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Analysis of Image Features Taken from Different Camera Types

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ABSTRACT

It is necessary to know how a camera resolution and/or its flashlight may affect the captured image properties and features, this is essential especially for those who work in the field of image processing. If the features are modified according to the mentioned two factors, they won't be valid for processing and analysis, therefore a study should be planed to discover the impact of the presence or absence of those two factors on image features and this was implemented by this paper. Using 11 different digital and cell phone cameras (with and without the flashlight), some histogram and texture image features showed that they change in value and level according to these factors. The Mean feature remains in the high level and does not affect when the resolution of the camera changes from the low to high resolution, but in the cell phone it almost gives medium to high levels in all cases. The Variance of an image showed that in low resolution without flashlight, the camera and cell phone give the same result which is a high level, while the Entropy feature is not affected when the device changes from the normal camera to cell phone camera. More histogram features also are studied later. Contrast feature, as being a texture feature, has a low level in high resolution without a flashlight, Energy, correlation and Homogeneity features are studied and many results were concluded to the researchers who are concerned in image processing.
Matlab 2015 and Microsoft Excel are used to complete this work

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تحليل ميزات الصور الملتقطة بمختلف أنواع الكاميرات

الخلاصة

من الضروري معرفة تأثير دقة الكاميرا و/أو إضاءتها على ميزات الصور الملتقطة وخاصة لمن يعمل ضمن مجال معالجة الصور . إذ أن أي تغيير يطرأ على هذه الميزات سيجعل من الصورة غير صالحة للتحليل والمعالجة لذا يستحسن تنظيم دراسة تتناول مدى تأثير هذه العوامل على ميزات الصور ، وهذا ما تم إنجازه في هذا البحث. من خلال استخدام 11 نوع مختلف من الكاميرات الرقمية وكاميرات الهواتف الخلوية تبين أن بعض ميزات الرسم البياني وميزات نسيج الصور تأثرت وتغير مقدارها ومستواها. حيث تبين أن ميزة متوسط قيم الصورة تبقى بمستوى عالي ولا تتأثر بدقة الكاميرا عموما في أنواع الكاميرات الرقمية لكن في كاميرات الهواتف الخلوية في بحدود متوسطة أو عالية عموما. أما ميزة التباين فهي في الكاميرات ذات الدقة الواطئة وبغياب الإضاءة فإن نتائجها عالية المستوى بينما ميزة الأنتروبيا لا تتأثر بتغير نوع الجهاز . ميزة التناقض وهي من ميزات نسيج الصور تمتلك مستوى واطئ في الكاميرات ذات الدقة العالية وبدون إضاءة. كما تم دراسة ميزات الطاقة، الترابط والتجانس وتم تسجيل نتائجها ليستفاد منها من قبل الباحثين المهتمين.

الكلمات المفتاحية:

ميزات الصور, إضاءة الكاميرا, ميزة الرسم البياني, ميزة نسيج الصورة.

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Introduction

As it is known for everybody, the main job of a camera is to capture pictures, but the principle of picturing evolved year after another since the early black and white cameras. The idea is to take a 2D picture after applying sufficient light to the object to remove the darkness. The 2D picture means that it contains coordinates defined by the spatial domain positions [1].

It is necessary to know that a digital image contains a finite number of elements, each having a particular amplitude and location and these elements are called image elements, or image pixels. So the image pixel is the unit that is used to represent the digital image elements. Thus, digital image processing encompasses a wide and varied field of applications [2].

In image processing, the pixels count in digital imaging is referred to as image resolution, Usually, with any given lens setting, the smaller the size of the pixel, the higher the resolution will be and the clearer the object in the image will be. Images having smaller pixel sizes might consist of more pixels. The number of pixels correlates to the amount of information within the image. Pixel resolution could be written by a set of two positive real numbers, in which the first number represents the image width or image pixels' columns and the second numbers is the image height or the number of the pixel rows, for example as *7680 by 6876*. Other conventions may include the description of pixels per length unit or per area unit, such as pixels per inch. An image having 1024 pixels in width and 2048 pixels in height has a total of 1024× 2048 = 2097152 pixels [2].

Images from Different Camera Types

1. Digital Cameras and Cell-phone Cameras:

It will take many pages to write about the early cameras but starting from the digital cameras: S. Sasson, who was an engineer at Eastman Kodak Company, invented the first electronic camera using a charge-coupled device image sensor in 1975[3]. Early cameras used tubes and they were used in military and limited uses but later ones digitized the signal and got through technology application.

As the electronic and digital technology is adopted by researchers and companies, the digital cameras started to be used and it took only few years that, Sharp introduced the world's first digital camera phone "the J-SH04 J-Phone", in Japan in the year 2000. By the mid-2000s, higher-end cell phones had an integrated digital camera. By the beginning of the 2010s, almost all smart phones had an integrated digital camera.

It is obvious that the worldwide boom in mobile cell phone penetration has changed the global technology landscape. As cell phone operators look to capitalize further on this huge market, there are high hopes that, following on from the success of text messaging (especially in Europe and Asia). A statistic study in Japan shows that camera phone sales exceed 50% of the mobile phone market, with major operators such as J-Phone reporting over 70% of customers subscribing to MMS (Multimedia Messaging Service). The value of the cell phones increases as the camera is more precise [4].

It is important not to forget the flash light that exits in both cameras and cell phones. Many cameras have an electronic flash built in, but most cameras need a separate unit. Called on-camera flash, these units slide into a bracket, called a shoe, located on top of the camera. There are many flash models available, but almost all can be generally classified as follows: TTL autoflash, non-TTL auto flash, and manual [1]. As it exists in cameras, the flash light became necessary in cell phone cameras.

Figure 1: Different camera types with flashlight

2. Conversion of Images from RGB to Gray Level:

The true colored images are known as RGB images according to (**R**ed, **G**reen, **B**lue) which are the three primary colors and each color represents an isolated plane or level which means each pixel is specified by three values one in each level. Assuming 8 bits for each level (24 bits all) we can get (256, 256, 256) different colors, or 16777216 color [5].

Usually most of image processing studies are done to images after their conversion from RGB image to a gray level image to become easier in processing (working on one layer instead of 3) and in this paper the gray level images are depended for the same reason. Most commonly used storage method is 8-bit storage. There are 256 gray levels in an 8bit gray scale image, and the intensity of each pixel can have from 0 to 255, with 0 being the pure black and 255 being the pure white [6].

The transformation can be made by using proposed equation:

$$Y=0.299R+0.587G+0.114B \qquad (1)$$

Where: R, G and B component represents the Red, Green and Blue intensities respectively and Y is the resultant intensity of equivalent gray scale or gray level of RGB image [6].

Figure 2: An RGB image and its conversion to the gray level

3. Image Features

There are a lot of image feature types, but in this work histogram and texture features are used. Most image processing projects work on histogram features because of being very common and give exact and precise results according to many previous studies, some histogram features where used, also four texture features based on gray level co-occurrence matrix (GLCM) were depended to achieve good results. Medical images, object detection, artificial intelligence, etc... are some application fields of the mentioned feature types.

3.1 Histogram Features:

The histogram of an image is a plot of the gray _levels values versus the number of pixels at that value. A histogram appears as a graph with "brightness" on the horizontal axis from 0 to 255 (for an 8-bit) intensity scale and "number of pixels "on the vertical axis. The histogram gives us a convenient easy to read representation of the concentration of pixels versus brightness of an image [7]. Examples of the different types of histograms are shown in the figure below [3].

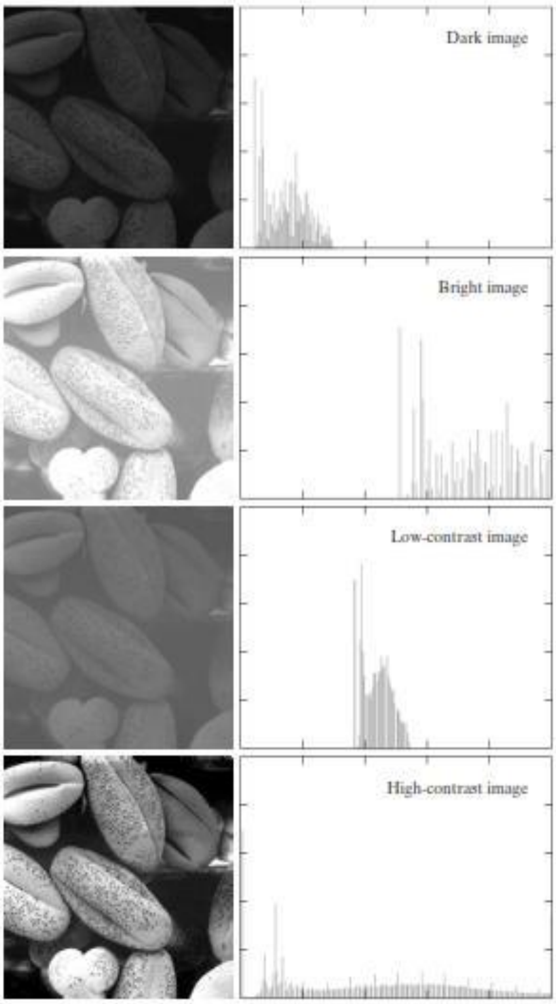

Figure 3:Different types of histogram [3]

Various features such as mean, entropy, variance, skewness and kurtosis based on the first order histogram are computed using the following equations [8]:

Mean Feature:

The average intensity values of the pixels are denoted by this feature.

$$\text{Mean } (\mu) = \frac{1}{MxN}\sum_{m=1}^{M}\sum_{n=1}^{N} Z(n,m) \qquad .(2)$$

Where: (z), represents the intensity value, n and m represent the rows and columns respectively.

EntropyFeature:

The randomness of a gray level distribution is represented by the entropy feature. The entropy would be high if the gray levels are distributed randomly throughout the image.

$$\text{Entropy } e(z) = -\sum_{i=0}^{l-1} p(Zi)\log_2 p(Zi) \qquad (3)$$

where: $P(Z_i)$ is the probability of the pixel (Z) at the given (i) values, i= 0,1,2, … L-1,where L is 256 for 8-bit image.

Variance Feature:

The variance between the pixels in the input image is represented by this feature.

$$\text{variance } \sigma^2 = \frac{1}{MxN}\sum_{m=1}^{M}\sum_{n=1}^{N}(Z(n,m)-\mu)^2 \qquad (4)$$

Where (μ) represents the mean value.

Skewness Feature:

Skewness measures the asymmetry of the probability distribution of a random, real-valued variable. The skewness value can be positive or negative and it is represented as the equation below, where M: number of row, N: number of Columns

$$\text{skewness} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(Z(i,j)-\mu)^3/M*N}{\sigma^3} \qquad (5)$$

Kurtosis Feature:

Kurtosis is any measure of the probability distribution of also a real-valued random variable. As in the skewness feature, kurtosis describes the shape of a probability distribution. There are many different ways of quantifying it for a theoretical distribution and corresponding ways to estimate it from a sample of a population.

$$\text{kurtosis} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(Z(i,j)-\mu)^4/M*N}{\sigma^4} \qquad (6)$$

3.2 Texture Features Based on Gray Level Co-Occurrence Matrix (GLCM):

Regardless the brightness or the intensity of the pixels, another feature type should be taken into account that deals with the pixels positions and their relations between each others, so the GLCM basically considers the relation between any two neighboring pixels in the same offset. The relationships between the gray valued pixels in a position are transformed into the co-occurrence matrix referred as GLCM [2]. The GLCM has information about the directions and positions of the pixels that have the same gray level values. Each element, let’s say: (x, y) represents the count of times that the pixel having the x value occurred horizontally adjacent to a pixel having the y. Computation has been made in the manner where, Element (1, 2) in the GLCM figure below contains the value 2 because there are two instances in the image where two, horizontally adjacent pixels have the values 1 and 2. On the other hand the pixel element (1, 1) in the GLCM contains the value 1 because there is only one instance in the image where two, horizontally adjacent pixels have the values 1 and 1as it is shown. Describing texture features should be based on regarding pixels relative position with respect to each other [2]. The proposed method in this paper is based on extracting and using texture properties of an image which are detected indirectly using the co-occurrence matrix, assuming *Z(i,j)* is the image pixels, having i and j as pixel positions and N as the number of rows and columns.

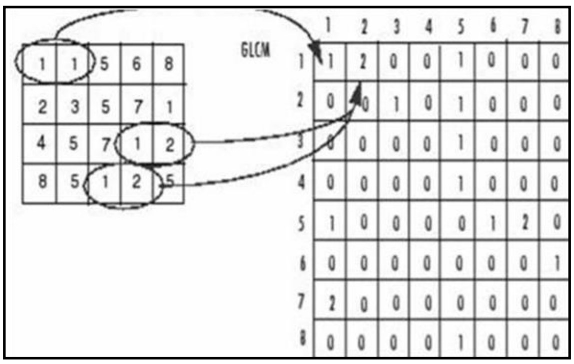

Figure 4: Creation of GLCM from Image Matrix

The Contrast Feature:

The local contrast of an image is denoted by this feature. The Contrast is expected to be low if the gray levels of the pixels are similar. Contrast is the feature that is concerned in the difference between visual properties that distinguishes an object from any other objects and the background. Contrast could be determined by the difference in brightness and color from one object to another within the same field of view.

$$\text{contrast} = \sum_{i=1}^{N}\sum_{j=1}^{N}(i-j)^2 Z i,j \qquad (7)$$

The Correlation Feature:

The gray level linear dependence between the pixels at the specified positions relative to each other is explained by this feature. It gives an indication of how much the pixels are correlated together.

$$\text{correlation} = \sum_{i=1}^{N}\sum_{j=1}^{N}\frac{(i-\mu)(j-\mu)Z(i,j)}{\sigma i\ \sigma j} \qquad (8)$$

Where: $\sigma i \neq 0$, $\sigma j \neq 0$

σi: is the standard deviation in rows.

σj: is the standard deviation in columns.

The Energy Feature:

The uniformity of the texture is described by this feature. In a homogeneous image, there are very few dominant gray-tone transitions; hence this image will have fewer entries of large magnitude. So, the energy of an image is high when the image is homogeneous.

$$energy = \sum_{i=1}^{N}\sum_{j=1}^{N} Z(i,j)^2 \qquad (9)$$

The Homogeneity Feature:

The closeness of the distribution of elements in the GLCM to the GLCM diagonal and range = [0 1] is measured by homogeneity. Homogeneity is 1 for a diagonal GLCM. Thus, the total number of features used in this work is 16 from three different categories.

$$\text{Homogeneity} = \sum_{i=1}^{N}\sum_{j=1}^{N}\frac{Z(i,j)}{1+|i-j|} \qquad (10)$$

4. Processing and Results

4.1 Choosing an Appropriate Image:

A suitable scene containing many color intensities and various texture types is chosen to be captured and to be studied.

5: **The chosen scene to study its features**

4.2 Image Capturing:

After choosing the scene, 11 digital and cell phone cameras are used twice to take pictures, with and without the flashlight, thus 22 pictures were created. It is worth noting that all these cameras differ in resolution. The previous table shows the camera types and their resolutions.

Table 1: Camera Types, Models and Resolutions

Device Type	Model	Resolution in Pixels
Cell Phone	IPhone 4s	8MP
Cell Phone	IPhone 6	8MP
Cell Phone	Nokia n8	12MP
Cell Phone	Nokia x2	5MP
Cell Phone	Samsung s4	13MP
Cell Phone	Samsung zoom	20.7MP
Cell Phone	Sony z1	21MP
Camera	Sony 12	12.1MP
Camera	Sony 14	14.1MP
Camera	Mercury	4MP
Camera	Canon 1100D	12.6MP

4.3 Preprocessing:

Preprocessing is achieved first by cropping the edges of images to trim the margins that are not captured in some cameras (because of exchanging cameras in every capturing) and normalize the boundaries according to the default scene, then by converting the images to gray level. In the next tables the letter (f) at the end of each device type means capturing images with flashlight.

Figure 6:An image cropped then converted to gray level

Table 2: Image resolution before and after cropping

Device Type	Original resolution	After cropping
Canon 1100D f	4272x2848	3027x2303
Iphone4s f	3264x2448	2542x1843
Mercury4 f	1120x840	967x701

Iphone6 f	3264x2448	2605x1872
Nokia n8 f	4000x2248	2896x2042
Nokia x2 f	2592x1944	2174x1618
Samsung s4 f	4128x2322	2978x1985
Sony 12.1 f	4000x3000	3787x2600
Samsung zoom f	5184x2916	3688x2649
Sony z1 f	3840x2160	2715x1907
Sony 14.1 f	4320x3240	3888x2685
Canon 1100D	4272x2848	3028x2238
Iphone4s	3264x2448	2530x1847
Mercury4	1120x840	965x700
Iphone6	3264x2448	2603x1875
Nokia n8	4000x2248	2910x2045
Nokia x2	2592x1944	2169x1612
Samsung s4	4128x2322	2974x1996
Sony12.1	4000x3000	3875x2707
Samsung zoom	5184x2916	3685x2661
Sony z1	3840x2160	2708x1907
Sony 14.1	4320x3240	3909x2672

As the resolution is mentioned in [2], the image loses its original resolution in case of cropping pixels from its margins, therefore the results of resolution changed after cropping.

4.4 Feature Extraction:

After cropping and converting to gray level images we extract histogram and texture features.

Through this flow chart the steps of this paper could be understood clearly, the first step is to read the image, then applying some preprocessing steps which are: unifying all images by cropping then converting from RGB level to Gray level. Thus the extraction of histogram and texture feature values is applied. saving the results into a data base, Leveling step is necessary to separate the feature values into low, medium and high values, later, classifying features according (LR WF, LR WOF, HR WF HR WOF), Finally analysis the features and concluding the results of this work.

Where:

LR: Low Resolution, WF: With Flashlight,

HR: High Resolution, WOF: Without Flashlight

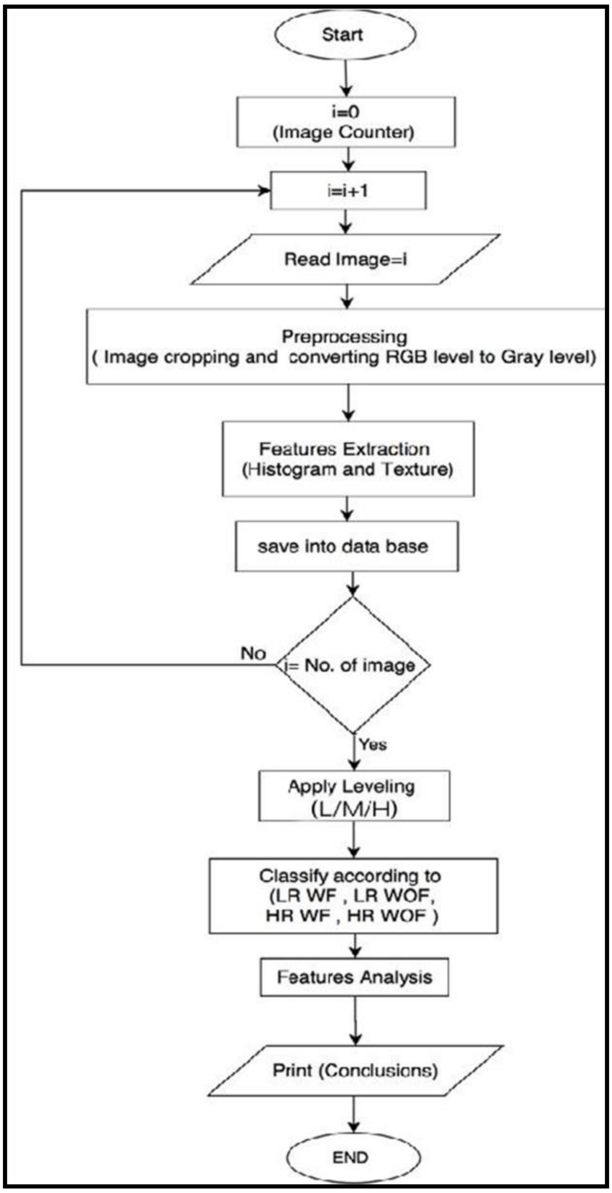

Figure 7:The main work flow chart

4.5 Results:

The camera results according to the features were saved in the following tables 3 and 4:

Table 3: Result of histogram features

Device Type	Mean	Variance	Entropy	Skewness	Kurtosis
Canon 1100D	105	2.70E+03	3.63E-06	0.19894	2.1229
Canon 1100D f	125	2.62E+03	3.47E-06	0.1291	2.100
Iphone4s	111	3.44E+03	0.00	0.252	2.267
Iphone4s f	101	3.45E+03	0.00	0.3756	2.376
Iphone6	103	3.59E+03	2.19E-05	0.3783	2.164
Iphone6 f	106	3.43E+03	1.36E-05	0.3768	2.181
Mercury 4	121	3.76E+03	1.11E-04	-0.0280	2.105
Mercury 4f	101	2.14E+03	1.11E-04	0.6079	3.270
Nokia n8	101	2.82E+03	3.79E-05	0.2815	2.48
Nokia n8f	103	2.69E+03	6.02E-05	0.3084	2.541
Nokia x2	107	3.42E+03	1.28E-4	0.2335	2.178
Nokia x2f	94.9	2.86E+03	1.22E-04	0.3245	2.274
Samsung s4	117	3.80E+03	4.22E-04	0.1684	2.043
Samsung s4f	110	3.40E+03	2.6E-04	0.2860	2.189
Samsung zoom	108	2.45E+03	0.00	0.2384	2.430
Samsung zoomf	119	2.28E+03	0.00	0.1769	2.438
Sony 12.1	106	3.31E+03	0.00	0.1232	2.235
Sony 12.1f	66	1.89E+03	0.00	0.9470	4.115
Sony 14.1	109	2.83E+03	2.37E-06	0.2301	2.387
Sony 14.1f	125	2.28E+03	0.00	0.3042	2.55
Sony z1	118	3.14E+03	4.6E-06	0.0563	2.151
Sony z1f	117	3.01E+03	0.00	0.1046	2.168

Table 4: Result of texture features

Device Type	contrast	correlation	energy	homogeneity
Canon 1100D	0.11263	0.97966	0.13441	0.94784
Canon 1100D f	0.1347	0.9745	0.1296	0.9355
Iphone4s	0.1708	0.9751	0.108	0.9278
Iphone4sf	0.1826	0.9730	0.1134	0.9283
Iphone6	0.239	0.9665	0.1062	0.9174
Iphone6f	0.2532	0.9630	0.1044	0.9095
Mercury 4	0.362	0.9508	0.08873	0.8856
Mercury 4f	0.3864	0.9109	0.1265	0.8758
Nokia n8	0.1501	0.9729	0.1272	0.935
Nokia n8f	0.1648	0.9693	0.1263	0.9296
Nokia x2	0.3060	0.9553	0.1029	0.9095
Nokia x2f	0.2661	0.9533	0.1215	0.917
Samsung s4	0.3149	0.9582	0.0939	0.8961
Samsung s4f	0.2636	0.9615	0.1081	0.9160
Samsung zoom	0.1168	0.9766	0.1402	0.946
Samsung zoomf	0.09393	0.9790	0.1531	0.9561
Sony 12.1	0.09579	0.9854	0.1259	0.9527
Sony 12.1f	0.07322	0.9809	0.1942	0.9647
Sony 14.1	0.1032	0.9822	0.1318	0.9523
Sony 14.1f	0.1211	0.9739	0.1444	0.9455
Sony z1	0.19315	0.9697	0.109	0.9215
Sony z1f	0.2208	0.9639	0.109	0.9164

To focus more on each feature individually according to the same camera type (resolution), with dual cases of flashlight, multiple diagrams are created to compare results in both Histogram and Texture features.

Samples of the diagrams are shown below:

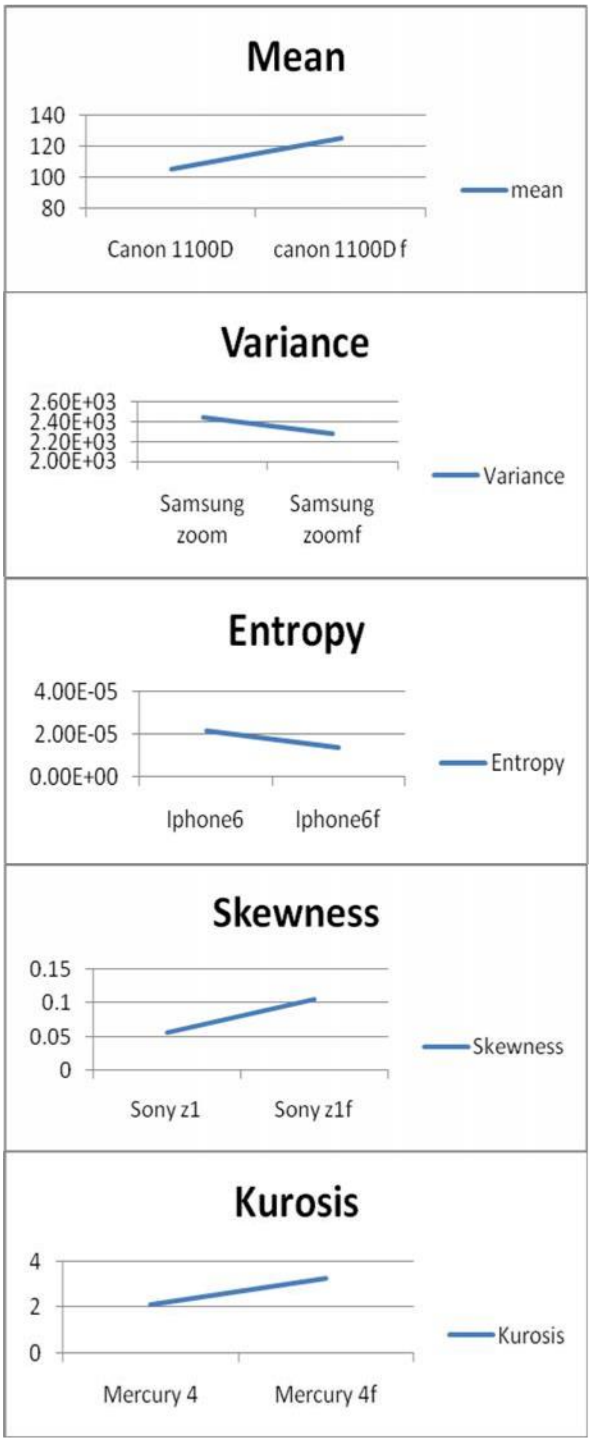

Diagram 1: Samples of histogram features for both Cases of flashlight in the same camera type

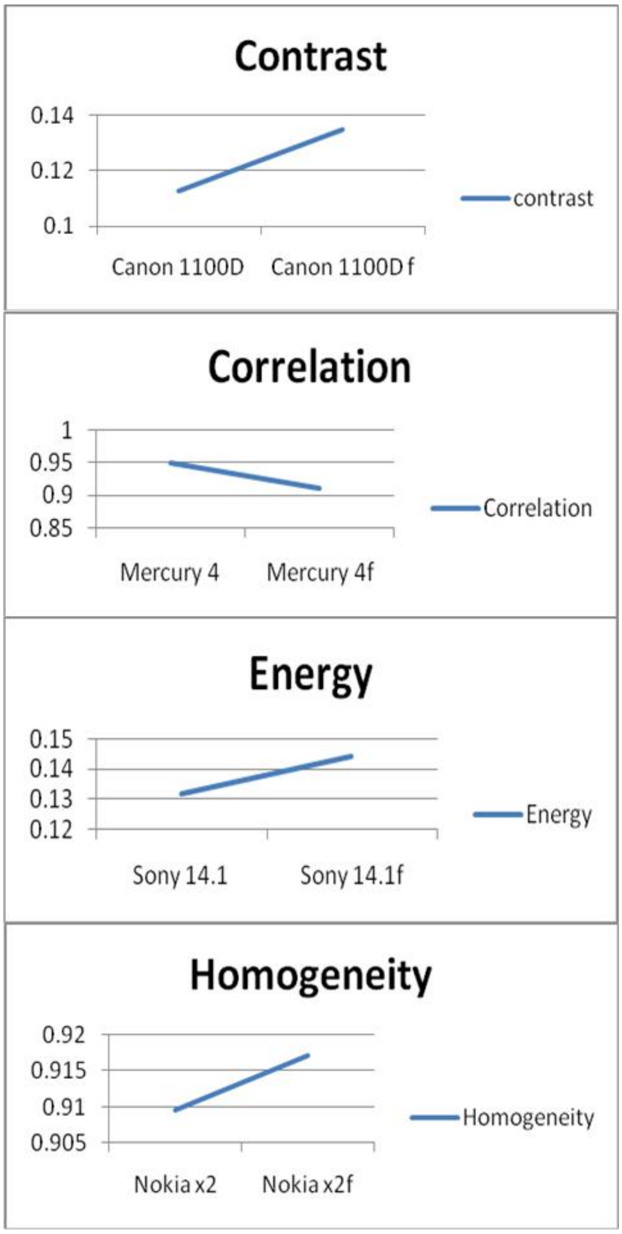

Diagram (2): Samples of texture features for both Cases of flashlight in the same camera type

4.6 Leveling:

After gathering the results, the numbers (feature values) should be substituted by levels of Low, Medium and High to differentiate them easily by letters not by pure numbers. The next formulas describe intervals and are depended to convert numbers to levels, where: A represents the Minimum value of the feature, B represents the Maximum value, division by 3 stands for the 3 levels required. The results after leveling are show in the table 5.

- **Low Range:**

$$\text{mini low} = A\,, \qquad \text{max low} = \frac{(B-A)}{3} + A \qquad (11)$$

- **Medium Range:**

mini medium $= \frac{(B-A)}{3} + A$, which is the same as the max low.

$$\text{max medium} = B - \frac{(B-A)}{3} \qquad (12)$$

- **High Range:**

mini high $= B - \frac{(B-A)}{3}$, which is the same as the max medium. max high $= B$

Table 5: Leveling the results into Low, Medium and High Values

Device Type	Mean	Variance	Entropy	Skewness	Kurtosis	Contrast	Correlation	Energy	Homogeneity
canon	M	M	L	L	L	L	H	M	H
canon f	H	M	L	L	L	L	H	M	H
iphone4s	H	H	L	L	L	L	H	L	M
iphone4sf	M	H	L	M	L	M	H	L	M
iphone6	M	H	L	M	L	M	H	L	M
iphone6f	H	H	L	M	L	M	H	L	M
mercury4	H	H	L	L	L	H	M	L	L
mercury4f	M	L	L	M	M	H	L	M	L
nokian8	M	M	L	L	L	L	H	M	H
nokian8f	M	M	L	M	L	L	H	M	M
nokiax2	H	H	L	L	L	H	M	L	M
nokiax2f	M	M	L	M	L	M	M	L	M
samsungs4	H	H	H	L	L	H	M	L	L
samsungs4f	H	H	M	L	L	M	H	L	M
Samsung zoom	H	L	L	L	L	L	H	M	H
Samsung zoomf	H	L	L	L	L	L	H	M	H
sony12.1	H	H	L	L	L	L	H	M	H
sony12.1f	L	L	L	H	H	L	H	H	H
sony14.1	H	M	L	L	L	L	H	M	H
sony14.1f	H	L	L	M	L	L	H	M	H
sonyz1	H	M	L	L	L	M	H	L	M
sonyz1f	H	M	L	L	L	M	H	L	M

4.7 Classification

Depending on the previous table (Table 5), it is easy to classify the features in the Low and High camera resolutions in the presence or the absence of flashlight. As we have the level of the camera resolution from the Leveling part described previously, the table below shows the feature levels according to the flashlight.

Table 6: Features Classification

Features	Flash Light Case	Low Resolution Devices						High Resolution Devices				
		mercury	nokiax2	iphone4s	iphone6	Sony z1	Nokia n8	Samsung s4	canon	Samsung zoom	Sony 12.1	Sony 14.1
Mean	with flash	M	M	M	H	H	M	H	H	H	H	H
	without flash	H	H	H	M	H	M	H	M	H	L	H
Variance	with flash	L	M	H	H	M	M	H	M	L	L	L
	without flash	H	H	H	H	M	M	H	M	L	H	M
Entropy	with flash	L	L	L	L	L	L	M	L	L	L	L
	without flash	L	L	L	L	L	L	H	L	L	L	L
Skewness	with flash	M	M	M	M	L	M	L	L	L	H	M
	without flash	L	L	L	M	L	L	L	L	L	L	L
Kurtosis	with flash	M	L	L	L	L	L	L	L	L	H	L
	without flash	L	L	L	L	L	L	L	L	L	L	L
Contrast	with flash	H	M	M	M	M	L	M	L	L	L	L
	without flash	H	M	L	M	M	L	H	L	L	L	L
Correlation	with flash	L	M	H	H	H	H	H	H	H	H	H
	without flash	M	M	H	H	H	H	M	H	H	H	H
Energy	with flash	M	L	L	L	L	M	L	M	M	H	M
	without flash	L	L	L	L	L	M	L	M	M	M	M
Homogeneity	with flash	L	M	M	M	M	H	M	H	H	H	H
	without flash	L	M	M	M	M	M	L	H	H	H	H

Conclusions

1- The followings represent some conclusions about the effect of camera resolution and flash light on each image feature individually:

- **Mean Feature**:

In general, in low resolution cameras when we capture the image using flashlight it produces medium and high level results, and when the image is taken without the flashlight it produces almost high level results. But in high resolution cameras when capturing the image with the flashlight it gives almost high level results but when we take the image without the flash the mean feature produces random values as it is shown below:

- **Variance Feature**:

When the image is captured with the flash produces almost different results but when the flash is not used it produces high results in the case of low resolution cameras. In high resolution cameras when using the flash, it gives different results but without use the flash increases the value of variance.

- **Entropy Feature**:

Through the results we can notice that the value of the entropy is almost constant in all cases with and without the flashlight in cameras with high resolution and low resolution. Therefore we can rely on this feature in the study of image processing.

- **Skewness Feature**:

We notice that when using flash in low resolution cameras the value of the skewness is almost medium and without flashlight gives low level results. In the case of high resolution cameras when using the flashlight gives different results ranging between low, medium and high but when not using the flashlight it gives low results. So without flashlight we can say that the skewness is almost constant at low level even if resolution changes.

- **Kurtosis Feature**:

This feature is not affected if the resolution of camera is change and in cases of using the flashlight or not. Thus we can depend on this feature in the study of image processing because of having a constant (low-level) feature value especially in images taken without flashlight.

- **Contrast Feature**:

In low resolution camera this feature gives almost medium results when using flashlight and random results if the flashlight is not used. In high resolution cameras and in the case of using or neglecting the flashlight most often gives low results.

- **Correlation Feature**:

According to this feature results we notice that low resolution cameras have different results ranging from low to medium and high with and without flashlight. But in high resolution cameras almost high results are produced when using the flash and without using the flash. So it is still at high values in high resolution cameras.

- **Energy Feature**:

According to energy feature we notice that in low resolution cameras that takes pictures with or without flashlight the results are almost low. But in high resolution cameras the results are usually medium in both cases with flash and without flash means that it is not affected by the presence or the absence of flashlight.

- **Homogeneity Feature**:

For this feature, the low resolution cameras produce medium results usually in both cases: with and without flashlight. But in high resolution cameras the results are different but most likely high in both cases with the presence or the absence of (which means that flashlight) does not affect this feature values as an average flashlight.

2- Most of the devices that are currently available in the markets have high resolutions, so we are interested in focusing on the high resolution cameras in the study of this project. We can discover through the results of some features that the difference in the quality of high resolution cameras gives constant results which can be relied on in the studies of image processing.

3- Some Differences in Features between Normal and Cell Phone Camera Types:

Mean Feature: This feature is not affected when the resolution of the camera changes from the low to high resolution, it stills at the high level, but in the cell phone it almost gives medium to high level in all cases.

- **Variance Feature:** In low resolution without flashlight, the camera and cell phone give the same result which is a high level.
- **Entropy Feature:** This feature is not affected when the device changes from the normal camera to cell phone camera, it is obvious that in all cases it gives a low-level result.
- **Skewness Feature:** In low resolution, without a flashlight, the camera and cell phone give same low level result, but in the case of low resolution with a flashlight the result is medium and in the high resolution without flashlight gives low level results.
- **Kurtosis Feature:** In most cases, the results are in the low level regardless the type of the camera (weather it is a camera or cell phone camera), except the case of low resolution with flashlight, it gives a different result.
- **Contrast Feature:** In high resolution without a flashlight, the result is at the low level regardless the device type, but in all other cases, the result is different when changes from normal cameras to cell phone cameras or vise versa, But noticing the results of the cameras only, it gives high results in low resolution cameras and low results in high resolution cameras, regardless the flashlight effects.
- **Correlation Feature:** In all cases gives a different results when the device changes from camera to cell phone. In the only case of high resolution with a flashlight the device results are at a high level.
- **Energy Feature:** In low resolution without a flashlight, the result is in a low level. All other cases, produces unstable results.
- **Homogeneity Feature:** Changing from normal cameras to cell phone cameras affects the homogeneity feature and gives different result, but in the cameras only, it gives low results in low resolution cameras and high results in high resolution cameras, regardless the flashlight.

However, because of the development in technology, most of the modern cameras have high resolutions; therefore it is important to focus on high resolution cameras more. According to the previous results some features ranges didn't change while enabling or disabling flashlight. This conclusion is described in table (7):

Table 7: The effect of flashlight on features in high resolution cameras

High Resolution	**Mean**	**Variance**	**Entropy**	**Skewness**	**Kurtosis**
Flash : No	L/M/H	L/M/H	L	L	L
Flash : Yes	H	L/M/H	L	L/M/H	L
High Resolution	Contrast	Correlation	Energy	Homogeneity	
Flash : No	L	H	M	L/M/H	
Flash : Yes	L	H	L/M/H	H	

It is obvious that Entropy, Kurtosis, Contrast and Correlation features remained in the same range and didn't changed due to flashlight status changing. Also some important conclusions about the resolution of cameras were discovered:

The Entropy and the Kurtosis features didn't change while changing the resolution of the cameras, also did the Skewness feature while the flashlight was off.

Future Works:

Many other features in the field of image processing could be depended in such studies, like:

Color Features: Multi color spaces have been used previously in some projects and researches, such as RGB, HSV and HMMD. After specifying the color space, a color feature can be extracted from images or from regions within the image. This subject include many color features like the color histogram, color moments (CM), color coherence vector (CCV) and etc [9].

Shape Features: shape feature extraction techniques can be classified into: Contour Based and Region Based methods [9]. Contour based methods calculate the shape features only from the boundary, but Region based methods extract features from the entire image region [10].

Wavelet Transform Features: This features allows analysis of images at various levels of resolution. It is good at isolating the discontinuities at edge points. The Discrete Wavelet Transform (DWT) uses the Haar function (which is one of the simplest wavelet types) in image coding and edge extraction [11]. The structure of the 3-level wavelet decomposition is shown in figure 8.

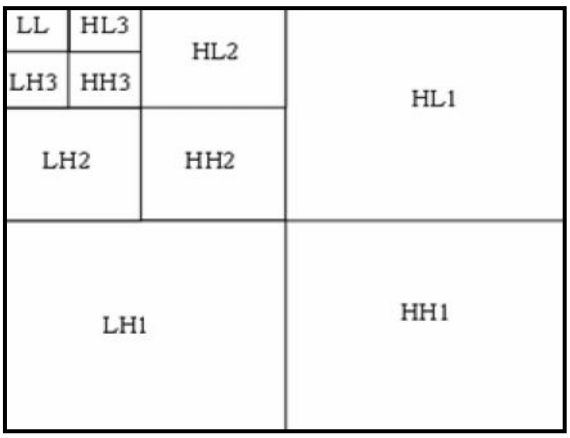

Figure 8: Structure of wavelet decomposition

Other Types of Images: The field of medical imaging is a good platform to be depended. The Sonar, MRI, X ray and CT scan are examples of medical images.

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