

AN EXPERIMENTAL SET-UP OF A GRAPHICAL USER INTERFACE FOR IMAGE ENHANCEMENT USING CNN

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A B S T R A C T

MATLAB GUI provides a friendly graphical user interface. We know that deep learning is very in demand in today's life. It is used when talking about a large number of data, deep learning is used to learn features of a data set, or we can say that an image. So for this process of convolution, neural networks play an important role. CNN is used for speech recognition, face recognition, image classification, etc. In this research, an experimental set-up has been done for low-light image enhancement based on deep learning, and also enhancement has been done based on intelligent retrieval with the help of GUI in MATLAB. The authors also stressed minimizing the complexity as computational time has been measured, including all parameters. It is also known as Deep Learning. Enhancement, in terms of strengthening, is the same. Deep learning and CNN are the same; it is a subclass of intelligent retrieval. When we talk about a massive number of facts, and we have to classify them, so the system is very complex at that time, so we need to reduce that complexity. If we talk about GPU, it is very expensive. It is used for both software and hardware design; when we need to train data with a large amount of data, system complexity automatically increases.



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1. INTRODUCTION

Image enhancement is the process that gives clarity to a visual appearance of an image. It is a task of improving the quality of the graphic design. Image enhancement may be classified into two categories, qualitative and quantitative. Qualitative modification refers to the modification of images to make more appear too human visually, i.e., the picture looks better. Quantitative enhancement refers to the revision of information that an image carries; for example, in the border observation process, the edge is necessary. Using image processing techniques, the image edges have

been modified. This type of modification is known as a quantitative modification. Image modification or strengthening intends to make clear ocular information intelligible. So image modification is an individual because it turns on information the user wants to extract from the image. It has two conditions for this: image enhancement is expected information must live in the image. For example, if an end user wants to enhance some particular slice of an image, the image must contain that portion. The second condition is the expected information must not be washed out by noise. If expected information is enclosed by noise in such a way that it cannot be processed, we cannot be

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enhanced; so we can say the main target of image strengthening is the way how an image can be made more satisfactory for a required task than the original image. Figure 1(a) shows the input image, and (b) shows the enhanced image (da Silva & Mendonca, 2005)

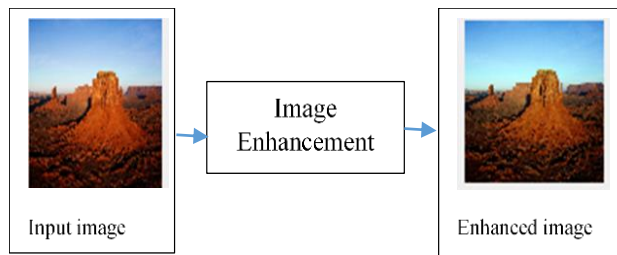


Figure 1. Image Enhancement

Image enhancement has different techniques like stretching, slicing, histogram equalization, etc. With the help of these techniques enhancement of an image can be done more accurately and clearly. These techniques used a different algorithm to process. The image enhancement plan is to give better results in the form of visual appearance; Figure 1(b) shows an enhanced effect than figure 1. Digital image enhancement is a method of working that furnishes different choices boosting the ocular appearance of an image. Enhancement of an image can be done by different methods such as histogram, sharpening, balancing, etc. The histogram is also various types, such as bi-histogram, contrast limited adaptive histogram equalization, and global histogram.

These are used for pixel intensity. Image enhancement based on single-pixel transformation functions. These functions can be gain, square, offset, logarithm, and negative also. Image processing is done by various tools like MATLAB and Python. But in this paper, the authors used MATLAB GUI. In Graphical User Interface.

The rest of this investigation analysis is assembled as: section II is CNN for image enhancement and classification. Section III demonstrates here the GUI-based CNN image enhancement. Result discussions explained in section IV, and section V demonstrate the future scope and conclusion of the research work.

2. CONVOLUTION NEURAL NETWORK

A convolutional neural network is a subclass of intelligent retrieval. In CNN, if work wants to as a machine algorithmic expression that can take in a loading picture, assign features such as learnable weights and biases of images or objects in the image. CNN used multiple layers for its processing. Convolution neural networks (Singh et al., 2019; Ahmad Radzi, 2016; Ashraf et al., 2020; Li et al., 2020) is a type of neural network which is used for image processing application. It is used in many applications like object recognition in image & video (for example,

image search from google, adding a filter in snap chat app), natural language processing (speech recognition in google assistant or Amazon Alexa), and medical innovation (from drug discovery prediction of disease). Figure 2 shows a simple way to read out an image or classify an image.

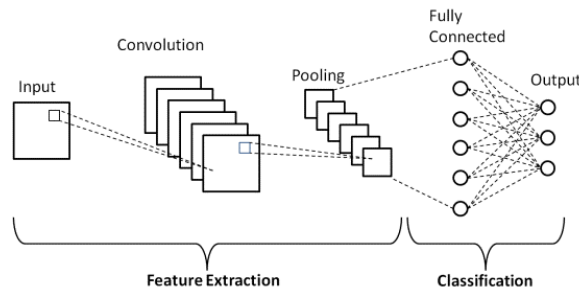


Figure 2. The architecture of Convolution Neural Network

CNN is a deep neural network that has multiple layers in it. Each layer of CNN learns multiple features (or multiple sets of weights) that connect to the previous layer. CNN takes an input image (2D, 3D, gray, or color), and it tries to identify the relationship between this image and some target data example, a classification. There are multiple neurons in a single layer, and each has its own weight to the subsection of input. This different set of weights is called Kernel (Latif et al., 2019).

Intelligent retrieval, or DL, is a subclass of machine learning. This investigation algorithm is inspired by the functioning of the human brain, or we can say that neural networks. There are multiple methods of deep learning, like ANN, but CNN or Conv Nets is best for computer vision and image analysis. CNN is used for basically image classification, pattern recognition, edge detection, etc.

CNN building is encouraged by the concerned group and the workability of the visual cortex and sketch to copy the connection with edges of neurons within the human brain. The neurons within a CNN break into a three-dimensional form, with one and all sets of neurons analyzing a tiny region or attribute of the picture.

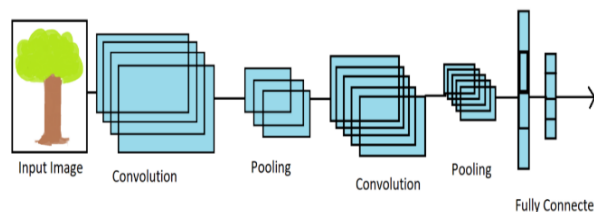


Figure 3. Image process through Convolution Neural Network

Figure 3 shows here the architecture of the convolution neural network. In this, an image of the tree has been taken and fed forward to the different or multiple layers of convolution neural networks. After crossing multiple layers, an image is provided to the fully connected layer

(Zhang et al., 2017; Kaur & Kaur, 2018). Convolution means a simple mathematical operation, is the way of multiplying. It is used in many common image-processing operators. Multiplying two arrays of numbers, sizes can be different, but the dimensions are the same and produce a third array of numbers of the same dimensions (Xia, 2018). Convolution Neural Network is also called CNN or Conv Net. A convolution Neural Network is complex feedforward neural network. It is used for image classifications, image recognition, object detection, and face recognition (Li, 2019). It has multiple layers in it for processing.

3. GRAPHICAL USER INTERFACE

In Graphical User Interface, a guide is developed with different components. These component areas are a pop-up button, push-up button, text box, etc. When clicking on a push- a switch is used for an action. Pop-up is used to open the list of choices. Static text is used to control the display lines of a text. We cannot change the static text. Axes are used for graphics of objects. The basic steps for GUI are as follows: (Shenoy et al., 2017):

- Start MATLAB
- Type GUIDE to open GUI at MATLAB prompt or in the command window.
- “In the guide, a quick start dialog box,” select blank GUI.
- Press on this prompt.
- Component names display the names in the component box.
- Choose file > preference > Guide.

GUI is also known as an app in MATLAB. It provides point-and-click controls in software applications. MATLAB is a powerful mathematical tool that is used for matrix calculations. (Paso, 2016; Qiu et al., 2019; Wang et al., 2020).

Fig 4 (i) shows here a simple user interface. A small program is shown here for this interface[14]in step 1 start GUIDE “by typing guide at the MATLAB prompt,” which is shown in Figure4 (ii).

Some steps are given here to create a GUI layout.

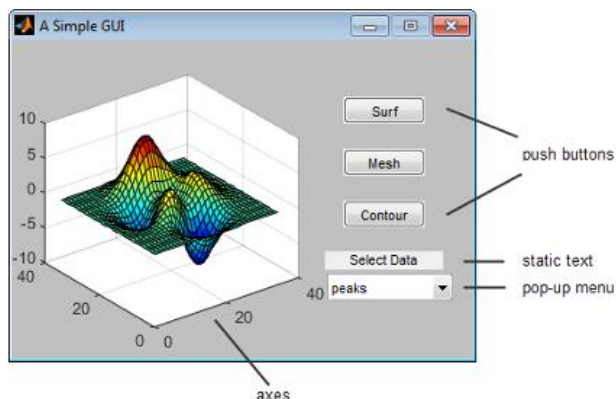
In step 2, select a blank GUI, then press ok, shown in Figure 4 (iii).

In step 2, select a blank GUI then press ok, which is shown in Figure 4 (iii).

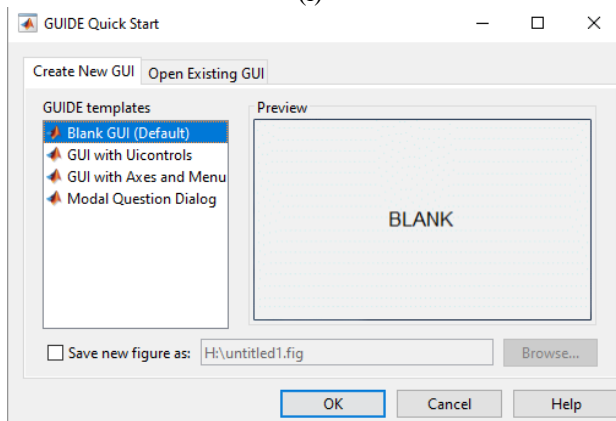
Step 3, in this we can show the name of the components prompt:

- (i) Choose file > preference > GUIDE
- (ii) Choose a name in the component box
- (iii) Press OK

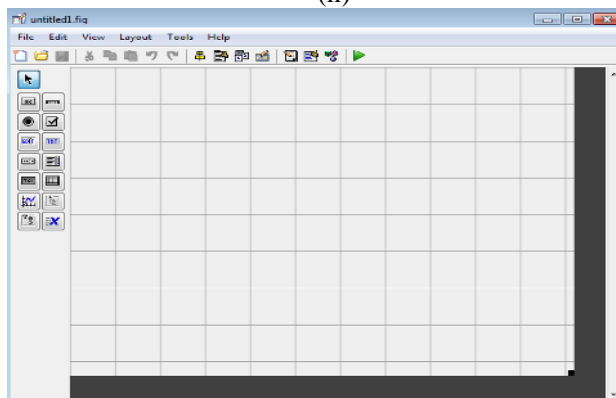
In step 4 labeled the push button and click ok and save the layout, which is showing in Figure 4 (iv) (Shenoy, 2017; Mathworks, 2015).



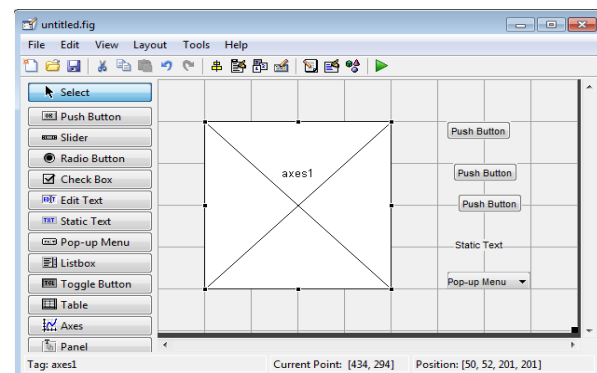
(i)



(ii)



(iii)



(iv)

Figure 4. (i) GUI window, (ii) Create a blank window, (iii) Component prompt window, (iv) Push-button window

For example, having many pictures like a dog, cat, and rat can quickly learn the critical features for an individual class. Convolution is a simple application of filtering. A CNN network for reuse a pre-trained network. It shows a pre-trained network with approximately 1 million images at one time, and all this goes through a different layer. The early layer learned the low-level feature, and the last layer learned the specific features. The replaced final layer will be learned the specific features. Then the next process is a trained network, known as a fuzzy set. Image enhancement is a method of improving the quality and information of the content; in this, a training option is given. It is used hundreds of images tens are be classified. Then it goes through to the prediction, which tells the accuracy of the test image and finds a single image with its probability of accuracy network. This network works for image classification if multiple random images and a wand to identify the image. The Figure is shows that a have image and needs to classify it. What will be the image that is a flower, cup, car, or tree? It will identify the image with the help of a deep neural network. CNN has multiple layers for its working for image identification like RELU, Pooling, etc. Figure 1 shows the input image then the enhanced image. Fuzzy collects all methods that can understand, represent and process the images. Their features and segment are significant advantages are they automatically detect the essential features without any supervision of a human. For example, having many pictures like dog, cat, and rat can quickly learn the critical features for an individual class.[5]

4. RESULT AND DISCUSSIONS

Performance evaluation is an analysis of measure different parameters like MSE, PSNR, entropy, SSIM, and execution time. The output image and their measured parameters are shown in table.1.

PSNR (Peak Signal to Noise Ratio)

PSNR is the ratio of maximum possible power of a signal and power of corrupting noise that affects the quality of an image. Higher PSNR shows the good quality of an image. (Zhang et al., 2017) (Anwar et al., 2018) image enhancement using fuzzy and convolution neural networks.

$$PSNR = 10 \log_{10} \frac{MAX^2}{MSE}$$

MSE (Mean Square Error):

It is the squares: average of the errors, i.e. the squared dissimilarity between the estimate values and the actual values. It is used in image and signal processing for

Measurement of the average of squares of errors. (Anwar et al., 2018; Chen et al., 2020).

$$MSE = \frac{(\sum(I_1(i,j) - I_2(i,j))^2)}{(m \times n)}$$

MSE = Mean Square Error

Y_i = Observed values

^Y = Predicted values

n = number of data points

Computation time: it is the duration of time required to execute a processor or for a computational operation. It is also called running time. Representation of a “computation a sequence of application rule”. Computation time is proportional to the number of application rules.

BER: it is the total bits percentage “that have faults respective to the total number of bits obtained in a dispatching” the bit error rate is usually expressed as 10 to a negative power.” (Kaur & Sidhu, 2016)

SSIM: Structural Similarity Index is used for the evaluate picture quality degradation it is generate due to preparing.

Entropy: entropy is in image processing is the state of intensity level, this level is adapt by individual pixels. Entropy is used in the quantitative. Entropy value provide a better comparison of image. It can be calculating at each pixel position (i, j). It is an arithmetical measure of changeable function that can be used “characterize the appearance of the load image.” It is expressed as sum (p.*log₂ (p)). Where p carry the normalized histogram compute returns out of the image histogram, (imhist).

SSIM is also known as processing such as image compression, data compression or come loss during transmission. It is an emotive metric and mentioning metric it needs two images from same image capture i.e. a mentioning image and a refined image.

Figure 5 is showing here different images, which are taken as input image and then after that apply different operation for enhancement on these. This figure 5 (a) is showing the original image, then convert the original image to the (b) gray, gray image only carries intensity information, (c) is showing the dark channel prior image, DCP are blur or fog free images it carry a few pixels and intensity of these pixels are very less. The Figure (d) is showing the contrast histogram that is used to grow fine details of an image and highlights the edges also and at last in (f) is displaying the CNN output images, after applying various enhancement methods. Variance of an image, variant of enhancement is called CLAHE. White balancing is showing in 5 (d), it is used to remove the unrealistic color, (e) is showing the sharpening of an image, it is the technique that gives the Figure6 (a) original desert image & output CNN image (b) Correlation adjacent pixels of original and CNN output image (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor of output image. Correlation of original ocean image and correlation of CNN. X axis is showing here pixel location and y axis is showing the directions of at positive axis or at

negative axis. $X+1$ is showing the direction at positive axis. Figure 7 (a) original ocean image & output CNN image (b) Correlation adjacent pixels of original and CNN output image (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor

of output image. Figure 8 (a) original atmospheric image & output CNN image (b) Correlation adjacent pixels of original and CNN output image (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor of output image.

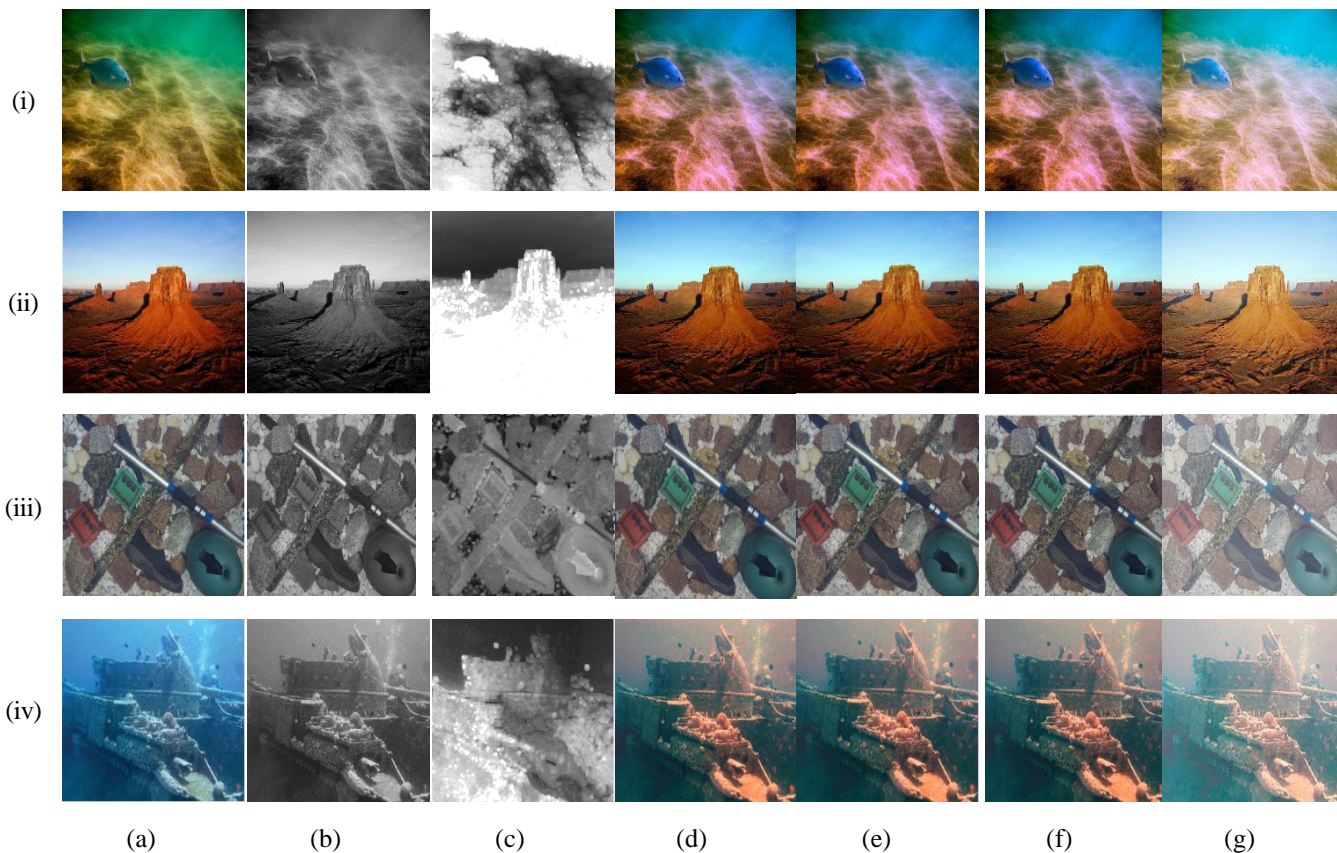


Figure 5. (i) Ocean image, (ii) Desert image, (iii) Object image, (iv) Atmospheric light Image (a) Original image, (b) Gray image (c) Dark channel prior, (d) CLAHE, (e) White balancing, (f) Sharpened, (g) CNN

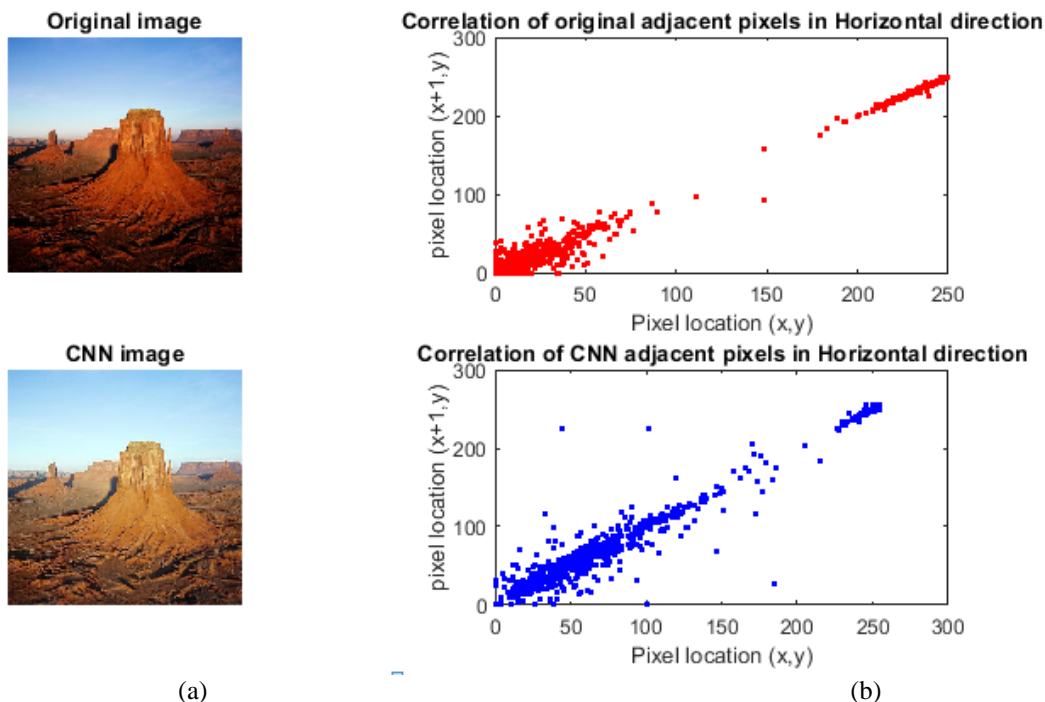


Figure 6. (a) Original desert image & output CNN image (b) Correlation adjacent pixels of original and CNN output image

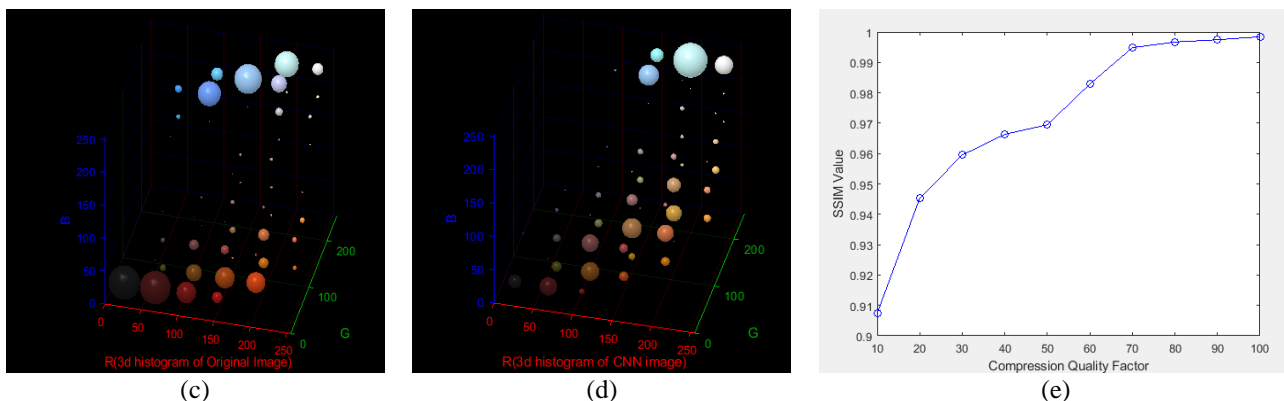


Figure 6. (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor of output image

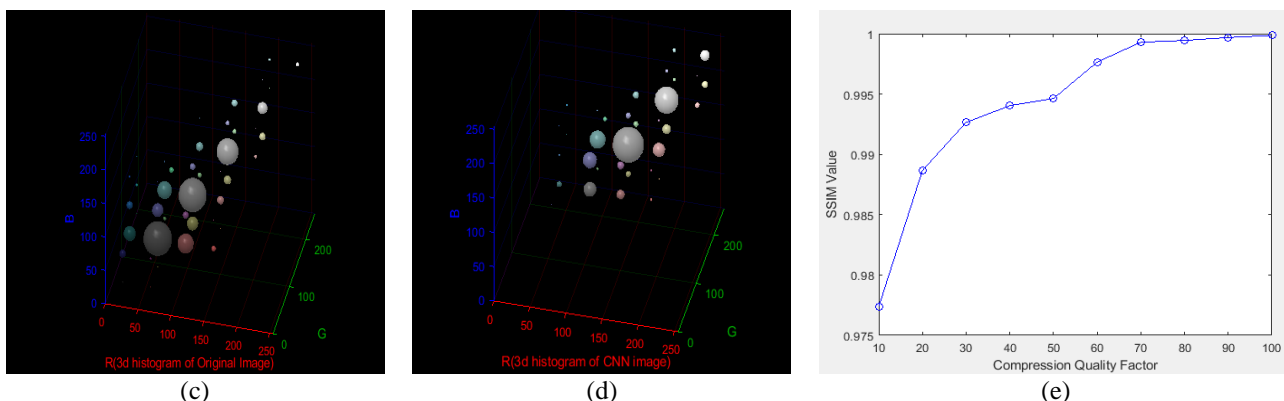
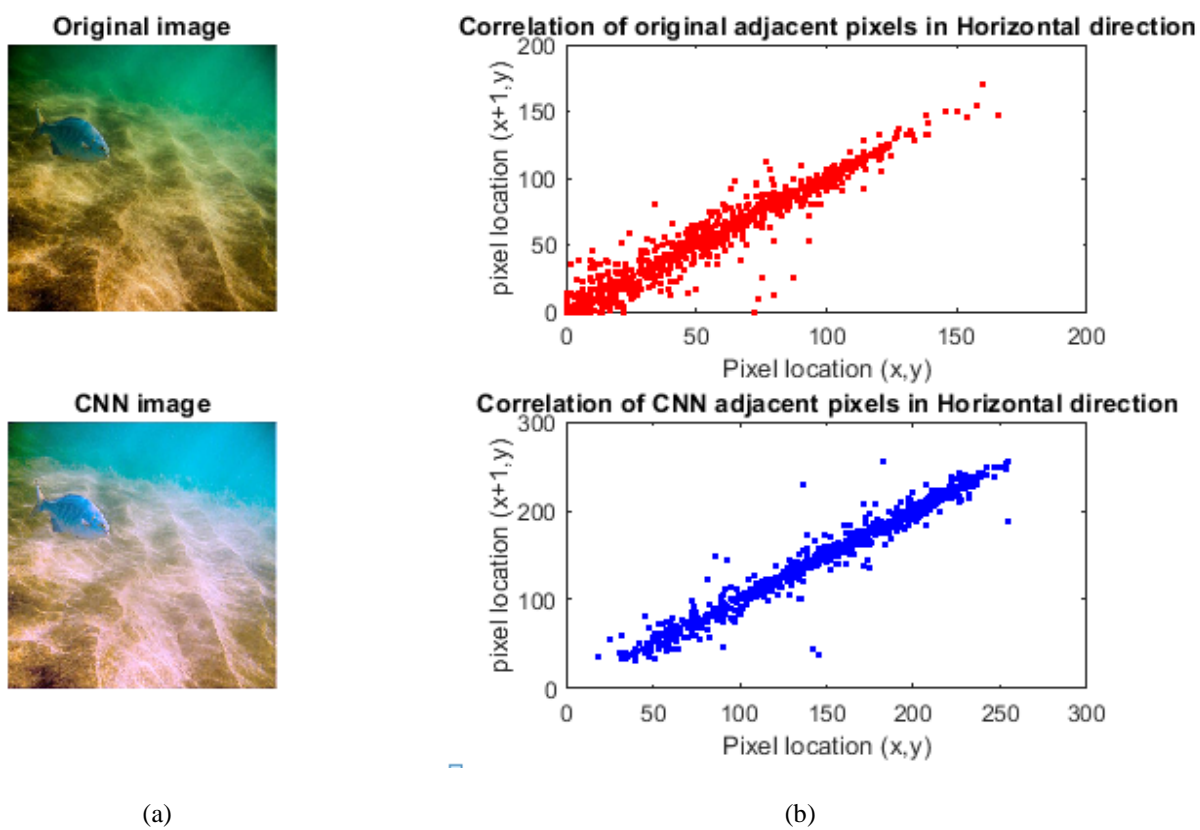


Figure 7. (a) Original ocean image & output CNN image (b) Correlation adjacent pixels of original and CNN output image (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor of output image

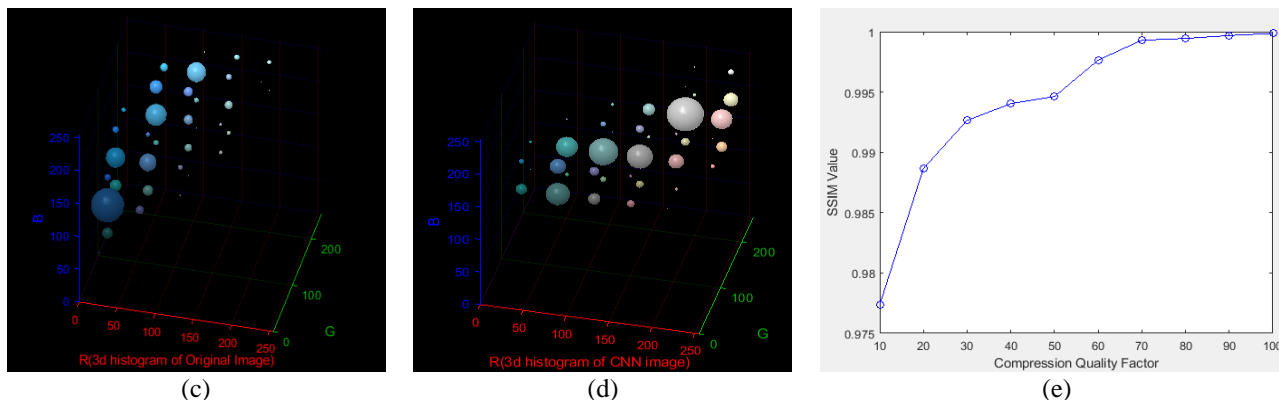
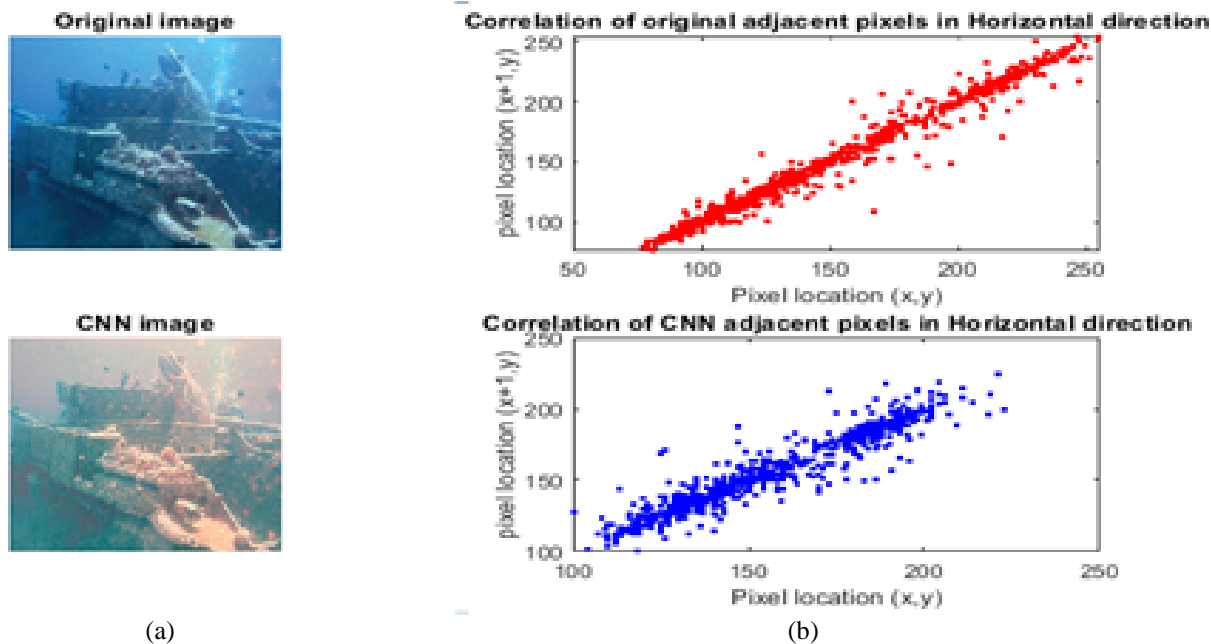


Figure 8. (a) Original atmospheric image & output CNN image (b) Correlation adjacent pixels of original and CNN output image (c) histogram of original image (d) histogram of output CNN image (e) SSIM & compression quality factor of output image

Table 1. Performance evaluation of different types of low light images after applying CNN

Input Image	PSNR (db)	Entropy	SSIM	BER	MSE	EME	RCEF	Computation time (sec)
Ocean Image	26.1871	7.79032	0.5716	0.9848	47.4014	10.3619	158.082	0.905
Desert Image	35.9809	7.67559	0.7771	0.9961	17.8016	22.0293	240.341	0.1432
Object Image	29.8344	7.1646	0.8376	0.9999	32.914	14.1868	0.8416	0.7542
Ship (Atmospheric Light)	28.4319	7.79032	0.4292	0.9972	37.7048	8.8878	193.35	0.278

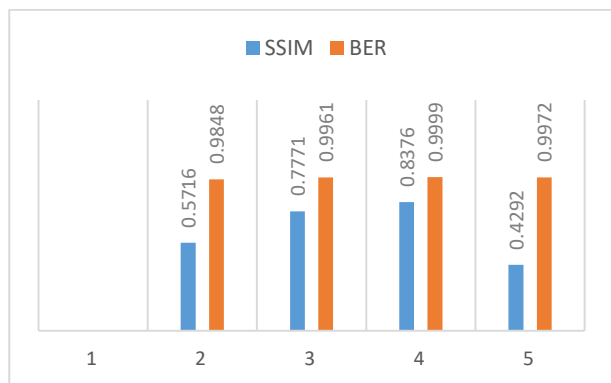


Figure 9. Graphical Representation of SSIM vs BER

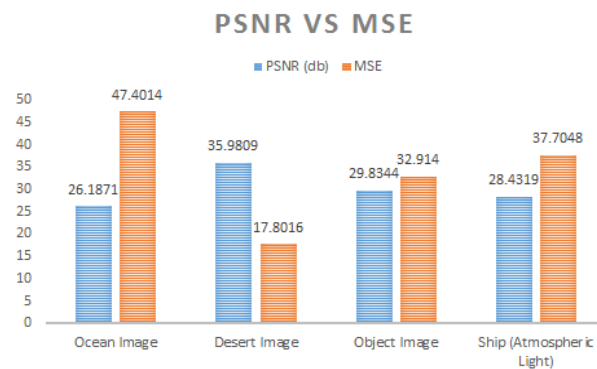


Figure 10. is showing the computation time and Figure 12 is showing the different entropy values.

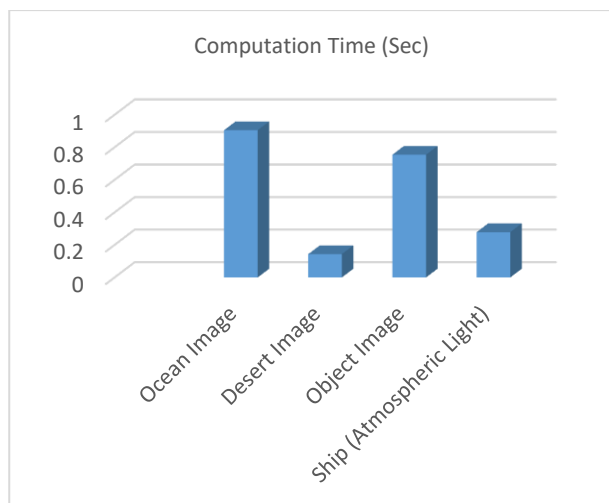


Figure 11. Graphical Representation of Computation time

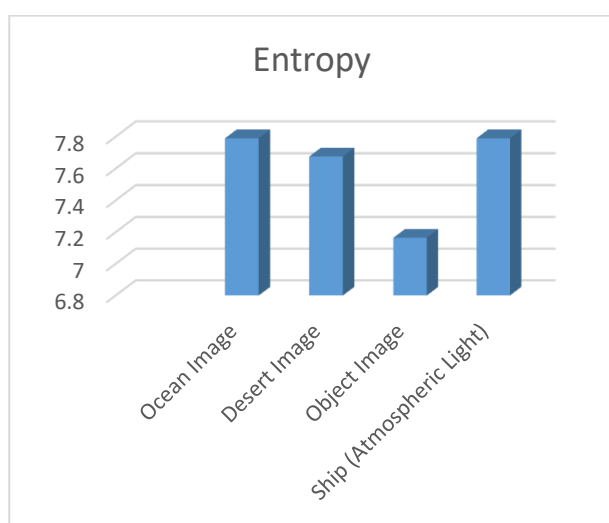


Figure 12. Graphical Representation of Entropy Value

Table. 1 is showing different parameters calculated after apply algorithm on GUI MATLAB. In this various parameters has been calculated such as PSNR, execution time, MSE and entropy. Figure 9 is showing the chart between BER and SSIM. The SSIM values are in between 0.4292 to 0.8376. Figure 10 is showing the evaluated parameters between PSNR vs MSE. The better PSNR value is 35.98dB and MSE is 17.80.

Figure 11 is showing the evaluated parameters computation time. The better Computation time value is 0.2 sec. The computation time is run time. Figure 12 is shows the evaluated parameters of entropy values. The better entropy value is 7.7.

5. CONCLUSION AND FUTURE SCOPE

In this research, a low light image enhancement has been done. This implementation set-up for low light in images based on MATLAB GUI. In this paper author stress on the GUI model for image enhancement by taking different enhancement techniques and also found various parameters like PSNR, MSE, SSIM, entropy and computation time. Also stress on the minimize the complexity. If we talk about computation time it increase the complexity of system, so author stress in this paper to reduce the complexity of system with the help of deep network. In the future scope it can be focus on the real time data for image enhancement and can also put a suitable optimization technique for better results.

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