Assignment 3 Report

1 Verifying Image Source by JPEG Quantization Table

1.1 Using JPEGsnoop to examine images

1.1.1 imageOrigin1.jpg

Exif information: Canon / Canon PowerShot A75

Luminance quantization table:

```
 1   1   1   2   3   6   8  10
 1   1   2   3   4   8   9   8
 2   2   2   3   6   8  10   8
 2   2   3   4   7  12  11   9
 3   3   8  11  10  16  15  11
 3   5   8  10  12  15  16  13
 7  10  11  12  15  17  17  14
14  13  13  15  15  14  14  14
```

Chrominance quantization table:

```
 4   4   5   9  15  26  26  26
 4   4   5  10  19  26  26  26
 5   5   8   9  26  26  26  26
 9  10   9  13  26  26  26  26
15  19  26  26  26  26  26  26
26  26  26  26  26  26  26  26
26  26  26  26  26  26  26  26
26  26  26  26  26  26  26  26
```

This software reports that the image is very likely to be original – that is, quantization tables match the make and model in metadata section.

1.1.2 imageOrigin2.jpg

Exif information: Minolta Co., Ltd. / DiMAGE S304

Luminance quantization table:

```
 1   1   4   5   6   5   2   5
 1   2   6   5   1   2   8   5
 1   1   2   1   1   8   3   6
 1   1   1   1   6   2   8  12
 1   2   5   1   7  10  10  12
 4   6   2  10  11   8  10  11
 5   3  10   9   7   7   9  10
 5   6   4   6   9   9  10   9
```

Chrominance quantization table:

```
 1   1   9   9   9   9   9   9
 2   9   9   9   2   9   9   9
 4   1   9   2   6   9   9   9
 2   6   5   4   9   9   9   9
 2   9   9   9   9   9   9   9
 9   9   9   9   9   9   9   9
 9   9   9   9   9   9   9   9
 9   9   9   9   9   9   9   9
```

This software reports that the image is very likely to be original – that is, quantization tables match the make and model in metadata section.

1.1.3 imageOrigin3.jpg

Exif information: Canon / Canon PowerShot SD400

Luminance quantization table:

```
 1   1   2   2   3   3   7  14
 1   1   2   2   3   5  10  13
 1   2   2   3   8   8  11  13
 2   3   3   4  11  10  12  15
 3   4   6   7  10  12  15  15
 6   8   8  12  16  15  17  14
 8   9  10  11  15  16  17  14
10   8   8   9  11  13  14  14
```

Chrominance quantization table:

```
 4   4   5   9  15  26  26  26
 4   4   5  10  19  26  26  26
 5   5   8   9  26  26  26  26
 9  10   9  13  26  26  26  26
15  19  26  26  26  26  26  26
26  26  26  26  26  26  26  26
26  26  26  26  26  26  26  26
26  26  26  26  26  26  26  26
```

This software reports that the image is very likely to be original – that is, quantization tables match the make and model in metadata section.

1.1.4 imageOrigin4.jpg

Exif information: Minolta Co., Ltd. / DiMAGE S304

Luminance quantization table:

```
 4   3  11  14  17  15   8  14
 2   6  17  16   4   6  24  15
 4   3   7   3   4  22  10  18
 3   5   4   4  17   6  23  34
 4   6  16   5  22  29  29  34
11  19   6  29  32  24  28  32
16  10  31  26  22  20  28  28
16  19  14  18  26  27  29  28
```

Chrominance quantization table:

```
 4   5  28  28  28  28  28  28
 6  28  28  28   6  28  28  28
13   5  28   7  18  28  28  28
 6  18  16  13  28  28  28  28
 7  28  28  28  28  28  28  28
28  28  28  28  28  28  28  28
28  28  28  28  28  28  28  28
28  28  28  28  28  28  28  28
```

This software reports not being able to classify the image – that is, the quantization tables do not seem to match any tables that used by this make and model. While from the Exif information, there is no evidence that the image is edited.

1.1.5 imageOrigin5.jpg

Exif information: Sony / DSC-V1

Luminance quantization table:

```
1   1   1   1   2   3   4   5
1   1   1   2   2   5   5   4
1   1   1   2   3   5   6   4
1   1   2   2   4   7   6   5
1   2   3   4   5   9   8   6
2   3   4   5   6   8   9   7
4   5   6   7   8  10  10   8
6   7   8   8   9   8   8   8
```

Chrominance quantization table:

```
1   1   2   4   8   8   8   8
1   2   2   5   8   8   8   8
2   2   4   8   8   8   8   8
4   5   8   8   8   8   8   8
8   8   8   8   8   8   8   8
8   8   8   8   8   8   8   8
8   8   8   8   8   8   8   8
8   8   8   8   8   8   8   8
```

This software reports that the image is very likely to be original – that is, quantization tables match the make and model in metadata section.

1.1.6 imageOrigin6.jpg

Exif information: None

Luminance quantization table:

```
 8   6   5   8  12  20  26  31
 6   6   7  10  13  29  30  28
 7   7   8  12  20  29  35  28
 7   9  11  15  26  44  40  31
 9  11  19  28  34  55  52  39
12  18  28  32  41  52  57  46
25  32  39  44  52  61  60  51
36  46  48  49  56  50  52  50
```

Chrominance quantization table:

```
 9   9  12  24  50  50  50  50
 9  11  13  33  50  50  50  50
12  13  28  50  50  50  50  50
24  33  50  50  50  50  50  50
50  50  50  50  50  50  50  50
50  50  50  50  50  50  50  50
50  50  50  50  50  50  50  50
50  50  50  50  50  50  50  50
```

This software reports that the image is modified by other editing software. The 2 tables match Sony Cybershot U, and do not match any editing software. Since no Exif information found, and quantization tables are not ideal match, JPEGsnoop reports it as edited.

1.2 Conclusion and Analysis

Not every image contains complete and accurate Exif information. If JPEGsnoop does not find a match, it does not necessarily mean that the origin has been falsified. It is possible to use customized quantization table that not recorded, and Exif information can be easily edited or erased. Under such circumstance, an original image may also have no matching tables.

1.3 Way to Pass JPEGsnoop

Record some quantization tables that used by other makes and models, replace the default quantization tables in current camera. When JPEGsnoop examines falsified image, a match between other makes and models will be reported. Meanwhile if Exif information is edited accordingly, the image would pass JPEGsnoop.

2 Detecting JPEG Blocking Artifacts

2.1 MATLAB Function

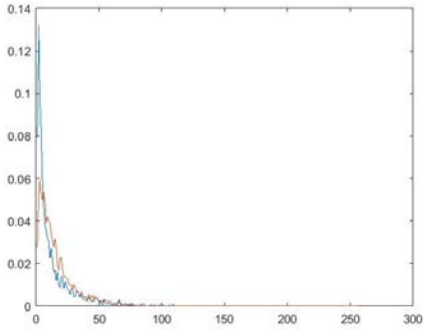
```
function K = JPEGblockArtifact(image)
% Input
%     image: original image for detection
% Return
%     K: the strength of block artifacts

    image = int16(image);
    % Size information.
    [imgRow, imgCol] = size(image);
    % Enlarge image by 1 row and 1 column for Z'' calculation.
    image = [image image(:, 1); image(1, :) image(1, 1)];
    blockRow = floor(imgRow / 8);
    blockCol = floor(imgCol / 8);

    % Initialize Z' and Z'' matrix.
    Zp = uint8(zeros(blockRow, blockCol));
    Zpp = uint8(zeros(blockRow, blockCol));

    for i = 1 : blockRow
        for j = 1 : blockCol
            iBase = (i - 1) * 8 + 1;
            jBase = (j - 1) * 8 + 1;
            % Calculate Z' and Z'' element one by one.
            Zp(i, j) = abs( ...
                image(iBase+3, jBase+3) - image(iBase+3, jBase+4) - ...
                image(iBase+4, jBase+3) + image(iBase+4, jBase+4));
            Zpp(i, j) = abs( ...
                image(iBase+7, jBase+7) - image(iBase+7, jBase+8) - ...
                image(iBase+8, jBase+7) + image(iBase+8, jBase+8));
        end
    end

    % Get normalized histograms.
    HI = imhist(Zp);
    HI = HI ./ sum(HI);
    HII = imhist(Zpp);
    HII = HII ./ sum(HII);

    % Draw histograms.
    figure, plot(HI);
    hold, plot(HII);

    % Calculate strength.
    K = sum(abs(HI - HII));

end
```

2.2 Examine Images

Detection is set to be 0.25, results of 3 images are shown as following.

2.2.1 Image 1

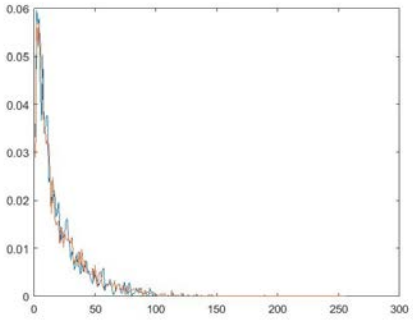
Histogram of H_I and H_{II} is shown below.



In this graph, blue curve is for H_I while red curve is for H_{II}. Value of K is 0.4518, which is greater than 0.25 threshold. This image is reported as having block artifacts so that compressed.

2.2.2 Image 2

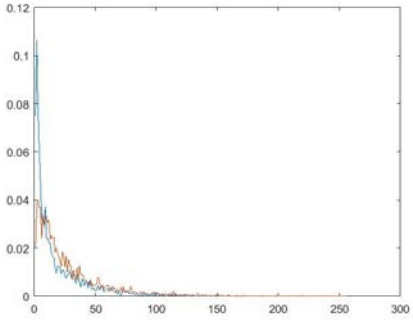
Histogram of H_I and H_{II} is shown below.



In this graph, blue curve is for H_I while red curve is for H_{II}. Value of K is 0.1875, which is less than 0.25 threshold. This image is reported as not having block artifacts so that uncompressed.

2.2.3 Image 3

Histogram of H_I and H_{II} is shown below



In this graph, blue curve is for H_I while red curve is for H_{II}. Value of K is 0.4570, which is greater than 0.25 threshold. This image is reported as having block artifacts so that compressed.

3 Detecting DCT Coefficients

3.1 MATLAB Function to Calculate and Display DCT Coefficients

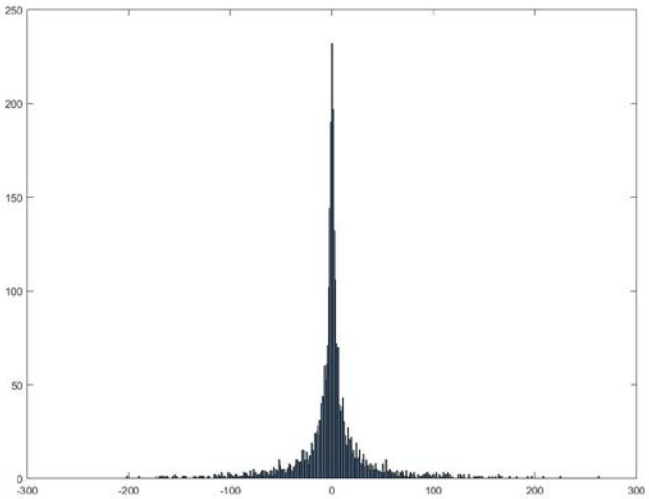
```
function coefficient = getDCTcoefficient(image, row, col)
% Input
%     image: input image for DCT dectection
%     row: row index of DCT subband
%     col: column index of DCT subband
% Return
%     coefficient: retrieved DCT coefficients

    % Initialize block size.
    blockSize = 8;

    % Performing DCT by 8 * 8 block
    image = double(image) - 128;
    image = blkproc(image, [blockSize blockSize], 'dct2(x)');

    % Get corresponding DCT coefficients.
    coefficient = image(row : blockSize : end, col : blockSize : end);

    % Display the histogram.
    histogram(coefficient, 'binmethod', 'integers');

end
```

3.2 Examine Images

The DCT sub-band index is set to (2, 2).

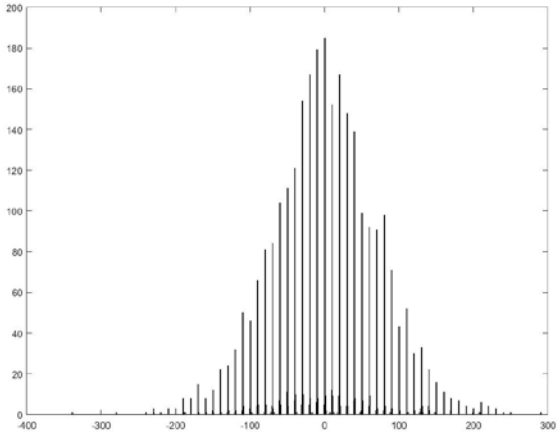
3.2.1 Image 1

The DCT coefficients plot is as the graph shown below.



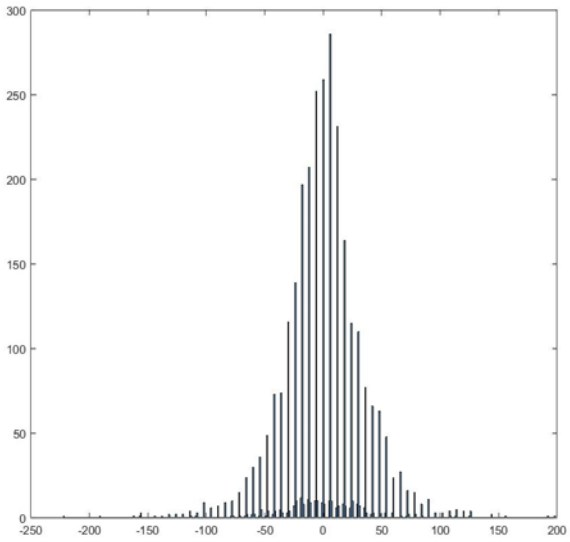
3.2.2 Image 2

The DCT coefficients plot is as the graph shown below.



3.3 Image 3

The DCT coefficients plot is as the graph shown below.



3.4 JPEG Image Compressed at Least Once

Image 2 & 3 are compressed at least once.

3.4.1 Image 2

According to observation of histogram, there are 10 intervals between 0 and 100. So that we can infer quantization interval of image 2 is 100 / 10 = 10. This image is suspected to be compressed twice, and 10 is considered to be the last compression interval.

3.4.2 Image 3

According to observation of histogram, there are 8 bins between roughly 0 and some integer slightly less than 50. If we choose the integer of 48, then we can infer the quantization interval can be solved easily: 48 / 8 = 6.

3.5 JPEG Image Compressed Twice

Image 2 is compressed twice. The quantization interval used by second compression is larger than first compression. (Quality factor q_2 is smaller.)

The histogram of second image matches this pattern – unreasonably lower bars than left and right appear periodically. Different intervals used during 2 compressions causes recent quantized values do not distribute unevenly to new intervals. For instance, it may happen that there are 3 first interval centers located in current second interval, while next larger interval only has 2 first interval centers located.