

Image Processing and Prioritization Through TOPSIS

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Master of Engineering
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Software Engineering

Submitted By
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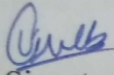
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CERTIFICATE

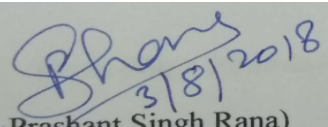
I hereby certify that the work which is being presented in the thesis entitled, “**Image Processing and Prioritization Through TOPSIS**”, in partial fulfillment of the requirements for the award of degree of Master of Engineering in Software Engineering submitted in Computer Science and Engineering Department of Thapar Institute of Engineering and Technology, Patiala, is an authentic record of my own work carried out under the supervision of **Dr. Prashant Singh Rana** and refers other researcher’s work which are duly listed in the reference section.

The matter presented in the thesis has not been submitted for award of any other degree of this or any other University.



Signature:
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This is to certify that the above statement made by the candidate is correct and true to the best of my knowledge.



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Abstract

This work goal is to show the image processing and to achieve the prioritization through topos. Image processing techniques is about to gain the important features from the image's data, from the illustration, clarification, or apprehension of the scenes could be given by the machine. The image processing is defined as the processing or the altering an image that exist in a required manner. This current system provide access to the user to accept the hard form of the image using printer as the tool and thereby allowing the users to keep the screen image into the drive dir using the format like bmp, jpg, gif. Image processing generally form pertain to the modification and analysis of illustrated statistics. We find examples of image processing that are take place all the time in our everyday lives. The most capable and efficient image processing system is the human's brain together with the eye. Where the system efficiently gathers, improves and save keeping the images at quit high speed. Objective of the image processing is to amplify the visual and the statistical evaluate of some aspect of an image that is not readily perceptible in its original form. As the core principles of image processing methods that are undertake will be assist us in greater appreciation and perception but it do not add any information content to it. This main objective is under take by the development with the help of implementation of handling means need or require to work on images. The recent availability of the sophisticated semiconductor digital devices and compact powerful computers are coupled with advancement in the image processing algorithms and has successfully brought digital image processing to the front. Digital image processing contains of wider range and applications, such as the sensing remotely through the satellites and other spacecraft images with the transmissions and data warehouse for the business needs, processing for medical, sonar in the radar and the image processing in acoustic, robotics along with automatic inspections of the industrial spares.

The goal of this work is to show the image processing and to achieve the prioritization through topos. In image processing images quality are measured. In this work image processing is done by measuring its features like Clarity, brightness, contrast and many more. Since measuring the image quality has been very complicated process when human psychological factor comes into play. There are two techniques to measures, the subjective way and the objective. This work uses the objective way in image processing.

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1. Introduction

Performing some operations on an image, in order to get an enhanced image or to extract some useful information from it, is the image processing. Signal processing is the type of the processing in which input is an image and output may be image or characteristics/features associated with that image. If we talk about rapid growing technologies then image processing is among them. In engineering and computer science disciplines it forms core research area too. Importing the image through image acquisition tools, analyzing and then manipulating the image and output in which result can be altered image or report that is based on image analysis includes in image processing. The two types of methods used for image processing are analogue and digital image processing [1] [2]. While using these visual techniques, image analysis uses various fundamentals of interpretation. By using computers digital image processing techniques are helpful in manipulating the digital images [3]. The three general phases through which all types of data undergo while using digital technique are pre-processing, enhancement, and display, information extraction. From all of the feasible alternatives, decision making is the best process. Judging the alternatives in almost all such problems, the multiplicity of criteria is pervasive. There may be no solution satisfying all the criteria simultaneously, because all the criteria are conflicting with each other. The decision maker wants to solve a multiple criteria decision-making (MCDM) problem for many such problems [4]. For solving MCDM problems, there are several methods and techniques. One of them is TOPSIS (technique for order preference by similarity to an ideal solution [5]. In this method the rank of units depends on the distance from ideal and negative-ideal. There exists a large amount of literature involving TOPSIS theory and applications. TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives. The basic principle is that the chosen alternative should have the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution.

2. Literature Survey

This section discusses about the literature survey of work done in the domain of image processing and prioritization of image through topology. This chapter presents the several approaches that are already developed to process images and their features extraction for prioritization.

2.1. Image Processing

For image preprocessing the Frost Filter technique was proposed by M. Mansourpour, M.A. Rajabi, J.A.R. Blais. Multiplicative noise and stationary noise statistics are assumed by this filter [6]. For removal of speckle noises in SAR images, gradient based adaptive median filter is there. S.Manikandan, Chhabi Nigam, J P Vardhani and A.Vengadarajan proposed the method to cut off or lower the spotted noise, required information, edges and resolution that is, spatial [7]. The wavelet coefficient shrinkage that is, WCS filter is based on the usage of the symmetric daubechies that is, SD wavelets [8]. L. Gagnon and A. Jouan in 1997, develop the WCS filter. To safeguard the high in frequency elements of the image the discrete wavelet transform that is, DWT has been employed [9]. P. Karunakar, V. Praveen and O. Ravi Kumar proposed that to attain the clear cut image and an in between phase, for determining the high in frequency of sub bands. Yang Gui, Xiaohu Zhang and Yang Shang proposed the maximally stable extremal regions that is, MSER algorithm and spectral clustering that is, SC method, to provide the effective and for robust segmentation [10]. Young Gi Byun, You Kyung Han, and Tae Byeong Chae develop the modified SRG (MSRG) procedure [11]. The tool to deploy the spatial and the spectral statistics as together for the computation of the degree of texture around every pixel in the maximum resolution panchromatic images is the Holder exponent. Debasish Chakraborty, Gautam Kumar Sen and Sugata Hazra in 2009, proposed this method [12]. The novel markov random field that is, MRF based segmentation algorithm is used by Ousseini Lankoande, Majeed M. Hayat, and Balu Santhanam. Which was taken from the statistical possessions of speckle noise [13]. For getting the information regarding attribute of pressure ridge features in SAR images of sea ice, John F. Vesecky, Martha P. Smith and Ramin Samadani report the image processing

techniques. Either that is intersection between the linear property or ends of properties bounds Bright filamentary features which are identified and broken into segments. The filamentary segment properties computes ridge statistics [14]. The feature that is taken out from sea ice SAR images on the grounds of non-negative factorization methods were studied by Karvonen, J. and Kaarna.A. The sparseness constrained non-negative matrix factorization (SC-NMF) and Non-negative tensor factorization (NTF) are the methods [15]. The backscatter data and textural characteristics of the images is used by Neural Network algorithm [16]. Natalia Yu. Zakhvatkina, Vitaly Yu. Alexandrov, Ola M. Johannessen, Stein Sandven and Ivan Ye. Frolov proposed Gray-level coo currence matrix (GLCM) method. The multiple level that is, SAR sea ice image categorization way, that is, Euclidean distance discriminant method was proposed by Wang, Tan, Yang and Xuezhi [17]. For the categorizing the objects on the bases of closest or the most similar training samples in the feature sample, the K-Nearest Neighbor (KNN) Algorithm method is used [18]. Kanika Kalra, Anil Kumar Goswami and Rhythm Gupta proposed this algorithm. To determine the sets of core vectors for the image as data, i.e. for small randomly chosen image windows, Karvonen, J. and Simila, M. used independent component analysis that is, ICA [19]. Lars Kaleschke and Stefan Kern for classification, namely Kohonen's Learning Vector Quantization that is, LVQ, used supervised neural network learning architecture. The LVQ neural network categorization was seemed to be very ductile by learning from examples [20].

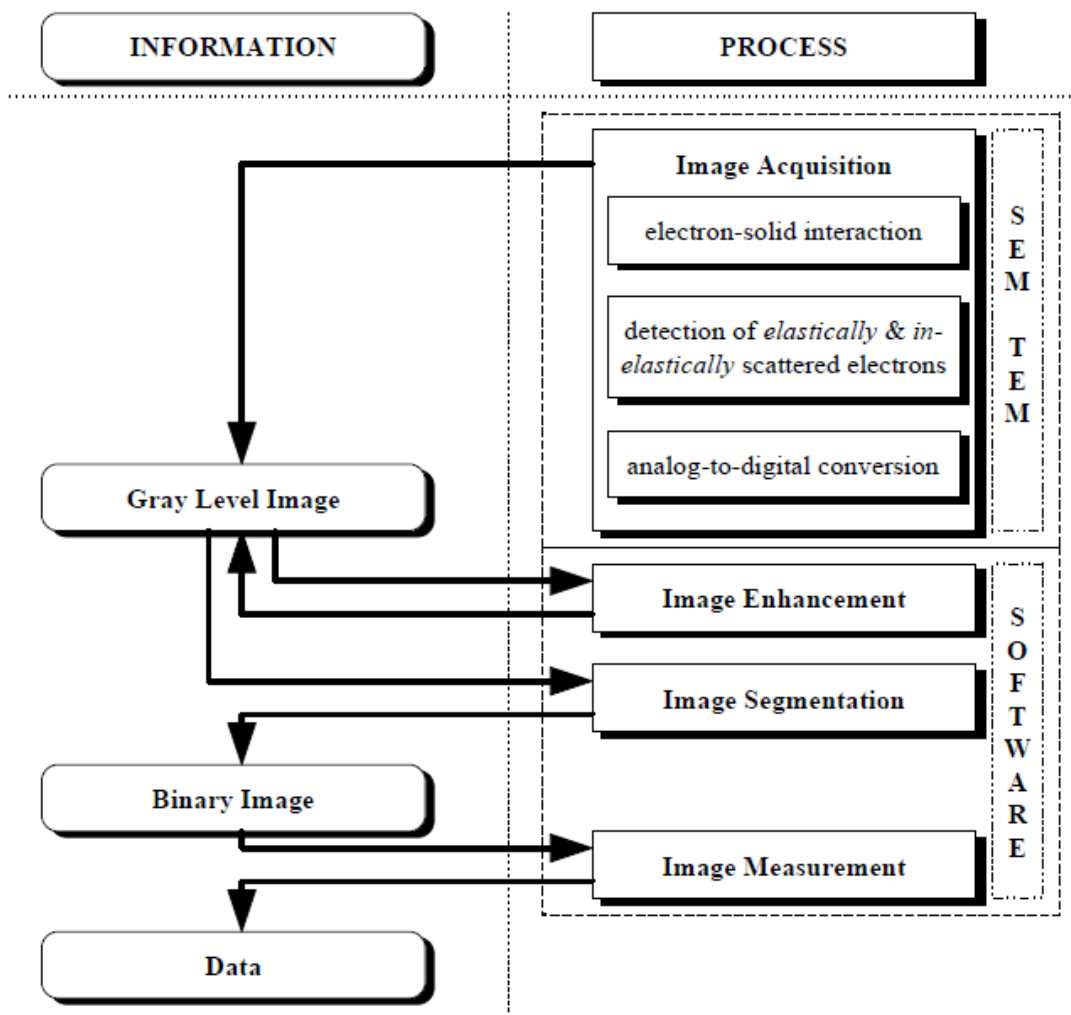


Fig. 1 Image Processing Techniques

2.2. The Machine Learning

The bayesian nets, decision trees, genetic algorithms, nearest neighbors and neural nets are included in researching several machine learning algorithms, K-Nearest-Neighbors is the form decided to use. This kind of method provides lucidity, fastest training in terms of time taken, and the directness of outside parameters that are beneficial and that must be adjusted or change with respect to the each data set. And also, with this algorithm other researchers seems to have had quite accurate results of classifying the images, so it seems to be a good choice to use this algorithm [21].

K-Nearest-Neighbors, the method that is executed in the work is a alternative of the standard K-Nearest-Neighbor algorithm. K-Nearest Neighbor seeks the k closest points in the set of training data, to classify an unknown data point. Discussed below, the definition of closest. As for the k closest points, the algorithm returns back the major categorization as the predicted category of those point which are not known. At the time of tie situation for the majority of categorization of the k of closest points, the classification algorithm there returns is not specific the majority classifications as any can be return back. (Cover and Heart, 1967; Stanfill and Waltz, 1986; Aha, Kibler, and Albert) For measuring the success rate of a classification algorithm there are many possible ways. The percent of correct classifications, the algorithm makes is the first and most straight forward . However, this method seems to be deceiving one. Considering, for example, lets say, the categorization of a rare disease that is to be noticeable is in one ten-thousandth of the total. The success rate on the order of 95% can be achived by the Good classifying algorithms for diseases. Considering, however that, a classifier that are blind, that always asserting that the patient does not seems to having the disease. 99.99% of the times it will be classifying correctly, since the majority from the total population showing no signs of having the disease. Therefore, it does not fit in this that a blind classifier of such kind is really that useful as this percentage is trying to tell. Therefore, the correct positive classification rate and also the correct negative categorization rate seems both to be more reasonable measure to be taken on for performance as examine. Example above, the blind classifier 0% is the correct positive categorization rate, where as 100% is the correct

negative categorization rate. The numbers telling that 0% is the correct positive classification rate for this blind system seems to better making evidence in the weakness of the system. The resulting Receiver Operating Characteristic (ROC) curve is the third in measure for an algorithms ability to perform correct classification of unknown data. When there are two classifications, that is normal and abnormal, then this kind of analysis is used. The observe rate is that percentage rate at which the algorithm can correctly predict that an abnormal data point is not normal. Hence similarly, the percentage rate at which the algorithm not correctly classifying the normal points as abnormal are known to be the false alarm rate. An ROC curve is produced by plotting graph of detects rate and the false alarm rate where it is varying the sensitiveness for the given classifications. As told earlier that, changing the parameter j it also affects the sensitiveness of the algorithm which is used in this work. Therefore by holding this parameter k as the constant and the changing parameter, that is j from 1 to $k-1$, the sensitiveness of the methods is affected, and many that is, relaying on the value of k , points of an ROC graph curve are gained. Note that this differentiate from a standard ROC curve in that the responsiveness can not be disparate in a uninterrupted form, but only over distinct values of the parameter j [22].

To evaluate the percent of rates of accurate and inaccurate grouping that are needed for the survey mentioned above, cross-validation was used. Estimating how the algorithm will carry out on new, unspecified data of the given set of data with known classifications is the cross-validation. A training set and a testing set are the two subsets of the data set. The training set is used in training the learning algorithm. The moment algorithm has been trained, then classifications of the test data set's prediction is done using it. As the data in the test set has known classifications, the predictions made by the algorithm are compared with the known classifications, and the percentage of classified accurate and inaccurate can be acquire.

To spontaneously detect rooftops in aerial images, machine leaning techniques have been used. In a contrast of a closest of the neighbors methods, a naïve bayesian network method, and a budds classifier method used in detecting rooftops. While using these three methods on images, nearest neighbors is not as good as naive bayes

as it perform better, which performed remarkably better than the Budds classifier method. For classifying images based on content, decision tree algorithms is used by Brodley and Utgoff. The project using the cross validation on the same data set, 96.5% accuracy is what they claim to achieved. In image content analysis this level of accuracy is quit successful (Brodley and Utgoff, 1992).

3. Data Set Description

In the duration of the last few decades various types of methods have been developed in Image Processing. For intensifying the images obtained from spacecrafts that is unmanned or from the space probes or from the military observation flights many types of techniques are developed. As due to easily availability of powerful personnel computers with large capacity of memory devices along with the graphics software and many more for, image processing system are becoming well accepted.

3.1. Digital Image Processing

The processing of a two-dimensional picture by a digital computer refers to the digital image processing. In the broader context, it suggest that digital processing of the two dimensional data. An array of real numbers constituted by a finite number of bits is the digital image. The main basic advantage of Digital Image Processing methods is its ability to adapt, testretest reliability and the maintenance of original data accuracy [2]. Some of the image processing techniques are, image preprocessing, image enhancement, image segmentation, feature extraction and image classification.

3.1.1. Image Processing

In the image preprocessing, the errors are related to the geometry and brightness values of the pixels as recorded by the sensors on the satellite for image data. The suitable mathematical models or algorithms which are either specific or statistical models are used to correct the fallacy. The improvement of image by varying the pixel and the brightness numbers to refine its visual impact is known as image enhancements. A collection of methods or algorithms that are used to enhance the visual aspect of an image or to transform the image to a form the better purpose for human and machine clarification is termed as image enhancement [6].

Sometimes because of some circumstance imaging sub systems and illumination dependencies while capturing image, image attained from satellites and usual and digital cameras lack in contrast and brightness values. Different types of noise are there in image. In the image enhancement process

the main objective is to emphasize on certain image features for subsequent analysis or for image showing. There are examples including contrast and edge enhancement, pseudo-coloring, noise filtering, sharpening, and magnifying. In feature extraction, image analysis and an image display, image enhancement comes very handy. Information content in the data that is inherent is not affected by the enhancement process. Certain specified image attributes are only emphasizes. The enhancements methods are normally influencing each other and are dependent on the applications. Some of the intensification methods are like contrast stretching, filtering of noise, modification of the histogram

i. Contrast Stretching:

There are few images like water environment, deserted lands, forest lands, lands with the snowfall, clouds with under foggy state over heterogeneous areas are congruent that is they do not have that much of any change in their states. If we to talk in the expression of histogram depiction they are to distinguish as the phenomenon of very limited peaks. Due to the inaccurate radiance of the scene it can be homogeneity. And so unfortunately the images therefore gathered are not that easy to interpret for poor human noticeable. The reason is that there occur only a limited range of gray extent in the image contains presentation for wider range of gray levels. For frequently encountered situations there are some of the contrasts stretching methods are intended exclusively. To stretch the limited area to the whole of the available dynamic area, different stretching techniques and methods have been developed [25].

ii. Noise Filtering:

To sieve out the unwanted statistics as data from the images then noise filtering is brought into use. For the removal of many kinds of noises from the images, noise filter is used. This feature has shown the interactive.

Such as the pass that are low and high, mean and the median and many more, are accessible as other filters [26].

iii. Histogram Modification:

In the image enhancement there is lot of importance for histogram. The characteristics of image is reflects in it. If the modification is made in the histogram then image characteristics will also be modified. Histogram Equalization is one of the examples. However histogram standardization is a straight forward elongate that redistributes the pixel readings so as there are almost the same readings of pixels along every reading is under the coverage range. The histogram with flat graph is the approximates result. Hence the contrast's value is lessened at the tails while increased at the peaks [27] [28].

3.1.2. Image Segmentation

One of the key problems we see to get in image processing is segmentation. When the image is subdivided into its constituent parts or objects then that process is known as image segmentation. The amount to which the subdivision can be carried out it depends on the problem statement, that is, when an application is been cut-off, the sections of the object should be stopped for instance, in self determining from air to the ground target accession, assume we are interested in lies in distinguish vehicles moving on the roads, firstly, the procedure is to wedge that road from the images and then next part is to segment the contents of that road into the possible vehicles. For image segmentation, the image threshold techniques are used. The object pixels the one having one gray color level and all the other pixels on the background having another, normally the object pixels are black and the background are white, after the threshold is formed. The one that chooses all the object pixels and hence matches them to black are known to be the best threshold. For the automatic selection of the threshold many different types of approaches have been proposed. The one that uses a interrelationship standard to pick the foremost threshold and is based on this proposal, is described. It seems sometimes gray color shade histogram graphs consist with only one as supreme. Which give rise to, for instance, by inhomogeneous illumination of various regions of the image. In this type of scenarios it is very difficult to choose a singular threshold reading for the image as whole thus the local binary methods must be apply to it. In general form the methods to get the right solution for the problem of binary in homogeneously illuminated images seems that are not available. Not only the intolerance among the objects with there background, but also detachment between the different areas, the segmentation of images is involves. Watershed segmentation is one of the separation methods [29] [11].

3.1.3. Features Extration

To calculate the features in synthetic aperture radar images, feature extraction techniques were developed. In order to perform classification of different targets this method is there to calculate the high-level features that are required. The size, shape, composition, location etc are the features that are unique in nature. The desired object from the scene is used to isolate so that measures can be taken on it subsequently by the segmentation methods. The classification and description of the image is allowed by the quantitative measurements of object's features. Some characteristic uprooting methods is apply to the component to acquire attribute after the pre processing and the crave level of the division into separate parts has been gained therefore which is then come after by application of grouping and post processing methods. This is important that to concentrate on the attribute calculation procedure as it is an noticeable impact on the effectiveness of the recognizing system. The single most important and the effective component in achieving high recognition performance is the feature selection of the feature calculation method. Feature calculation is result of the calculating from the data that is raw as a statistics that is more appropriate for categorization methods where as reducing the within class pattern that is lack of consistency and intensify the between class pattern variation. Therefore, the selection of a appropriate feature calculation methods following to the given input that is used needs has to be done with allot care [30].While looking into all reviewing all these points, it is now becoming essential that to go through the different available methods and procedures for the feature uprooting in a provided area, covering the major probility of such cases. Feature extraction methods of different types are shown in Table 1.

Table 1: Various types of feature extraction methods.

Grey scale subimage	Binary		Vector (skelton)
	Solid character	Outer contour	
Template matching	Template matching		Template matching
Deformable templates			Deformable templates
Unitary Transforms	Unitary Transforms		Graph description
	Projection Histogram	Contour profiles	Discrete features
Zoning	Zoning	Zoning	Zoning
Geometric moments	Geometric moments	Spline curve	
Zernike moments	Zernike moments	Fourier descriptors	Fourier descriptors

3.1.4. Image Classification

The maximum number of hops metric is not as good as the proposed algorithm accomplish much more with the total conveyance energy metric as shown by the earlier works. The lifetime of entire network is maximized and energy efficient path for data transmission by the proposed algorithm. As the staging of the this presented method is evaluated among the two metrics in upcoming time with some changes in design exploration the efficiency of the suggested method can be equate with other energy efficiency algorithms. Here used is the very small network of five nodes, as we can see that when the number of nodes are incremented there will be increment in the complexity also. Therefore we can increment the value of the nodes and survey on the performance. The details of a pixel or the bunch of pixels on the bases of its grey color scale reading are known to be image classification. In information extraction the most frequently used methods is the classification. In the case of classification there is usually many of the attribute are used for a bunch of pixels that is, allot images of a given class are required. As in sensing places remote, image classification methods conjecture that the imagery of the particular geographical area is gathered in many areas of the spectrum that is, electromagnetic and is in the good registration. As for the statistics uprooting

methods many of them depends on the evaluation of the spectral reflectance premises of such images and employ special methods plot to achieve many category of spectral analysis. The procedure of multiple spectral grouping can be done implementing either of the two provided methods, that is unsupervised and supervised [31]. The uniqueness and location of few of the places types such as areas that are industrialized, wetland or dry areas or forest and many more, are known to be deductive through a fusion of field works and topo sheets, in supervised classification. These land cover types are the examples to try to look for the particular area in the remotely sensed data that means homogeneous by the analyst. These fields are normally refer as the training site because the spectral characteristics of these known regions that are used for the training of the classification algorithm for eventual land cover mapping of the prompt of the image. Multiple variate statistical parameters are extracted for every training site. Every pixel both that are within and on outside these training sites is then are calculated and allocated to the group of which it has the maximum probability of being a member. The identities of land that is cover types has to be specified as groups within a scene are not commonly known to be priori because ground of been real is lacking or surface features within the scene are not well defined, in the unsupervised classification. To bring together pixel data into different spectral groups, the help of the computer is needed, according to some statistically determined principle. Based on their type of shape and there size with the color and the texture, which act as attribute, the contrast in medical area is the tagging of cells.

3.2. Features and Methods used

This work is using the objective way for image processing to calculate the features of the image. The features calculated in the image processing are clarity, brightness, pixel density, contrast, resolution, and vignette. In the image processing all the factors are weighted equally. And here the python support was take to measure the features of the images. There are others tools also for image processing but in this, thesis uses the python support for the image processing to extract the features. Table 2 tells the features and the methods used in the python language to extract the image quality, along with brief detail. The objective way totally focus on the numbers unlike the subjective way in which the human interference is done. Not only this subjective way is also costly, and time consuming and observers may take too much time to make any decision.

Table 2: Data, Features and Methods used in work.

Sno	Feature	Method	Details
1.	Clarity	<code>cv2.Laplacian(image, cv2.CV_64F).var()</code>	Perform blur detection with OpenCV.
2.	Brightness	<code>gs = (math.sqrt(0.241*(r**2) + 0.691*(g**2) + 0.068*(b**2)))</code>	import couple of packages that are ImageStat and math.
3.	Pixel Density	<code>pix_val = list(im.getdata())</code> <code>pix_val_flat = [x for sets in pix_val for x in sets]</code>	Pixels per inch (PPI) or pixels per centimeter.
4.	Contrast	<code>hist = cv2.calcHist([img], [0], None, [256], [0,256])</code> <code>e=sum(hist*np.log2(hist))</code>	To get the contrast of an image we first calculate the histogram of an image. Then we uses hist in the entropy formula.
5.	Resolution	<code>height = (a[0] << 8) + a[1]</code> <code>width = (a[0] << 8) + a[1]</code>	JPEG headers contain information like height, width, number of color (grayscale or RGB) etc. We find the resolution of a jpeg image reading these headers, without using any external
6.	Vignette	<code>mask = 255 * kernel / np.linalg.norm(kernel)</code>	Vignetting is often an unintended and undesired effect caused by camera settings or lens limitations. However, it is sometimes deliberately introduced for creative effect, such as to draw attention to the center of the frame.

3.2.1. Blurriness

In the field of image processing, image quality assessment is one of the most challenging problems for the researchers. Image sharpness or blurriness is very important factor in image quality assessment. To design and develop algorithms and measures for detecting clarity and blurriness in an image is the motto of researchers in the field of image quality assessment. To calculate image sharpness or blurriness this work has proposed new techniques, measure in frequency domain . Allot many factors such as out of focus, camera shake, motion and many other causes blur in the image. To design an algorithm to evaluate an image quality measure blindly, is the one of the challenging work. To quantify the quality of blur images it is very important for many image processing applications. While considering human opinion score or objectively the image quality algorithm design can be done subjectively also. Hence there are three various types of strategies to design objective image quality evaluation algorithms first one is full reference image quality assessment (FR-IQA), second one is reduced reference image quality assessment (RR-IQA) and the third is no-reference image quality assessment (NR-IQA) [32]. In this work, NR-IQA technique in frequency domain is put forward which will help in recognize which of the given image is blurred or clare and will give us the numeric value of clarity in the image. Different design approaches has been used in different works to evolve the image quality measures for blur images. Calculation of edge-width, variance based [35], histogram based [27] [28], power spectrum based measures [36] and wavelet based techniques are kurtosis based [33], derivative based [34], approaches. Two of the popular image sharpness or blurriness image quality analysis are- first is image sharpness technique based on cumulative probability of blur detection (CPBD) [37] and the second one is no-reference objective image sharpness metric based on just noticeable blur (JNB) [38].

3.2.2. Brightness

Another most significant pixel characteristics is the Brightness. In many of the image editing techniques such as contrast or shadow or highlight it is

involved. Whether it seems, there is no conventional formula for the calculation of brightness of an image and also same image processing methods may employ many other different brightness measurement. However it is seem to be that the stimuli, equip the bright as stated by to one measure and also might they differ more, than many times according to other. The length of a color vector for Brightness and demonstrates with major image editing procedures is the advantage of this measure, as proposed by earlier works. It is because it untangle the design of algorithms that carry out only those knowing techniques or methods without any existing unwilling change in some other image parameters. For instance, Pixel Brightness can be modifying by contrast editing method but it does not put any affect on the related coordinates. When they are applied to a high dynamic range image, the advantage of using the algorithms is notable. For non-quantitative references to physiological sensations and perceptions of light is only for what the brightness should be used. The brightness is as an attribute of a visual effect according to which a given visual spur appears to be more or less fierce or according to which the part in which the visual spur can be seen appears to emit less or more light, and range differs in Brightness from bright to dim is what defines by Wyszecki and Stiles. But it seems that for digital image processing this definition is not suitable, as it gives no basic information for editing images. To find a proper solution to interpret the brightness quantitatively, the developers of algorithms for the digital image processing are working on this. But what so ever there seems no current conventional numerical description for this spur feature. The most popular values used for Brightness calculations and discuss the effectiveness of those values in editing image methods that are weighted allot dependent on the choice of Brightness measure, is proposes a review and analysis in this work [39] [40].

3.2.3. Pixel Density

In a fixed area of a display, number of pixels is told by the pixel density. It tells us that how closely packed the pixels on a display screen are, hence it is a

very essential metric. The quality, clarity, and readability of the image that is shown is determined by this. Pixels per inch (ppi) is the measurement unit for the pixel density. Many times whenever there is the confront with evaluating the quality of two displays and or comparing more than two displays at the same time it is seen that all the information is not available. It is seen that some where that is the pixel density is missing, it is very important metric which can not be missed out and thus provide allot many valuable information about the image quality we would require. Knowing always know the size that is diagonal of the screen in form of inches or centimeters and the resolution. By acquiring such information it become very much easier for the calculation the pixel density [41].

3.2.4. Contrast

The most important factor in image processing is Contrast enhancement also, the indirect method and the direct method are the two classification. Histogram equalization is well-known indirect methods. Through using cumulated function as its mapping function, histogram equalization can attain contrast amplification of the image as whole, normally it also might results in the loss of the local blurry of output image and deep essential information because of uncontrolled merge of gray levels of pixels of which number is much less than others in the process. For X-ray images, linear and non linear contrast stretching have not much of enhancement as they can not be effectively use to enhance the details of that image(s). The most effective method to requite image contours abrupt and enhance the edge, while variation in gray level, to make particular image more legible is termed as image sharpening [39]. According to certain transformation rules the contrast of the edges and regions full of details will be improved and the visual effect of the images will be much improved by changing the dynamic value of gray image . The basic idea of direct contrast improvement techniques is to install a standard for contrast evaluation and to improve the image by improving the

contrast values. The difference in luminance between an object and its surrounding region is refer as contrast.

3.2.5. Resolution

There are many ways to defined resolution. Pixel resolution, spatial resolution [42], temporal resolution, spectral resolution [43] are some way to refer as resolution. Among whom here we are going to talk about the pixel resolution. In your own computer when you goes to the settings you can see some monitor resolution as 800 x 600, 640 x 480 and so on. Where as in the resolution that is pixel resolution, the word here resolution tells that the digital image has how many total number of pixel count in it. Let's take an instance, if an image with n columns and m rows, then m x n is how its resolution can be defined. The total number of pixels, if defines the resolution then the set of two numbers defines the pixel resolution. The first number refers to the width of the image and the pixels are across the column and hence the second number refers to the height of the image or the pixels are across the width. What we can say is that higher the pixel resolution is, more better is the quality of the image we will get.

The spatial density of the image and optical resolution of the microscope is the spatial resolution that is used to capture the image. The sampling interval is the number of pixels having in a digital image and the distance between the pixels each, which is a function of the accuracy of the digital devices. To resolve the details present in the original specimen, the optical resolution uses the microscope's ability to measure, and thus it is relate to the quality of the optics, sensor, and electronics plus to the spatial density that is the number of pixels in the image that is digital. In situations where microscope the spatial density is not superior to the optical resolution, then the spatial density put the limit on the spatial resolution of the resulting digital image. All the details checks in a digitalize image that is ranging from very rough to supper fine and thus also consist of adjustment in brightness that circle between different level of dark and light. This circle rate between brightness adjustments is termed to

be spatial frequency of an image, with higher rates equivalent to high spatial frequencies. The specimens observed through the microscope are common in different levels of brightness, with the background normally having the uniform potency and the sample manifest brightness levels of a spectrum. In places where the potency is relatively fixed such that, as of the background and the spatial frequency changes in very less amount across the view. Although, there are allot sample details often that is exhibit high intensity of dark and light with a wider spectrum of intensity in between. The optical image averaged over the sampling interval is represents the intensity by the numerical value of each pixel in the digital image. Hence therefore, a relatively uniform mixture of pixels consist in background intensity, while the pixels with values ranging from allot darker to allot lighter is contain by specimen. To accurately capture all of this information by the ability of a digital camera system is based on the sampling interval. Features that are seen in the microscope that are allot tiny than the digital interval, sample that is have a high spatial frequency, will not be able to constitute precisely in the image, that is digital. The Nyquist criterion needs a sampling interval that is equalized to two times the high specimen spatial frequency for be able to accurately preserve the spatial resolution in the final digitalized image. The digitizing device must uses a sampling interval that should not be greater than one and a half the size of the smallest resolvable feature of an optical image, is stated by the Shannon's sampling theorem for equivalent measure. However if you want to capture the tiniest amount of details that are contained in the sample then sampling must start at a rate quick enough so that a minimum of two samples that are obtained for each feature can guarantee that both the dark and the light part of the spatial period are collected by a imaging device. If in some case sampling of the sample might happens to start at allot slower pace than what is needed by either of them, that is, the nyquist criterion or Shannon theorem. The details with the more spatial frequency will not be precisely be entitled in the finalized image. In that of optical microscope, 0.22 micrometers is the Abbe limit of resolution for optical image which means that a

digitalizing must be able to sample at intervals that match in the specimen space that is, 0.11 micrometers or lesser. The digitalization that which will samples the specimen at 512 points per horizontal scan line will process a maximum of horizontal field of view of about 56 micrometers that is, 512 x 0.11 micrometers. To gather the sample if very less pixels are brought together then all of the comprising details have with spatial, the sample will not be available there in the final digital image. Similarly just in case if there are too many pixels are grouped together by the imaging device that is often as a result of excessive optical magnification then no additional spatial information is to get, and thus the image will be said to have be over the sampled. The surplus pixels do not add up to the spatial resolution theoretically, but can frequently provides help to improve the precision of feature calculations extracted from a digital image. To make sure that sufficient sampling for resolution imaging that is high in resolution, an interval of 2.5 to 3 samples for the smaller resolvable feature is proposed. Coupled to modern microscopes have a fixed maximum sampling interval in this majority of digital cameras, which cannot be alter to match the sample's frequency that is spatial. It is very much important to choose a camera and digitizer combination very carefully that can meet the minimum spatial resolution requirements of the microscope magnification and specimen features. If the sampling interval is seems to be going beyond that required for that specific specimen then the final digital image will have much info than what is required, still information lost of spatial will not happen [42].

3.3. Materials

The ten sample images were used for image processing for the research to extract the features for their prioritization process afterwards using topsis. In image processing images used were eps format and coloured, here grayscale images are not used. Figure 1 shows some images which were used in this research. This research took the images of different features, like some are blurry some are much brighter some might have much better resolution and some might have better vignette value. So these images were taken intentionally to do the image processing on them and to see how it will prioritize them. Here they are analyse to see how accurate the result is made and how much it differ from the human decision making process [23] [24].

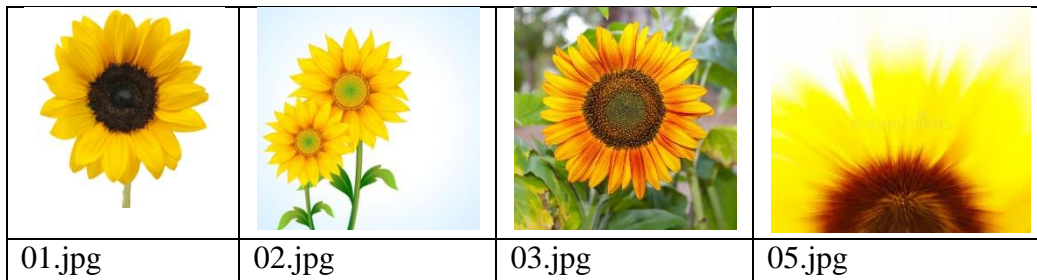


Fig 2: Sample Images for Image Processing.

When the features were calculated from images taken in this research, their data were collected in form of numeric values in csv format for further processing of image in topsis. These data were collected programmatically by using python language. There were total six features which were measured in the image processing. All the features which were taken are show in the Table 3. As you can see here, feature like Clarity, Brightness, Pixel density, and Resolution there values need to be more, but feature Vignette its value need to be less.

Table 3: Features Calculate.

Image	Clarity	Brightness	Pixel	Contrast	Resolution	Vignette
01.jpg	411.82	208.31	255	1675484	700	0.43
02.jpg	370.71	230.7	239	5416306	2061	0.08
03.jpg	324.95	144.34	223	7318182	1536	0.019
04.jpg	105.89	209.18	254	520755.9	5121	0.92
05.jpg	1467	155.39	230	417886.7	9473	0.91
06.jpg	1354.3	154.48	250	437813.9	5121	0.92
07.jpg	247.15	123	270	24497698	2725	0.003
08.jpg	696.31	130	190	1711726	808	0.31
09.jpg	1111.39	131.59	210	1964976	875	0.25
10.jpg	252.99	170.83	220	11104642	1864	0.003

3.4. Topsis

TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives [5]. Topsis was done on the data collected. The data collected in the Table 3, is further processed. As the features in the Table 3, were weighted same, that is, w for all were taken equal. Also the impacts on these features were taken as positive and negative both, that is, the vignette features impact was taken negative and all other features were taken as positive. This toposis was done in R language with the help of R studio. There were three parameters taken in the process of toposis: d as decision- a numeric matrix with m rows, for m alternatives and n columns for n criterions, w as weights- a numeric vector with length equal to number of columns in decision matrix for weights of criterions, and i as impacts- a character vector of "+" and "-" signs for the way that each criterion influences on the alternatives.

4. Methodology

For this work the sample data of image was collected. Some images were taken blurry some of them were taken more brighter but lesser in resolution, so like this all kind of images of particular category of image were taken in for image processing. So in this work all the images of the sunflower were taken very carefully so as to test the image processing by the objective way that how accurate was its decision then the subjective method. Then the features of images were measured in python language and the numeric data was stored in the form of excel file in csv format. The features calculated are shown in the Table 3. Then these features which were measured further processed through the tophis, to prioritize the images by ranking them.

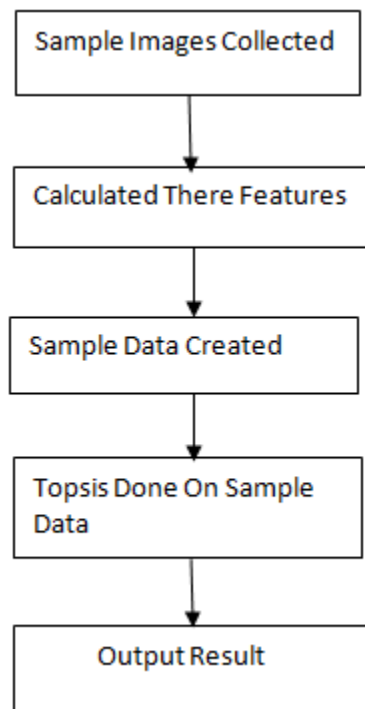


Fig 3: Flow Diagram of Image Prioritization

5. Evaluation

In evaluating image quality there are two followed methods, the subjective and the objective method. The subjective method evaluation is considered costly, expensive, and time consuming; since we have to select a number of observers, show then a number of images and ask them to score images quality depending on their own opinion. The objective evaluation uses automatic algorithms to assess the quality of the image without human interfere. After performing, the topsis as explained in section 2.3. Table 4 is the topsis scores generated from the topsis. Showing the high value for image 07.jpg and the lowest for 01.jpg.

Table 4: Scores based on the Topsis.

Images	Scores
01.jpg	0.1821902
02.jpg	0.2853722
03.jpg	0.2757720
04.jpg	0.2609303
05.jpg	0.4959894
06.jpg	0.3894970
07.jpg	0.5467379
08.jpg	0.2125052
09.jpg	0.2973639
10.jpg	0.3468607

6. Results

In this work image processing method used on all the ten images were the objective one i.e. the features were measured programmatically as it is much efficient than the subjective one. So when the topsis is done on the Table 3, resultant is the topsis score i.e. Table 5 and then further on these scored topsis the ranking is decided. If this result will be compared by the human decision then the ranking might differ, as they only take decision based on the psychological parameters.

Table 5: Ranking based on the Topsis.

images	rank
01.jpg	10
02.jpg	6
03.jpg	7
04.jpg	8
05.jpg	2
06.jpg	3
07.jpg	1
08.jpg	9
09.jpg	5
10.jpg	4

7. Conclusion

There are many different types of image quality metrics implemented for getting the quality of an image, but there are still limitations. Not every feature is acceptable by the image(s). It is important to work on those features which are acceptable by everyone. It is also important in the prioritization of image that to weight all features equally. So when comes to the prioritization of images through the TOPSIS, it just doesn't see one feature that is lacking in, but all whole as one. And then image prioritization is done.

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