Colour detection using Enhanced K-Means Clustering

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Abstract:
Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further image analysis. Carrying out image enhancement understanding under poor quality image could be a difficult downside. Due to low distinction, we cannot clearly extract objects from the dark background. Most colour based methods will fail on this matter if the colour of the objects and that of the background are similar. Our algorithm improves the overall image quality.

Keywords - Segmentation, Histogram Equalization, Enhanced K-means Clustering, PSNR, MSE.

I. Introduction

1.1 Image
An Image is a spatial representation of a two dimensional or three-dimensional scene. It is an array or a matrix pixel (picture elements) arranged in columns and rows as shown in figure 1.
An image is also a two-dimensional array specifically arranged in rows and columns. Digital Image is composed of picture elements, image elements, and pixels. A Pixel is most widely used to denote the elements of a Digital Image.
A digital grayscale image is presented in the computer by pixels matrix. Each pixel of such an image is presented by one matrix element an
integer from the set. The numeric values in pixel presentation are uniformly changed from zero (black pixels) to 255 (white pixels).

When it comes to a binary or boolean image that comprises of only two colours, i.e., black and white, the matrix represents the colour black as 0 and the colour white as 1 [1].

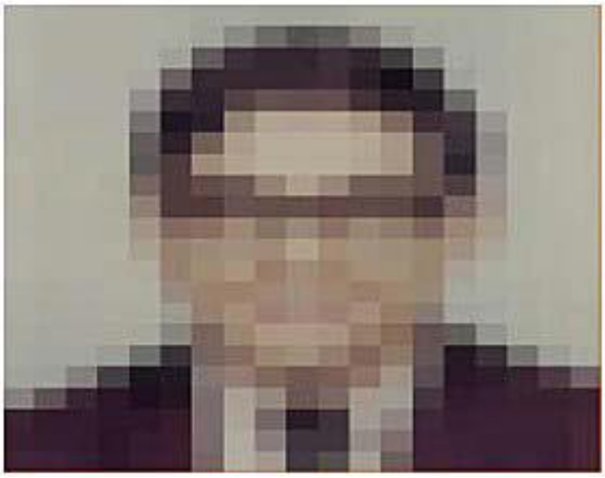

Figure 1. An image: a matrix of pixels arranged in columns and rows

1.2 Types of Images
1.2.1 Binary Images are the simplest types of images and they take discreet values either 0 or 1 hence called binary image. Black is denoted by 1 and white by 0. These images are utilized in computer vision and utilized when only outline of the image required.
1.2.2 Gray scale images are also known as monochrome images because they do not show any color only the level of brightness for one color. These images consists of 8 bytes that is from 0 to 255 levels

of brightness 0 is for black and 255 is white in between are various levels of brightness.

1.2.3 Colored images usually consist of 3 bands red green and blue every having 8 bytes of intensity. The various intensity levels in every band are able to convey the entire colored image it is a 24 bit colored image.

1.3 Phases of Image Processing

Below are the fundamental steps in Digital Image Processing:

1.3.1 Image Acquisition

Image acquisition involves preprocessing such as scaling etc. It could be as simple as being given an image that is already in digital form.

1.3.2 Image Enhancement

Basically, enhancement techniques bring out detail that is obscured and highlight certain features of interest in an image, such as changing brightness & contrast etc.

1.3.3 Image Restoration

Image restoration is an area that also deals with improving the appearance of an image. Image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

1.3.4 Colour Image Processing

Colour image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. This may include colour modeling and processing in a digital domain etc. On the other hand, enhancement is subjective.

1.3.5 Wavelets and Multi-resolution Processing

The foundation for representing images in various degrees of resolution is enabled by wavelets. Images are subdivided into smaller regions for data compression and for pyramidal representation.

1.3.6 Compression

Compression techniques reduce the storage required to save an image or the bandwidth to transmit it. Particularly for use over the internet, it is very much necessary to compress data.

1.3.7 Morphological Processing

Morphological processing extracts image components that are useful in the representation and description of shape.

1.3.8 Segmentation

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward a successful solution of imaging problems that require objects to be identified individually.

1.3.9 Representation and Description

Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data that constitutes either the boundary of a region or all the points in the region itself. Description deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another.

1.3.10 Object recognition

Recognition is the process that assigns a label, such as, “apple” to an object based on its descriptors.

1.4 Image Segmentation by Clustering

Clustering [2] can be regarded as a grading technique where given a vector of N measurements explaining each pixel or group of pixels in an image, a similarity of the measurement vectors and therefore their clustering in the N-dimensional measurement space implies similarity of the mean pixel groups or corresponding pixels. So we can say that, clustering in the case of measurement space may be a showing of similarity of image regions, and may be it can be used for segmentation purposes.

The vector of estimations portrays some helpful picture highlight and in this way is otherwise called an element vector. Similarity between pixels or image regions implies clustering in the feature space.

1.5 Clustering Based Segmentation

Clustering in image processing is the grouping together of pixels from an image, depending on calculated similarity between them. Clustering can be often defined as a non-coherent design of pixels. The shading picture information is normally bunched in three dimensional color space (RGB). All dominant colors in the image create dense clusters in the color space.

1.5.1 Skin detection

A reliable and efficient human skin detection has been the first necessary step in many image processing applications, such as face detection and tracking, gesture analysis, content-based image retrieval systems, de-identification, privacy-protection and other human computer interaction domains. In recent years, numerous skin detection methods have been presented in literature. They vary from methods based on manipulation of color-space channels to more sophisticated statistical modeling and machine learning methods. The former have been the most common methods in literature, and they are in general considered as computationally effective. The common steps in a skin detection algorithm usually include transformation of skin pixels into an appropriate color space and classification through labeling of skin pixels into skin and non-skin pixels (skin classifier). The common problem has usually been high false skin detection, which must be corrected with some additional method(s). The latter methods required a pre-processing step for training a binary classification system, and have one major drawback: the classifier performance highly depends on the size of a training set. Thus, the existing solutions usually make a trade-off between precision and computational complexity.

Detection of human skin has been a challenging task because many factors affect skin appearance in images. These factors include illumination, camera characteristics, ethnicity, individual characteristics, background characteristics, etc. There are three main problems when designing a method based on skin color as a feature. These are: what color space to choose? How to model skin and non-skin pixel distribution? and how to classify the modeled distribution? This research work attempts to provide answers to all three problems. There are several color spaces with different properties in literature. The most popular color spaces are RGB, Normalized RGB, HSV, TSL and YCrCb. The RGB color space is the default color space for the most image formats, while other color spaces can be obtained with linear and non-linear transformation of RGB color space. The choice of color space significantly influences modeling efficiency of the skin-color distribution. The goal of skin modeling is to build a decision rule in order to classify skin and non-skin pixels. There have been several modeling choices: explicitly defined skin region (a number of rules), nonparametric (histogram-based), parametric (Gaussian, Elliptic boundary model) and dynamic skin distribution (used for face tracking).

The primary steps for skin detection in our method include (1) combining two color spaces, HSV and YCrCb, to represent image pixels, (2) using histogram-based modeling with new approach for defining threshold value and (3) using K-means clustering for unsupervised classification with new data set for pre-processing. K-means clustering [3] is unsupervised, nondeterministic technique for generating a number of disjoint and flat (non-hierarchical) clusters. It is used to cluster similar pixels with an equal cardinality constraint. Special dataset consisting of three input features has been defined for clustering image pixels into three clusters: background, foreground and skin pixels.

1.5.2 K-Means clustering algorithm

Clustering [4] is a method to divide a set of data into a specific number of groups. It's one of the popular method is k-means clustering. In k-means clustering, it segments an accumulation of information into a k number gathering of information. It classifies a given set of data into k number of disjoint cluster. K-means algorithm consists of two separate phases.

In the first phase it calculates the k centroid and in the second phase it takes each point to the cluster which has nearest centroid from the respective data point. There are different methods to define the distance of the nearest centroid and one of the most used methods is Euclidean distance. Once the grouping is done it recalculate the new centroid of each cluster and based on that centroid, a new Euclidean distance is calculated between each center and every datum point and doles out the focuses in the group which have least Euclidean separation. Each bunch in the segment is characterized by its part questions and by its centroid. The centroid for each cluster is the point to which the sum of distances from all the objects in that cluster is minimized. So K-means is an iterative algorithm in which it minimizes the sum of distances from each object to its cluster centroid, over all clusters.

We present this process at the following steps to show that how the algorithm works:

Step 1: start with a decision on the value of k like taking the first k samples of the table and dedicate each of remaining (N-k) samples to the cluster.
Step 2: Create a distance matrix between each the centroids and pattern where difficulty of this step is the heavy calculation, it means that when we have N samples and k centroids then the algorithm will have to evaluate N×K distances.
Step 3: Put each sample in the cluster with the nearest centroid and if the sample is not in the cluster with the closest centroid, then switch this sample to that cluster.
Step 4: Update the new k centroids for each cluster where the updated location will be a centroid.
Step 5: Repeat until the isotropy condition satisfied [5].

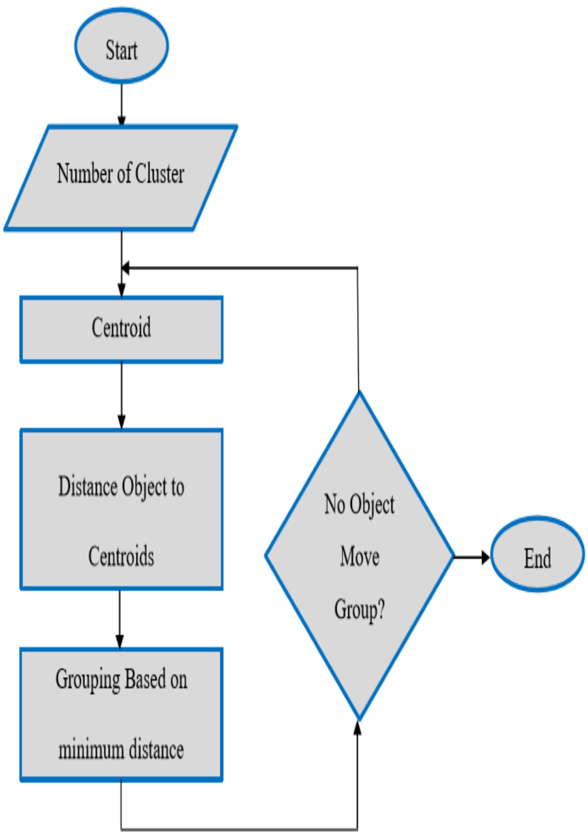

Figure 2. Block diagram of K-means process [6]
Figure 2 shows the all steps involved in the K-means clustering in the form of diagram.

II.RELATED WORK

Huang et al.[7] proposed a work of fiction hardware oriented contrast enhancement algorithm that will be often implemented effectively for hardware design. The proposed h/w oriented contrast enhancement algorithm achieves good image quality by measuring the outcomes of qualitative and quantitative analyses.To decrease hardware cost and improve hardware utilization for real time performance, a decline in circuit area is proposed through utilization of parameter controlled reconfigurable architecture. The experiment result proved that the proposed hardware oriented contrast enhancement algorithm provides the typical frame rate of 48.23 frames/s at hd resolution 1920 × 1080.

Jha et al.[8] proposed contrast enhancement technique using scaling of internal noise of a dark image in discrete cosine transform (DCT) domain. This transition is effected by the inner noise present because of not enough sufficient illumination and could be modelled with a general bit able system exhibiting dynamic stochastic resonance. The proposed technique adopts a near adaptive procedureing and altogether enhances the image contrast and color information while ascertaining good perceptual quality. When compared with the existing enhancement techniques such as for instance like adaptive histogram equalization, modified high-pass filtering, multi-contrast enhancement,multi-contrast enhancement with dynamic range compression, color enhancement by scaling, the proposed technique gives remarkable performance with regards to relative contrast enhancement, colourfulness and visual quality of enhanced image.

Jose et al. [9] divide the process into three parts, pre-processing of the image, advanced k-means and fuzzy c-means and lastly the feature extraction in this paper. First pre-processing is implemented by using the filter where it improves the quality of the image. At that point the proposed development K-means algorithm is utilized, trailed by Fuzzy c-intends to bunch the picture. At that point the came about fragment picture is utilized for the element extraction for the district of intrigue. They utilized MRI picture for the examination and ascertain the size of the removed tumor area in the image.

Kaur et al. [10] showed the comparative study of Histogram Equalization based methods. They showed that the cases which require higher brightness preservation and not improved well by HE, BBHE and DSIHE, have been accurately improved by RMSHE. MMBEBHE is the extension of BBHE method that provides maximal brightness preservation. Although these techniques can perform better contrast enhancement, these cause more infuriating side effects depending on the variation of gray level distribution in the histogram. DHE ensures uniformity in preserving image details and is free from any severe side effects. BPDHE can preserve the mean brightness better than BBHE, DSIHE, MMBEBHE, RMSHE, MBPHE, and DHE. MCBHE is simple and heuristic method for contrast enhancement in grayscale images and able to enhance the quality of images such that both global and local contrast is enhanced with minimum distortion in the image appearance. WMSHE achieves the best quality through qualitative visual inspection and quantitative accuracies of Peak Signal to Noise Ratio (PSNR) and Absolute Mean Brightness Error (AMBE) compared to other state of the art methods.

Kawulok et al., [11] combined global and local image information to construct a probability map that is used to generate the initial seed for spatial analysis of skin pixels. Seeds separated utilizing a neighborhood model are profoundly adjusted to the picture, which incredibly improves the spatial examination result. Despite the fact that shading isn't utilized legitimately in some skin recognition draws near, it is one of the most conclusive apparatuses that influence the presentation of calculations (Mahmoodi and Sayedi, 2016)[12].

Khan et al.[13] has proposed Weighted Average Multi Segment Histogram Equalization (WAMSHE), which decomposes smoothed histogram into multiple segments based on optimal thresholds and equalized every segment by histogram equalization. WAMSHE shown better brightness preserving and contrast enhancement among Multi-histogram equalization methods and also helps to reduce the noise present in the image.

Kil et al.[14] proposed a dehazing algorithm predicted on dark channel prior and contrast enhancement approaches. The typical dark channel prior method removes haze and thus restores colors of objects in the scene; nonetheless it doesn't consider the enhancement of image contrast. On the contrary, the image contrast method improves the local contrast of objects, nevertheless the colors are generally distorted consequently of to the over-stretching of contrast. The proposed algorithm combines the advantages of those two conventional approaches for keeping the colour while dehazing. On the basis of the experimental results, the proposed approach compensates for the disadvantages of conventional methods, and enhances contrast with less color distortion.

III. Results

For implementation we have used the MATLAB. In this paper, some experiments are conducted on several images.

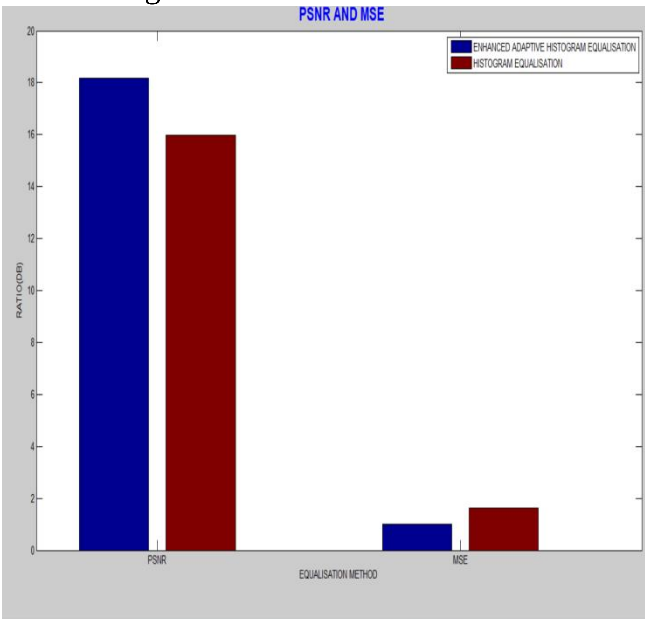

Figure 3. Peak signal to noise ratio and Mean

square error of the image after applying the histogram equalization and enhanced histogram equalization technique

Figure 3. shows the Peak signal to noise ratio and Mean square error of the image after applying the histogram equalization and enhanced histogram equalization technique which shows that peak signal to noise ratio increases and Mean square error decreases in the enhanced histogram, equalization technique as compared to Histogram equalization technique.

IV.CONCLUSION

Clustering is a method to divide a set of data into a specific number of groups. K-means is an iterative algorithm in which it minimizes the sum of distances from each object to its cluster centroid, over all clusters. In this paper, we have used the enhanced k-means clustering. Our approach showed promising results on human images from different ethnicities, with simple background and high illumination. We improved the accuracy in our method. In our proposed method Peak signal to noise ratio increased and Mean square error is decreased than the traditional method.

V. REFERENCE

[1] https://www.mygreatlearning.com/blog/digital-image-processing-explained/#:~:text=An%20Image%20is%20a%20spatial,arranged%20in%20rows%20and%20columns.

[2] Wei, C. T., Ling, C. Y. and Shao, C. Y., 2008. ‘‘Fast image segmentation based on K Means clustering with histograms in HSV color space,’’ IEEE 10th Workshop on Multimedia Signal Processing, Vol. 4, pp. 322-325.

[3] Busin, L., 2004. ‘‘Color space selection for unsupervised color image segmentation by histogram multi-thresholding,’’ International Conference on Image Processing (ICIP), Vol. 2, pp. 1280-1283.

[4] Patil, R.V., Jondhale K.C., 2010. “Edge based technique to estimate number of clusters in k-means color image segmentation”, 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), Vol. 2, pp. 117-121.

[5] Wongsritong, K., Kittayaruasiriwat, K., Cheevasuvit, F., Deihan, K. and Somboonkaew, A., 1998. “Contrast Enhancement using Multipeak Histogram Equalization with Brightness Preserving”, IEEE Asia-Pacific Conference on Circuits and Systems.

[6] Kettaf, F. Z., Beauville, A. de, 1996. “A comparison study of image segmentation by clustering techniques”, International Conference on Image Processing (ICIP), Vol. 2, pp. 1280-1283.

[7] Huang, S., and W. Chen, 2014. "A New Hardware Efficient Algorithm and Reconfigurable Architecture for Image Contrast Enhancement”.

[8] Jha, Rajib Kumar, Chouhan, Rajlaxmi, Biswas, Prabir Kumar and Aizawa, Kiyoharu, 2012. "Internal noise-induced contrast enhancement of dark images in Image Processing (ICIP)”, 19th IEEE International Conference on, pp. 973-976. IEEE.

[9] Jose, Alan, Ravi, S. and Sambath, M., 2014. “Brain Tumor Segmentation using K-means Clustering and Fuzzy C-means Algorithm and its Area Calculation”, in International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, No. 2.

[10] Kaur, Manpreet, Kaur, Jasdeep and Kaur, Jappreet, 2011. “Survey of Contrast Enhancement Techniques based on Histogram Equalization”, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 7.

[11] Kawulok, M., Kawulok, J., Nalepa, J., and Smolka, B., 2014. “Self-adaptive algorithm for segmenting skin regions”, EURASIP Journal on Advances in Signal Processing, (170), pp. 1–22.

[12] Mahmoodi, M.R. and Sayedi, S.M., 2016. “A comprehensive survey on human skin detection”, International Journal of Image, Graphics and Signal Processing, 8(5):pp. 1–35.

[13] Khan, M., Khan, E. and Abbasi, Z. A., 2012. “Weighted average multi segment histogram equalization for brightness preserving contrast enhancement”, IEEE International Conference on Signal Processing, Computer and Control, ISPCC.

[14] Kil, Tae Ho, Lee, Sang Hwa, and Cho, Nam Ik, 2013. "A dehazing algorithm using dark channel prior and contrast enhancement", in Acoustics, Speech and Signal Processing (ICASSP), IEEE International Conference on, pp. 2484-2487. IEEE.