PERFORMANCE EVALUATION OF IMAGE ENHANCEMENT USING FUZZY AND CONVOLUTION NEURAL NETWORK

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A B S T R A C T

Image enhancement is a technique to improve picture quality. Enhancement can be done in different types such as histogram, low or high light intensity, de-noising, etc. The main objective of image enhancement is to clear the picture or remove noise from the blurred image. In this paper, the author focus on image enhancement using soft computing. Soft computing plays an essential role in applications of image processing. It is used in different imaging fields like medical diagnosis, image processing, classification, prediction, regression, and learning. In this research paper, a study of soft computing has been done. After this study, we found that fuzzy and convolution neural networks are implemented in different areas of image processing. In this, an enhancement has been done based on fuzzy and CNN. Both are soft computing techniques. Both techniques have separate spaces in the field of enhancement. Different parameters like PSNR, MSE, SSIM, BER, entropy, and execution time has been carried out separately by both techniques. MATLAB is used for this work. We have to take a standard image data set; we can take real-time images soon

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1. INTRODUCTION

Image processing in the field is widespread all around in today's scenario. It works in different fields like aerospace, medical, biomedical imaging, military, and industrial applications. It is a technique that performs different types of operations on an image. When performing this operation on an image, it gives another result form or can say that enhanced or blur form of image for example contrast change of image. It is a signal in which input will be an image and get output is also an image. Here questions arise why the need for image processing—avoiding time to need image processing. Image processing has many methods such as image restoration, editing, filtering, morphological, etc. Image processing standard techniques are: a first geometric operation used as rotation, scaling, translation and remove distortion; the second technique is segmentation, which is used to divide an image into a required region also can say that edge detection, for example, the background of an image. A third technique is transformed that is used to noise reduction and extract information [1]. For image processing MATLAB tool is suitable. So far, in image processing, there is a dire need for image enhancement [2]. Image enhancement gives a clear picture of the output. In medical imaging, image enhancement is significant. It improves the picture quality of x-ray, MRI images so on. There is a question that arises how image enhancement works? So can say that it works by repeating the color shape area of the image where pixels are missing. It deals with compression, reducing the number of a pixel used for analysis. So in image processing, image enhancement is significant [3]. Soft computing is a set of computational techniques that depend upon artificial intelligence and natural selection that provides a quick and cost-effective solution [4].

Soft computing has some characteristics: first, it does not require mathematical modeling to solve problems. Second, it gives a different solution when we solve a problem of one input from time to time[5]. Fuzzy logic is an approach that allows for multiple values to be processed through the same variable. Fuzzy logic attempts to solve problems with an open, imprecise spectrum of data that makes it possible to obtain an array of accurate conclusions [6]. Advantages of the fuzzy system, these systems are flexible and allow modification in their rules. There are many types of fuzzy logic sets, such as centroid, uncertainty, etc.[7]. A Neural convolution network is also a technique of artificial neural networks used in image recognition and processing; it is specially designed to process pixel information. Convolution is a simple application of filtering an image. CNN has one or multi-layer for image processing, image classification so on. CNN's main work is to provide a deep algorithm, which can take an input image and then learn its weight and biases to various objects in an image. Deep meaning in convolution is repeated application of the same filter to an input results: in a map of activation called a feature map. It indicates the strength and location of a detected feature at the input. Does one question arise why we need to use CNN?

In CNN, it works as the reuse pre-trained network; in the 1st step, it loads or takes a pre-trained network for an image. Then replace the final layer with each other. Then trained a network with the final layer and predict the network accuracy. After classifying the image, find its parameters, such as how much probability of an identified image. This network uses multiple layers during this process; trained images like taking 100 images with different classes in the training network. Original data before processing. Fuzzy logic in image processing is the collection of segments and features. The representation and processing depend on the selected fuzzy technique. The prediction or classification is found during this process. Accuracy tells the probability of the image; that is, how much probability of a car image, tree image, a ship image. So we can say that it will tell about the probability of an image. A dire need of CNN, or we can say that CNN's most significant advantage is it automatically detects the essential features without any supervision of a human.

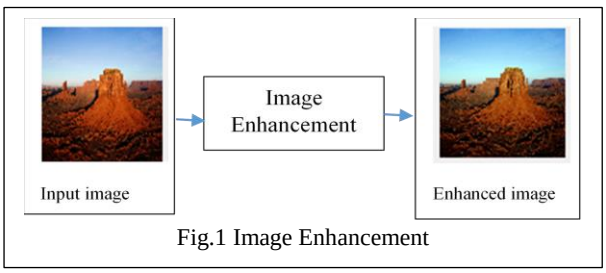

Fig.1 Image Enhancement

For example, having many pictures like 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 fig. 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. Fig. 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]

2. MOTIVATION

Literature Survey and Discussion:

In this article, Guofa Li **et al.** stress an image enhancement model for low light images. The low light situation, crash risk of connected autonomous vehicles. A light enhancement (LE) was developed on CNN. Author stress on real low night light situation. In the future, work net for video processing for object detection, tracking, and identification. Improve the image degradation. Improve the network to make images smoother, more colorful for better quality.[8]

In this paper, **Atal et al.** proposed a fuzzy clustering-based decision tree (FPSO-DT) to classify ECG heartbeat. This paper proposed the expert system, the ECG analysis system, which reduces computational time. PSO is used to optimize the computational time.

K. Zhang et al. Residual Learning of Deep CNN for Image De-noising this paper has developed a feed-forward de- noise CNN. In this learning algorithm, and regularization method is used.

Residual and batch normalization method has been used to speed up the training process. This Dn-CNN handles Gaussian denoising with the unknown noise level, known as blind

Gaussian denoising. In the future author will stress investigating a CNN model for denoising of images with complex real-time noise.[9]

S. Dutta et al. Diabetic Retinopathy (DR) and computed tomography (CT) methods are used in this paper. These techniques are used for a challenging task to diagnose an image classification by using K-mean clustering.

Syed Z et al., a new image enhancement technique, has been used based on homomorphic decomposition and fuzzy-based. In this paper, homomorphic decomposition is used to get the exact illumination image from the value layer.

Rajni et.al, In this paper author has proposed the algorithm for real time image enhancement using some soft computing techniques like Fuzzy and Convolution Neural Network for image enhancement, also used various enhancement techniques.[12]

Xiwen Liu et al., in this paper, the fuzzy algorithm has been proposed for image enhancement. In this algorithm, membership function and fuzzy enhancement operator have been proposed. In the simulation, the result enhances the blurred image, finds out the edges, and increases the image's contrast.[13]

Taranbir Kaur et al. This paper has already proposed digital image enhancement. This paper aims to evaluate the performance of existing image techniques like HE, AHE, and fuzzy image enhancement. It has been found that the value of contrast parameters' K'in fuzzy method has been taken as statically as 128. Different optimization techniques are also used, such as ACO, ABC, and PSO, which optimize the contrast of an image. This technique has been implemented on MATLAB with the help of an image processing toolbox.[7]

Pawan Dahiya et al. In this paper, author stress the comparative study of fuzzy logic and histogram equalization for image enhancement also implemented it on the Matlab Simulink toolbox [14]

In this research, **Chaohui et al.** a new proposed in which two-stage CNN image classification network has been used, which is named as improved CNN with image enhancement for image classification and planet in abbreviation, which is used as a new image data enhancement method the name inner move to enhance images and argument the number of the training sample.[15]

Rajni et al. this research paper provided a comparative study between the traditional and soft computing techniques for image enhancement[16]

3. METHODOLOGY

Fig. 2 shows the flow chart of the proposed work. In this flow chart, different images have been taken as input; then these images are converted into a gray image by image conversion algorithm then after applying conversion, we have to apply the enhancement to get a clear and noise-free image, in the enhancement, we have applied different method like dark channel prior, CLAHE, white balancing and sharpened of an image. After applied enhancement, soft computing is used in this fuzzy, and a convolution neural network has been used for image enhancement. Fig.4 shows the proposed workflow of image enhancement using a fuzzy and convolution neural network. A comparison has been shown in this flow. The input image is first converted into a gray image, then applied to the image enhancement. This applied DCP (dark channel prior) is a haze-free image containing some pixels whose intensity is very low in at least one channel. Contrast limited adaptive histogram equalization (CLAHE) is used for small regions present in the image. White balancing is also an enhancement technique used to remove unrealistic colors, which do not need the image. Image sharpened is used for a sharper appearance. Fig. 2 shows the proposed flow for the image enhancement using fuzzy and CNN. The proposed work shows the survey of image enhancement using fuzzy and convolution neural networks.

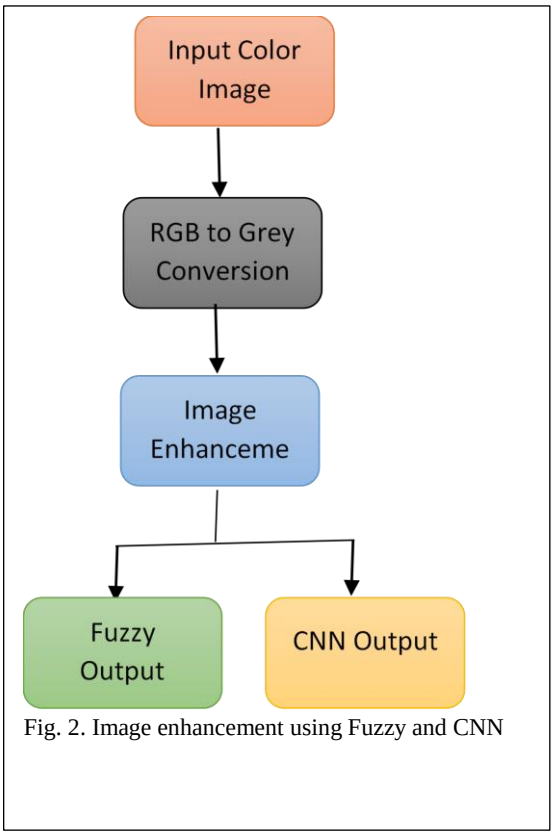

Fig. 2. Image enhancement using Fuzzy and CNN

4. RESULT & DISCUSSION

Experimental Analysis:

In the experimental analysis, we take some standard image data set as input. Fig.6 shows the input dataset image. Here we have to take ten images as input images. On these inputs, we applied a fuzzy and CNN method for image enhancement. These images' output shows the gray image, CLAHE image, sharpened image, white balance image, DCP image, fuzzy output image, and CNN output image. In this paper, the authors focus on image enhancement basis on soft computing techniques. Different parameters found like PSNR, MSE, entropy, BER, and SSIM are shown in table 1 and also plot their graphs. This experimental analysis is evaluated by getting different enhancement forms, which are shown in fig.3. [9][7]. operations like contrast stretching, transformation and intensity level slicing, etc.[17]

the result of execution time by fuzzy and CNN; in this fuzzy takes less execution time than convolution because an input, when passing through the CNN multiple layers, takes a large execution time

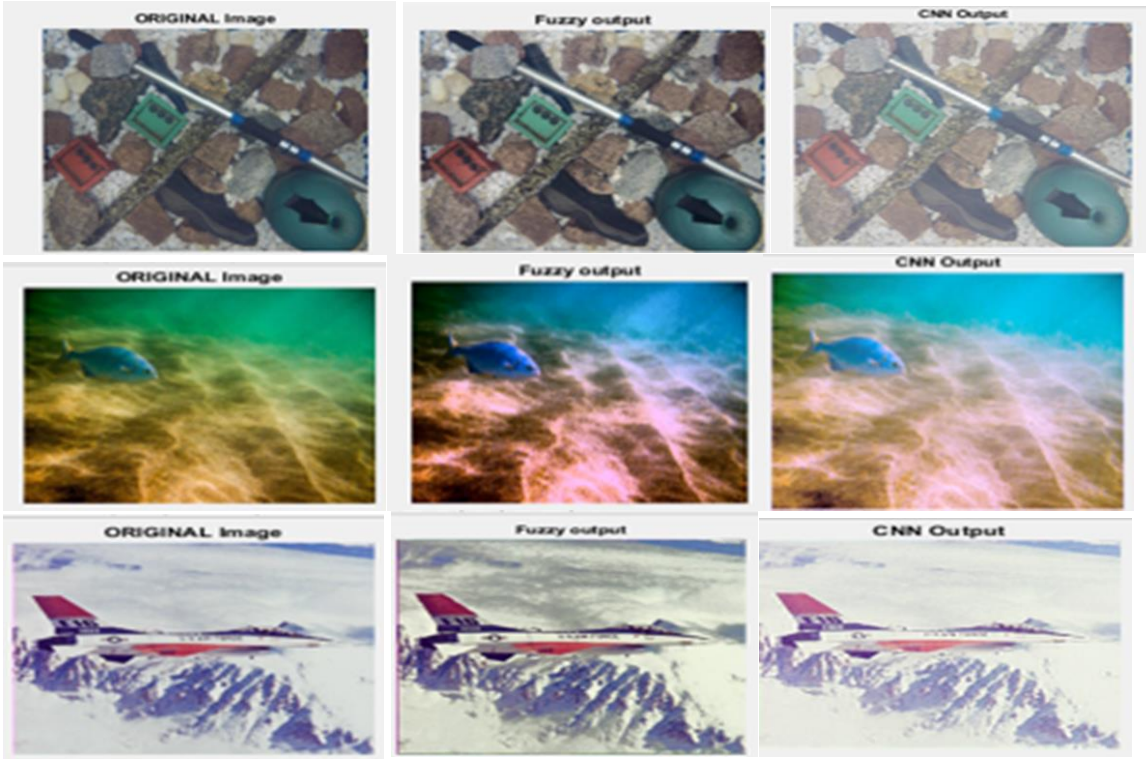

Fig.3 Image Enhancement (a) Original Image (b) Fuzzy enhanced Output (c) CNN enhanced output

Performance Analysis

Table.1 shows the results of the different parameters such as PSNR, MSE, SSIM, entropy, ET, and BER obtained by fuzzy and CNN methods for image enhancement. Here is also showing a comparison graph between these parameters. Execution time has also been calculated.[6][7][9][17] . In this table is a comparative implementation analysis that has been done by taking different parameters. If we talk about SSIM, entropy, and BER, this gives the same approximate result for both methods. In the execution time, fuzzy takes less time than CNN.

Fig 4(a) shows the PSNR result using fuzzy and CNN. This fuzzy gives the better results of PSNR as compared to CNN; it

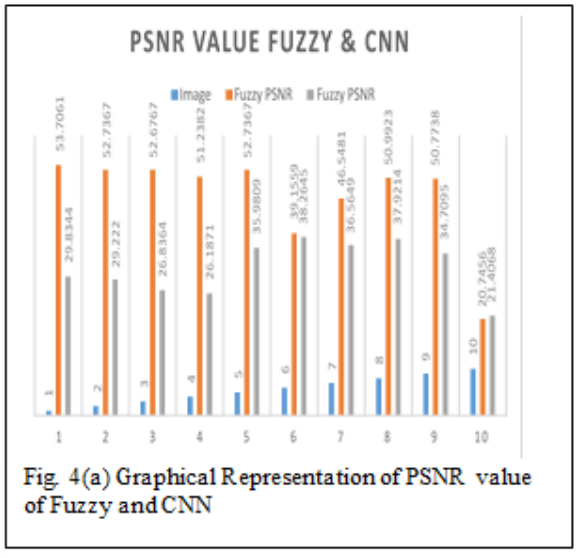

Fig. 4(a) Graphical Representation of PSNR value of Fuzzy and CNN

depends on the input image also. Fig 4(b) shows the Mean Square Error analysis graph between fuzzy and convolution neural networks. In the fig. 4(c) structural similarity index shows between fuzzy and CNN, giving similar approximate results. SSIM is used for measuring the similarity between two images. Fig. 4(d) shows the entropy value. Fig 4(e) shows

Table.1 Evaluate parameters using fuzzy and CNN method

Image	Fuzzy						CNN					
	PSNR	MSE	SSIM	Entropy	BER	ET	PSNR	MSE	SSIM	Entropy	BER	ET
1	53.7061	30.450	0.8212	7.1646	0.9798	0.0826	29.8344	32.9148	0.8376	7.1646	0.9999	12.3 98
2	52.7367	12.238	0.7974	7.0082	0.9363	0.1564	29.2220	34.9935	0.7980	7.6896	1	14.568
3	52.6767	324.2270	0.8321	7.8216	0.9483	0.0739	26.8364	44.4213	0.4596	7.5856	0.9980	11.563
4	51.2382	126.2723	0.7431	6.0082	0.9541	0.012	26.1871	47.4014	0.5717	6.0082	0.9848	18.5983
5	52.7367	98.2380	0.6541	7.0082	0.9636	0.5943	35.9809	17.8013	0.7772	7.6756	0.9636	11.8376
6	39.1559	68.2425	0.5986	6.6119	0.9544	0.1493	38.2645	14.1668	0.7422	6.6119	0.9907	14.5983
7	46.5481	231.7538	0.6869	7.3831	0.9730	0.1765	36.5649	16.7913	0.6326	7.3831	0.9937	11.567
8	50.9923	396.7482	0.4820	7.7292	0.9708	0.1729	37.9214	14.6613	0.5777	7.7292	0.9793	14.629
9	50.7738	125.5111	0.9449	7.2721	0.9112	0.5239	34.7095	20.2147	0.8116	7.2721	0.9558	16.2986
10	20.7456	404.4123	0.2543	6.8049	0.9537	0.1298	21.4068	76.4530	0.5221	6.8049	0.9941	14.1985

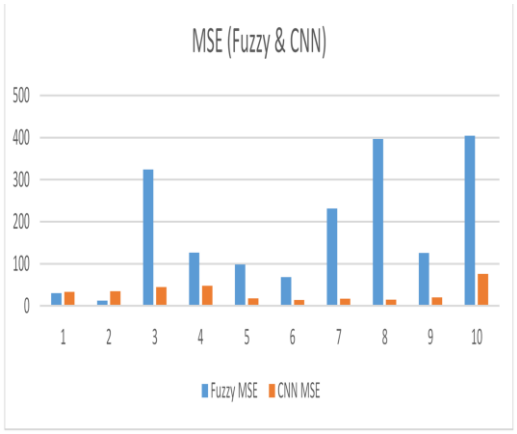

Fig. 4 (b) Graphical Representation of MSE values using Fuzzy and CNN

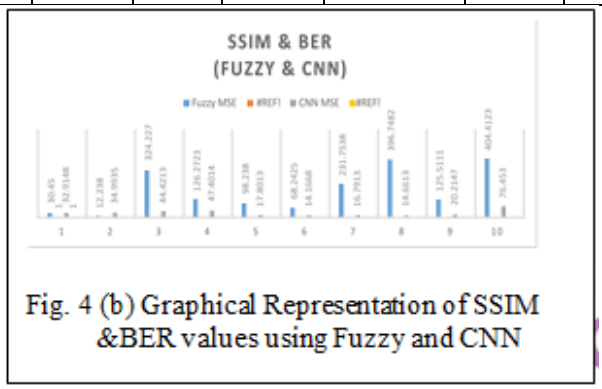

Fig. 4 (b) Graphical Representation of SSIM &BER values using Fuzzy and CNN

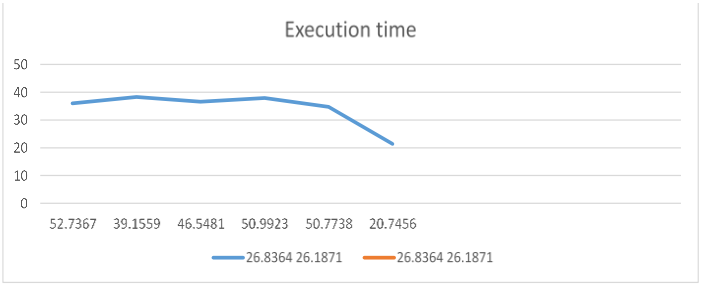

Fig. 4 (b) Graphical Representation of Execution Time values using Fuzzy and CNN

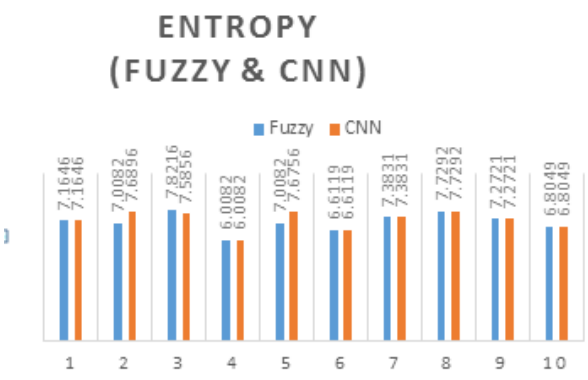

Fig. 4 (b) Graphical Representation of Entropy values using Fuzzy and CNN

5. CONCLUSION

Image enhancement is a technique to improve picture quality. Enhancement can be done in different types such as histogram, low or high light intensity, denoising, etc. The main objective of image enhancement is to clear the picture or remove noise from the blurred image. In this paper, the author focuses on image enhancement using soft computing. Soft computing plays an important role in applications of image processing. It is used in different imaging fields like medical diagnosis, image processing, classification, prediction, regression, and learning. In this research, paper a study of soft computing has been done.

After this study, we found that fuzzy and convolution neural networks are implemented in different areas of image processing. In this, an enhancement has been done based on fuzzy and CNN. Both are soft computing techniques. Both techniques have separate spaces in the field of enhancement. Different parameters like PSNR, MSE, SSIM, BER, entropy and execution time have been carried out separately by both techniques. MATLAB is used for this work. We have to take a standard image data set; we can take real-time images soon.

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