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Effective Application of Retinex Transformer with One-Stage In Low-Light Image Enhancement

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Abstract - *At present days most the researchers are carried out a lot of color enhancement of gray images in diverse field. We have most sophisticated methodologies in images enhancement but it may lack in expected result accuracy .The basic ideas is fetching out the hidden details present in the input image and also to highlight the interesting factors that may be implemented in some need calculation like weather, earthquake etc.. This method mainly corrects and secures the gray scale color transformation method. Other important enhancement technique like masking, histogram manipulation also plays a tedious role removing the noise present in the image then as further it is implemented for fetching information present in the image. This also prevents pixel self-transformation method rainbow coding, metal coding and also pseudo color enhancement algorithm based on frequency domain. In current centuries signal as well as image processing is based on fractional calculus has attracted extensive attention. Color Enhancement is realized by utilizing the constructed high gray scale enhancement algorithm when it is been analyzed with the traditional enhancement method the image results with a prominent difference in the performance which is relatively the objective indicators when dealing with image enhancement with the impression of low light t. The proposed method effectively with traditional jet coding as well as HSV pseudo color methods as well as find out the brightness of image, brightness of the distortion.*

Key Words: Low Light Enhancement, Histogram Equalization, Deep learning, One Stage Retinex, Traditional methods, Image Enhancement.

1. INTRODUCTION

The classic Retinex method only shows the way of pixel representation and the predicted edges of an image ot be enhanced .These factors make it harder for computers to recognize the images and for humans to do so as well. Enhanced approaches for low light photos were typically used in deep learning improvement methods, along with regularly used evaluation indicators for nighttime image enhancement. Issues and the advancement of deep learning techniques for improving 3D picture angles and low light photographs. (e.g. [1]). Spatial Domain performs manipulation of pixels directly in the image in the image plane itself .To represent a more clear specification of image the perform linear and non-linear operations. The approach in enhancement is frequency Domain here the enhance of an image is taken as f(x, y) and then the image again is implemented to manipulate as linear, position Then 2D convolution is been p e r f o r m e d . But till we are in need of more unique technique for images like neural network architecture and the learning algorithm which is been implemented in deep learning are taken into consideration. When implementing various deep learning image enchantment techniques. The images get have some very noisy and to filter those images so that the noise present in the image can be removed and the image appears much better. In some other kind of applications to enhance certain characteristics of the image .Even versatile image enhancement techniques where present in this situations. In the proposed paper an additional enhancing technique is implementing with Retinex One Stage Retinex which has assigned a unique level of restoration and it follows an illuminate Retinex Transforms which work for setting the expected highest clarity of the input taken.

Spatial Domain: It mainly work with pixels to manipulate directly in the image according to image plane itself .To make it more clear a unique specification of image is used the perform linear and non-linear operations

$$\text{Spatial domain:} \quad g(x,y)=f(x,y)*h(x,y)$$
$$\text{Frequency domain:} \quad G(w_1,w_2)=F(w_1,w_2)H(w_1,w_2)$$

Frequency Domain: The enhance of an image is taken as f(x, y) and then the image again is implemented to manipulate as linear, position Then 2D convolution is performed. As the advancement in enhancement the deep learning which recognizes the complex digital images with respective to the human brain that's helps to predict the data pattern of the image that helps to explore further in image enhancement. The One stage Retinex helps to works in depth in data retrieval from a noise image.

2. HISTOGRAM EQUALIZATION AND RETINEX

2.1Bi-Histogram Equalization

It is the simplest and effectively proved as the basic enhancement technique in traditional methods of image enhancement. We have implemented here to do enhance the

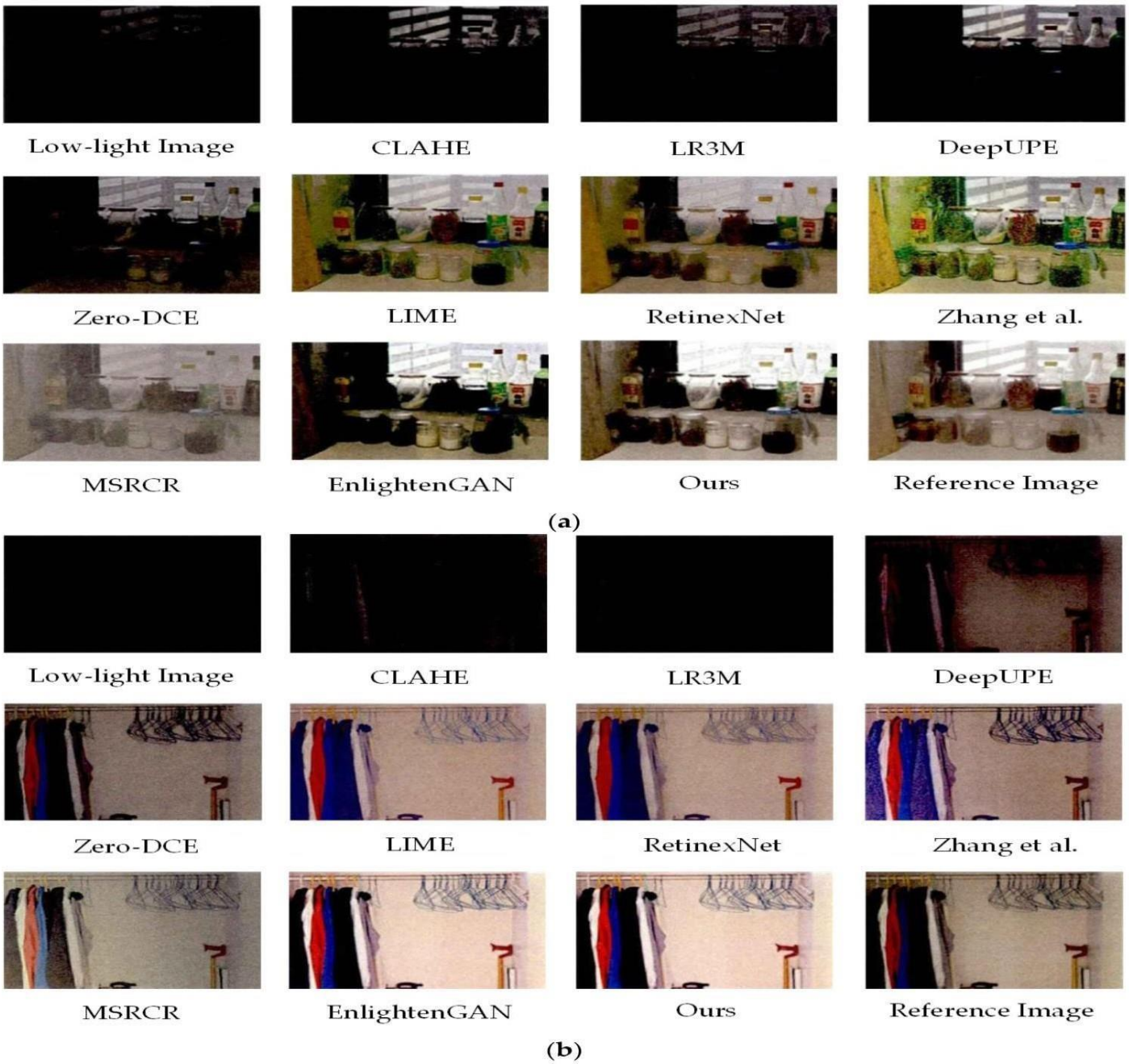

Fig 1: Comparison of Image Enhancement with different Datasets

basic or initial steps and effective steps in image enhancement method. We had taken Yeong-Teag Kim's proposed method which states the Brightness locking Bi-Histogram

$$X = X_L \textcircled{@} X_U$$

Equalization method [2] which has been based on the particular Mean value. It include partitioning an image X into two sub images, X and X. This can be represented as the images decomposed are been equalized and independently composed later .This method aims to preserve the contrast enhancement in the taken input image. When considering the image brightness it may also sometimes subjected to obtain the mean value by comparing with the calculated and pre predicted values which has been derived to compare the obtained values.

2.2 Dualistic Sub-Image Histogram Equalization

This particular Technique in histogram was been adopted by Yu Wang et al. implemented for image enhancement. It

depends on the calculation of the Median value as represented in [3].

$$X_L = \{ X(i,j) / X(i,j) < X_e, \forall X(i,j) \in X$$

$$X_U = \{ X(i,j) / X(i,j) \leq X_e, \forall X(i,j) \in X$$

works with the decomposition of image considered to be X by can be represented by the below mentioned equations which the two sub-images, X_L and X_U are been obtained this shows the difference and then the differences are then calculated with a mean value lying between L and U .Then for further clarification further histogram plotting's are carried out to the resultant means value present in the image. The above equation when implemented with the arrived values will gives to information of the decomposition level.

3. IMPLEMENTATION OF EDGE FILTER AND DECOMPOSITION

Low light image enhancement is considered to a tedious problem .By implementing edge filtering and decomposition methods it emboss and highlights the boundary areas and corresponding information hiding in the image The enhanced image is obtained more accurate when compared with the original image .This happens according needs even without considering the image degradation process and removing unimportant features so that the suits for specific applications. The images taken at night time appear to be mostly white and black. Even some times is the device used to shoot is not enough, it results in color blackness, and appears to be being stretched. By this impact there is no absolute improvement of color saturation. To solve it we can use a changing color space not taking color factors as an account.

$$E = S(O) + \tau D.$$

In this O is the observed image and S(·) is edge-preserving operation, D is the detail layer of the image, τ is an important parameter it controls the expansion of the detail layer, and E is the image after the above enhancement. The image signal processing method is processed by a series of subtasks that includes Denoising and white balance Based on deep learning, a straight forward conversion is made with the original image and converted into a color. It can be defined as:

$$I_c = F(I_l, \theta).$$

In this F *is* considered to be the proposed network and θ is data set parameter. We have to train data as samples in order to check the effects in different aspects. From the specific examples it is found to be harder retrieving needed data . To work with such situation an image conforms to human visual is considered to be the objective image quality evaluation method which is implemented as commonly used evaluation method. Our deep learning method with one stage comes with two phenomenon signal to the noise ratio and structural equality which helps to check the image quality by calculating the error between corresponding pixels. The calculation is expressed as follows

$$\mathrm{MSE} = \frac{1}{H * W} \sum_{i=1}^{H} \sum_{i=1}^{W} (X[i,j] - Y[i,j])^2,$$

$$\mathrm{PSNR} = 10 * \log_{10}^{(2^n-1)^2/\mathrm{MSE}}.$$

4. RETINEX BASED TRANSFORMS

The basic concept capturing enhancing can be done by using traditional methods which is currently available. The input image taken will result in a confused stage if there is misunderstand between the image projected digitally and absorbed in a wrong way this may also result in failure of predicting accurate information from the input image. To resolve this method named Retinex can be implemented which avoids these circumstances .Here these methods has implemented with two powerful carotenoids projected highly with concentrations in macula which is the seeing part of human eye. The important pre assigned task of Retinex is matching the illuminate value present in the image with respect to human eye and the screen. The luminance produces the reflectance of the image .We can formulate this as I as Retinex image S is the illumination and r is the reflectance coordinates. The light of the image can be adjusted till the uniformity is reached by adjusting the below factors.

$$\mathrm{Retinex(I)} = \mathrm{Reflectance(r)} * \mathrm{Illumination(S)}$$

5. DEEP LEARNING MODELS

Traditional methods the image perception are been proposed to explain the perceived color constancy of objects under varying illumination conditions. The One stage Retinex Transforms works with decoupling illumination and reflection components of low- light images involve complex priors but the presented theory, an image can be decomposed into to represent the object of the image with lighting conditions the illumination maps and reflectance part is converted to intrinsic property The quantified feature of Retinex Transforms helps in learning process been achieved by assigning weights or parameters of a model after many iterations similarly to how human vision is believed to operate to analyze the object and perform a particular computational task. The human retina system view the color of the image enhanced by this algorithm is more in line compared with human visual characteristics used the brightness masking characteristic detail with presents the

Retinex theory. Several approaches exist to implement the Retinex principles, among these the multistate Retinex with color restoration algorithm (MSRCR.) but when comparing with one stage the transforms apply the training data in different stage of enhancement process .The Image enhancement process can be divided on the basics of the previous mentioned processing applied on the spatial field and transformation field. Transform techniques when applied are been further classified as wavelet domain has to be curve let domain algorithms depends on the domain the adjusted multi scaling parameters and also utilizing the visual statistical characteristics to make a clear representing inner and the outer curves of the image. The radiant characteristics of OSR model to enhance the image to transforms besides the adjustment of the image.

Table 1: Comparison of Image Enhancement Methods

Enhancement Methods	Merits	Demerits
Adaptive Histogram Equalization[13]	It results in lower contrast thereby creating dark regions.	It does not work efficiently.
Histogram Equalization[14]	It is a most effective method for grayscale images.	It cannot work on color images
Decor relation Stretch[15]	It is used to improve the interrupted images and to improve the classification	It is a most complicated process

The brightness of image enhancement happens in a secure way it helps total process as well as the dual tree composite. The wave transform field by utilizing the nonlinear contrast mapping is more coefficient value. The above Image shows the output the different data sets are implied with the input taken has gave a dra

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hasizing the complexities involved in image enhancement. When applied in various photographic input images the Retinex method constructs a the better solutions when exposed to enhancement.

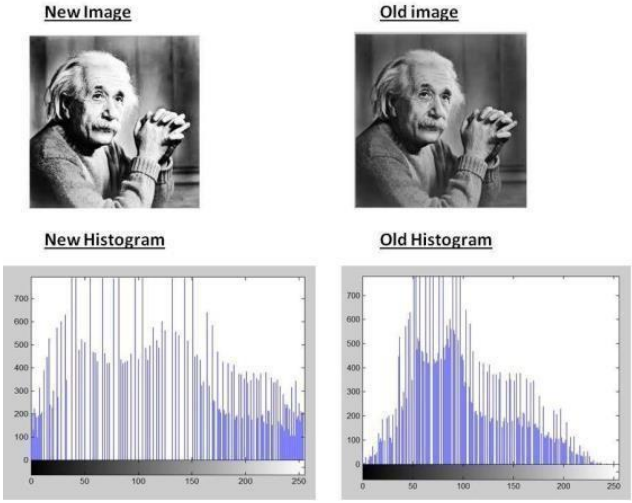

Fig 2: Image comparison after image Enhancement

The One It use an invisible or a silent parameter to work in enhancement which try to produce a feasible output .So it is considered to one of the straight forward method. stage Retinex techniques take advantage of calculative operations to achieve different effective output as expected results. Our contributions summarized as follows:

1. Implemented Transformer based algorithm.
2. Packed with Retinex former from image restoration.
3. An expected compressive output was produced with OSR.

6. CONTRAST ADJUSTMENT WITH ONE STAGE

In this paper we also try to solve the issues happened by contrast which is also considered to the key factor which affects the original image clarity .To make this issue clear we are in a situation to again work with histogram equation. It is also found that this contrast adjustment is also based on the balance color of retinal image. The color spaces present in the image is been categorized with RGB related to lightness finding the color opponent to match the range of the light present in the image. In this paper we apply CLAHE and the histogram stretching algorithms .When applied with histogram this method stretches the intensity value and try to enhance all the color and the brightness level present in the image from which we can able to find out the color shades and its percentage of presence in the image for calculating .

Fig 3: Contrast Adjustment comparison in image for One Stage Retinex

Contrast Adjustment =MaPI –MiPI

MaPI - Maximum Pixel Intensity
MiPI - Mimimum Pixel Intensity

The expected output shoes a vast improvement in aspect of contrast present in the original image. The histograms are also calculated for small regional areas of pixels. After this Intensity Correction Intensity Sometimes non-uniformity in satellite images may cause during the acquisition of the input image. This happens due to the noncooperation of the devices used and also artifacts caused by slow intensity variations. To solve this Maximization of Expectation algorithm is utilized to correct the variations of intensity. This method will not make assumption of the sequences type and texture intensity so they can be used in all image process. This method work as expectation Step maximization step. It is related to the K- means method where a set of data is recalculated till the expected range arrives. These steps are repeated till reaching the targeted output as satisfying the expected level. As the next continues stage of contrast and correcting intensity, an enhanced method of noise removal is applied It reducing the noise without affecting or altering the image content and also the edges, lines or other details are also not altered Anisotropic filter are used as filtering technique in digital images. The anisotropic diffusion algorithm introduces effects like blocking and evacuates structural and unwanted neighborhood information. We combined with edge- sensitive methods to make an effective noise removal process. Here the image features are been segmented by smoothening the image and enhances the edges of the image.

$$S(x,y) = R(x,y) \cdot I(x,y),$$

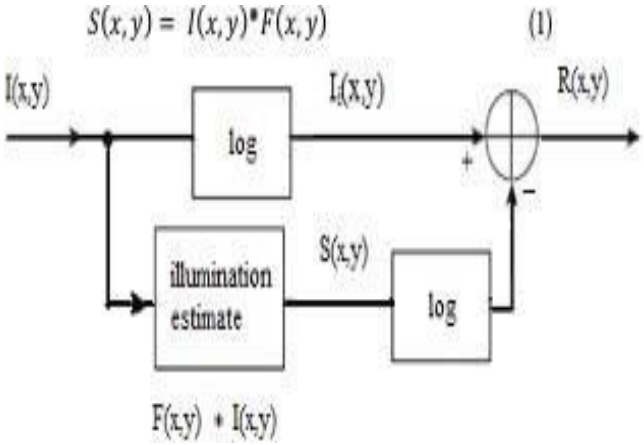

Fig 4: Implementation of One Stage Retinex Method

7. RELATED WORK

7.1 Low-light Image Enhancement

7.1.1. Plain Methods.

Usually called a mapping-based approach. Such a method enhances an image by modifying the distribution and dynamic range of the gray values of the pixels The main subclasses of this type method include linear and nonlinear transformations Nonlinear Transformation with one stage Retinex.

7.1.2. Traditional Methods.

Deep learning when implemented in traditional image processing can often provide an over solved solution which some time does not match expected output. This feature processed by deep net technique of Retinex and when applied to specific dataset will match the expected output which goes for further refinement.

7.1.3. Deep Learning Methods.

A deep Learning implemented Retinex decomposition method has been effectively learned to decompose to the fine extend of the image into reflectance and illumination in a data driven but it sometime produce an result more than the targeted output or more than the clarity that we are expecting will relay us in an confused stage of defining the image quality. The existing Retinex has been compared with Retinex-Net with the four state often methods, including the de-hazing based method naturalness preserved enhancement algorithm, simultaneous reflectance and illumination estimation algorithm and illumination map estimation based algorithm provides a noise free visual comparison on three natural images. The reference image and finally compute the loss function and optimize the parameters, which archive continuously improving the color restoration performance after been processed. Deep learning

techniques for image enhancement have emerged as finest output that gives us sophisticated results of artificial intelligence.

8. ONE STAGE RETINEX-BASED FRAMEWORK

The main goal of Image enhancement is a crucial and tedious process which works on effective visualization and analysis. An image can be decomposed into a reflectance in accordance with the Retinex theory where light I is decomposed to illumines L and reflection R and can be represented as below

$I \in L$

$I \in R$ and

$I = R \odot L,$

In Retinex theory, an input image can be explained as variety of reflection component and illumination component, which can be expressed as the Work flow of the One stage Retinex can be implemented as the below representation where we can also perform various Deep Retinex scaling . Accurate estimation and a clear normalization are the two important factors behind the deep learning. The reflectance and illumination are taken from the input image and can be represented by Represent R can be represented as reflectance and L can be taken to represent illumination. The edge has an important aspect which may cause blurring which also affects the clarity of image the one stage Retinex also establish the edge coordinates where I represent the original image, R.

$$\begin{aligned}\mathbf{I} &= (\mathbf{R} + \hat{\mathbf{R}}) \odot (\mathbf{L} + \hat{\mathbf{L}}) \\ &= \mathbf{R} \odot \mathbf{L} + \mathbf{R} \odot \hat{\mathbf{L}} + \hat{\mathbf{R}} \odot (\mathbf{L} + \hat{\mathbf{L}}),\end{aligned}$$

The Retinex former is implemented with on one stage Retinex-based Framework (ORF).It is composed of an illumination estimator, a corruption remover .An Illumination Transformer is implemented to remove the noise present in the input image .the frame work has a attention block in further classified into normalization and Multi processed module that do the work of noise removal and enhancement of image. The image enhancement can be successfully implemented in various fields that including important factors like health care, defense, and retail among others. The image data considering with its contrast and color are resulted as weak appearance when processed with traditional methods .The aim of imaging should produce a good visual representation when the input image visually screened by the human eye directly the image should produce a good visual impression subjected to the linear representation and rendering for a very restricted class of scenes those without any illumination and restricted

RESEARCH PROCESS

Dataset

The study chad carried by taking sample photography image 500X500 pixels to calculate and to estimate the one stage Retinex with traditional and deep learning methods. When using this one stage Retinex even the images captured at different times of the day and night provided with a varied of images produce good and adaptable illumination conditions. The original image has a structure of full HD 1920 × 1080 resolution images which is been captured by using Sony Alpha 6400 cameras and short with at 50 frames per second. These images with processed with Faster R-CNN .COCO dataset is implemented to test the trained data. As a Final result, the dataset has been identified with the subjects of interest by hand and selected representative images for each individual

Experimental Details

The process transformation includes the input image for nonlinear spatial processing. To calculate the One Stage Retinex and its performance we use a framework on NVIDIA GTX 1060Ti and Intel Core i7-7700HQ 3.7GHz CPU. The data preprocessing has been executed using training data implemented using task like scaling , rotation and cropping then it is been processed into the pixel format by which we can observe an noise free image at the beginning of the process itself. The Process carried in such a way that the input image taken is assigned as targeted input and compared with the framework of One Stage Retinex been the source of the paper calculate the noise and color distortion present in the input taken and produce an gowning histogram graph representation . A test dataset to complete training and the performance of the model was executed to check the expected level of performance. In the image decomposition network module's training phase, a learning rate of between 10 and 4 are was chosen with a batch size of 8 was incorporated. The light enhancement network structure , has used 10−3 learning rate and a batch size of 15 A learning rate of 10−4 was used and the batch size will be during the training of the color restoration module has been used. The human eyes may lose some details when the observation o f an picture is not done properly it may also be happened by low light, we calculated (perception-based image quality evaluator (PIQE), image quality measure metrics (mean-squared error (MSE), structural similarity (SSIM), and peak signal-to- noise ratio (PSNR)) and lightness order error (LOE) to measure the quality of the enhanced images derived

Table 2: Results of Image Quality Tested With Different Metrics

Metrics	LECARM	AFEM	FFM	JIEP	LIME	SDD	Proposed
PIQE	39.818	39.809	42.884	40.072	42.705	51.457	**38.601**
LOE	415.594	253.646	291.906	296.568	749.862	493.806	**7.660**
MSE	3777.2175	2021.305	2823.849	2241.768	**1153.584**	1617.479	1158.174
SSIM	0.531	0.747	0.709	0.732	0.739	0.751	**0.753**
PSNR	12.504	16.350	14.464	15.847	18.136	17.511	**18.258**

Table 2 shows the results of the different quality measure methods and the values represent the average value. The best scores are highlighted in bold and the near best scores are highlighted with underline values

CONCLUSION

Now consider an example if a green apple for instantly looks green efficient technique on collection of images by applying a common color factor. This approach addressing values initially recovers sparse pixel correspondences from input images and arranges them into a matrix finding missing entries. The parameters used here are viewed as white balancing parameters for each input image. The Retinex theory consider propose an well-developed model with combining to deep image enhancement technique will always produce a good output The methods like decomposing, enhancing, and reconstructing .A network model with an encoding and decoding vector has been incorporated in convolutions connections to gather the information and it helps to reduce the details that has been lost during decomposition. On observing all the other algorithm out current method also achieves the superior results in terms of PSNR, SSIM, and NIQE image quality assessment metrics in image .Future research directions include expanding the dataset, optimizing network loss functions, enhancing model speed and efficiency and increasing the algorithm's applicability across different domains Even in terms of PSNR, SSIM, and NIQE and other noise data the input taken image suffers a vast impression of noise representation which has to be considered produced. An dual discriminator when applied to low light image enhance the loss function by incorporating lightning up technique to measure image distortion even edge filtering technique can helps to achieve the same noise free image quality. The low-light image taken will be divided effective illumination mapped corresponding to reflectance. The illumination module will develop curves to map finally they are been employed for iterative in illumination mapping The noisy part of the image taken are been corrected and by using 3D LUT- based One Sage Retinex color restoration methodology has can up with an solution of improvement in the input image as its noise was cleared in an satisfactory way and even in low light the one stage Retinex estimate hidden details of the image .In the paper the input images has improved in noise by effectively enhancing the image and the color distortion issues helps to develop subjective visibility to compared to other algorithms to prove the efficiency of the chosen algorithm the effective processing of the information available in the image are been well improved using proposed algorithm which has implemented de finely improve and enhance the brightness of the low light image.

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