	TP	TP
PXL_20211208_001112507	299077	Large	TN	TN	TN	TP	TP	TP
PXL_20211210_182128878	282296	Large	TN	TN	TN	TP	TP	TP
PXL_20211220_042137350	279668	Large	TN	TN	TN	TP	TP	TP
PXL_20220104_013022232	278043	Large	TN	TN	TN	TP	TP	TP
PXL_20220106_203523709	277152	Large	TN	TN	TN	TP	TP	TP
PXL_20211125_195530884	274631	Large	TN	TN	TN	TP	TP	TP
PXL_20211130_024543915	255777	Large	TN	TN	TN	TP	TP	TP
PXL_20211225_041450333	235067	Large	TN	TN	TN	TP	TP	TP
PXL_20211123_075849670	212304	Large	FP	FP	FP	FN	FN	FN
PXL_20220207_211543518	203786	Large	TN	TN	TN	FN	TP	TP
PXL_20220110_211153569	195330	Large	TN	TN	TN	FN	FN	FN
PXL_20220202_191451628	169369	Large	FP	TN	TN	TP/FP	TP	TP
PXL_20220127_202938471	161896	Large	TN	TN	TN	FN	FN	FN
PXL_20211118_233802618	161121	Large	TN	TN	TN	TP/FP	TP/FP	TP/FP
PXL_20220202_021629209	152073	Medium	TN	TN	TN	TP	TP	TP
PXL_20211124_234835882	151210	Medium	TN	TN	TN	TP	TP	TP
PXL_20220123_172227166	148496	Medium	TN	TN	TN	FN	FN	TP
PXL_20211117_192545379	144420	Medium	TN	TN	TN	FN	FN	FN
PXL_20211114_024220416	142236	Medium	TN	TN	TN	TP	TP	TP
PXL_20211208_231246726	130406	Medium	FP	FP	FP	TP	TP/FP	TP/FP
PXL_20220109_223245302	126879	Medium	TN	TN	TN	FN	FN	FN
PXL_20211231_221719341	121865	Medium	TN	TN	TN	FN	FN	FN
PXL_20211204_040746262	118553	Medium	TN	TN	TN	FN	TP	TP
PXL_20220202_003812704	117856	Medium	TN	TN	TN	FN	TP	TP
PXL_20220101_231809947	107154	Medium	TN	TN	TN	TP	TP	TP
PXL_20220121_143546713	94797	Medium	TN	TN	TN	TP	TP	TP
PXL_20211204_183457116	91936	Medium	TN	TN	TN	TP	TP	TP
PXL_20220119_163512268	91741	Medium	TN	FP	FP	TP	FN	FN
PXL_20220122_182736072	87464	Medium	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20220203_194950797	86489	Medium	TN	TN	TN	TP	TP	TP
PXL_20220125_231758799	80752	Medium	TN	TN	TN	FN	FN	FN
PXL_20211201_004234519	73759	Medium	TN	TN	TN	FN	TP	TP
PXL_20220128_190449804	72621	Medium	TN	TN	TN	TP	TP	TP
PXL_20211223_145308256	70324	Medium	TN	TN	TN	FN	TP	TP
PXL_20211130_022617175	68501	Medium	TN	TN	TN	TP	TP	TP
PXL_20220128_180933948	65045	Medium	TN	TN	TN	FN	FN	TP
PXL_20211223_161103181	62265	Medium	TN	TN	TN	FN	FN	TP
PXL_20211118_150807317	61385	Medium	TN	TN	TN	FN	FN	FN
PXL_20220106_200910142	56327	Medium	TN	TN	TN	FN	FN	FN
PXL_20211130_152307787	53656	Medium	TN	TN	TN	FN	TP	TP

Filename	Cloned Pixels	Manip. Size	Unedited - After Facebook			Cloned - After Facebook		
			Quality 0	Quality 6	Quality 12	Quality 0	Quality 6	Quality 12
PXL_20211108_145346777	53027	Medium	TN	FP	FP	FP	FP	FP
PXL_20220103_022923925	50418	Medium	TN	TN	TN	FN	FN	FN
PXL_20220202_055706418	50089	Medium	TN	TN	TN	FN	FN	FN
PXL_20220205_155502780	47003	Medium	TN	TN	TN	TP	TP	TP
PXL_20211102_224010950	44798	Medium	FP	TN	FP	TP/FP	TP/FP	TP/FP
PXL_20220121_215805508	42840	Medium	TN	TN	TN	FP	FN	FN
PXL_20220203_170250905	42002	Medium	FP	TN	TN	TP	TP	TP
PXL_20220202_004959530	41282	Medium	TN	TN	TN	TP	TP	TP
PXL_20211203_192532020	41190	Small	TN	TN	TN	FP	FN	FN
PXL_20211125_011030722	37632	Small	TN	TN	TN	FN	FN	FN
PXL_20211112_155441302	36753	Small	TN	TN	TN	FN	FN	FN
PXL_20211230_182319363	35529	Small	FP	TN	TN	TP	TP	TP
PXL_20220207_210924601	35103	Small	TN	TN	TN	FN	FN	FN
PXL_20211127_032653437	34698	Small	TN	TN	TN	FN	FN	TP
PXL_20211031_232916890	31763	Small	TN	TN	TN	FN	FN	TP
PXL_20220130_220306079	30622	Small	TN	TN	TN	TP	TP	TP
PXL_20211101_012518674	29285	Small	TN	TN	TN	TP	TP	TP
PXL_20211230_175948761	28945	Small	TN	TN	TN	FP	FN	FN
PXL_20211127_161543654	27981	Small	TN	TN	TN	FN	FN	FN
PXL_20211203_192408677	27562	Small	TN	TN	TN	FP	FN	FN
PXL_20220203_021456944	25326	Small	TN	TN	TN	TP	TP	TP
PXL_20220127_193750034	25282	Small	TN	TN	TN	FN	FN	FN
PXL_20220123_025449943	24256	Small	TN	TN	TN	TP	TP	TP
PXL_20211227_002412122	22823	Small	TN	TN	TN	TP	TP	TP
PXL_20211223_143207013	21125	Small	TN	TN	TN	TP	TP	TP
PXL_20220122_234119635	20064	Small	TN	TN	TN	FN	FN	FN
PXL_20220131_190941169	17204	Small	TN	TN	TN	TP	TP	TP
PXL_20220204_163348941	15378	Small	TN	TN	TN	TP	TP	TP
PXL_20211129_231243713	11604	Small	TN	TN	TN	TP	TP	TP
PXL_20220123_000329973	10649	Small	TN	TN	TN	FN	FN	FN
PXL_20211202_192936903	9606	Small	TN	TN	TN	TP	TP	TP
PXL_20220112_172718498	8468	Small	TN	TN	TN	FN	FN	FN
PXL_20211130_184109511	7712	Small	FP	TN	TN	FP	FN	FN
PXL_20220112_171347858	7018	Small	FP	FP	FP	TP/FP	TP/FP	TP/FP
PXL_20211231_153858378	4745	Small	FP	TN	TN	FN	FN	FN
PXL_20220127_193817530	4510	Small	TN	TN	TN	FN	FN	FN
PXL_20220210_183619512	3429	Small	FP	FP	FP	FP	FP	FP
PXL_20220203_175537256	3387	Small	TN	TN	TN	FN	FN	FN
PXL_20211224_011426278	3031	Small	TN	TN	TN	FN	FN	FN
PXL_20220202_180720038	2456	Small	TN	TN	TN	FN	FN	FN
PXL_20220204_125528620	997	Small	TN	TN	TN	FN	FN	FN

	TP	TN	FP	FN	MCC
Quality 0	55	87	26	38	0.37
Quality 6	61	92	16	37	0.49
Quality 12	66	91	17	32	0.53

	Precision	Accuracy	Fall-Out
Quality 0	0.68	0.71	0.26
Quality 6	0.79	0.77	0.16
Quality 12	0.80	0.79	0.17