SHODH SANGAM -- A RKDF University Journal of Science and Engineering

Methodology for Deep Image Contrast Enhancement Technique for Low-Light Images

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Abstract: In many real time image applications, one of the essential steps is image enhancement. Many approaches have been used and implemented for image enhancement which totally depends on the type of input image. In this research, work is focused on designing of low light image enhancement technique. For this dataset is taken with different natural scene images. For processing, a high-quality reference image is generated and used for enhancement of the input low contrast images. Additionally, tests are run on various input photos. the Deep Edge contrast enhancer was used to create the suggested work (DECE). The low contrast input images can adapt to high quality enhancement by using CNN and Edge Enhancement utilizing the Sigmoid operator technique. The experimental result is performed on different images, are collected from different resources such as some images are of indoor and some are outdoor, with or without a lighting fixture. After result analysis, On the basis of picture quality metrics as SSIM and PSNR values, the suggested technique is contrasted with the existing methods.

Keywords:- Digital Image Processing , spatial domain , contrast image, image enhancement, geo-satellite imaging

1. INTRODUCTION

Worldwide production of multimedia material has increased dramatically during the past ten years. The development of digital devices like cameras, camcorders, and other tools made it possible for a sizable portion of the global population to produce such content. These devices have become increasingly popular, especially to improve their performance, their gradual erosion of prices and their integration into mobile phones. In fact, with the increasing mobility of these devices via mobile phones, combined with advances in low-cost storage, Instantaneous capturing of multimedia content in the form of pictures and videos was conceivable. We now have the chance to label, thanks to the population's vast output of multimedia content, classify and make it searchable [1]. This scenario has become even more important as the content can be downloaded from the Internet, to which millions of people can access. Man-directed tasks, such as commenting on content, to identify people in a stream of surveillance cameras have become difficult with increasing content [2].

Digital Image Processing

Image processing represents any image in two-dimensional function, f(x,y), in which x and y represents the x-coordinate and y represents y-coordinate values. So, any image on which calculation has to be performed, first of all converted into f(x,y) function. These values are further utilized by the computer system to perform calculation over it. So, all this process is termed as digital image processing, as in it any image is made to be in readable format to digital computer [4].Each and every pixel of digital image represents its respective intensity value and its location in x and y axis. Every pixel have different location but may have same intensity value. So, it is needed to focus on these two parameters to distinguish among pixels. An integer value expressing the brightness of the relevant position in the image is obtained by sampling and quantifying the brightness at each pixel point. An whole matrix can be used to represent an image once all of its pixels have been transformed. Position and grayscale are the two mappings that each pixel has. The position is defined by the line and column measurements of the sampling location in the scan line. The gray scale is an integer that represents the brightness of each pixel point. All digital image processing is based on the digital matrix, which is used to show the images known as digital images. The item that a computer processes is a digital matrix [6].Digital image processing involves manipulating images with digital computers. Its use has grown exponentially in recent decades. Applications include those for remote sensing, geological processing, entertainment, and medicine. Digital image processing is the foundation of devices and systems, one of the cornerstones of the contemporary information society [7].Digital signal processing methods and particular image processing methods are both included in the vast field of digital image processing. In many image processing applications, enhancement techniques are used widely such as in modern cameras there are number of filter inbuilt that can enhance the captured image according to user requirement. For enhancement one of the important factor is contrast and it is widely used to assess the quality of an image. It is known that contrast is created by reflection of brightness of two adjacent surface nearby in an image. So it is also termed as difference between intensity level between objects or background and foreground in order to distinguish them properly [9].

2. LITERATURE REVIEW

Negi et al. [4] proposed an algorithm for contrast enhancement and image sharpening algorithm by adjusting the pixels intensity and enhancing the boundaries of an image. Experiment was applied on grayscale images. Contrast stretching is done along with Laplacian mask. This Laplacian mask was applied to the grayscale image finally and sharpen the image to the desired level.

Wang et al. [5]designed a Non-linear Image Enhancement technique by using clipping and scaling parameters of the image and combines these parameters of various images. Experimental simulation was performed for NIE technique and get enhanced results on blurred image. By applying these techniques, a better quality is achieved in case of blurred image. The performance parameter used is PSNR and results shows the enhanced PSNR value.

Arunachalam et al. [6] proposed a Fast Fourier Fourier Transform (FFT) based on vedic rules termed as Urdhva Tiryakbhyam sutra. The simulation of this algorithm was performed on MATLAB platform. The proposed algorithm first of all divides the input image into blocks and further DWT-2 was applied as filter which improves the image quality. The performance of the proposed vedic algorithm is compared with traditional FFT algorithm and it is seen that vedic FFT outperforms better.

Ramiz and Quazi [7] proposed an effective image quality enhancement technique. In this enhancement technique frequency and spatial domain, both, are processed and thus this algorithm is termed as hybrid technology. The performance parameter for simulation of this algorithm are Mean Square Error (MSE) and Peak Signal to noise ratio (PSNR). The experimental results shows enhanced PSNR value and low MSE.

Panwar and Kulkarni [8] discussed and developed an image resolution enhancement technique by applying DWT ad SWT algorithm and compared the performance of the proposed technique with existing techniques and shows enhanced performance. Performance parameter, PSNR, shows the comparative enhancement of proposed algorithm with conventional methods.

Sumathi and Murthi [9] proposed an enhanced image enhancement technique that was implemented over satellite images. In this technique, high frequency sub-bands are extracted from image by applying discrete wavelet transformation (DWT). Remote sensing images were used for experimental analysis. The improvement of the proposed algorithm was tested by PSNR value over existing algorithms.

Arya and Sreeletha [10] also discussed and developed image resolution enhancement methods by applying multi-wavelet transform in an image. This multi-wavelet transform was applied on satellite images and performance was analyzed. MSE and PSNR are used as an performance metrices. The result was compared with DWT-SWT [8] and shows the improved result over it.

Badgujar and Singh [11] introduced an algorithm for image quality improvement of under water images. Histogram equalization, discrete wavelet transform are hybridized in this algorithm and further KL transform is performed. The proposed algorithm shows enhancement on under water images quality. The resolution and quality was improved and shows ehanced performance with respect to PSNR value. The results shows better PSNR value as compared to existing DWT-KLT, DWT-SVD and GHE algorithms.

Kaur and Vashist [12] proposed a hybrid algorithm by combining DTCWT, NLM and SVD filters. These filters helps in improvement of image enhancement technique over medical images. In this method, DTCWT was firstly applied on the medical input image and further NLM filters are applied. These approach removes the artifacts/noise that was raised during DWT transformation. The quality of the image is improved by NLM filter and further application of SVD approach, the originality of the image is preserved. The experimental result shows the better performance for medical images over conventional techniques.

HemaLatha and Vardarajan [13] proposed a dual tree complex wavelet transform for enhancement of LR images. The low resolution satellite images was taken as an input for dualtree complex wavelet transformation. According to the work, the high-resolution image is reconstructed out of low resolution images with a set of wavelet coefficients. The experimental results are evaluated using PSNR, RMSE, CC and SSIM and gives better performance with respect to DWT technique.

Kumar [14] proposed Discrete Curvelet Transform (DCT) for enhancement of the color image. The multi structure decomposition is performed for retrieving features out of the images and experimental result shows better result for qualitative and quantitative parameters.

Farzam and Rastgarpour [15] proposed an image contrast enhancement technique by using fast discrete curvelet transforms (FDCT) on cone beam CT (CBCT) images. According to proposed algorithm in this research work, first of all the two-dimensional transformation is performed by using unequal-space fast Fourier transform and further thresholding is applied on coefficients of Curvelet for image enhancement. As a result of applying this transform reconstruction of high-resolution images are formed. The experimental results outperforms better with respect to Peak Signal to Noise Ratio (PSNR) and Effective Measure of Enhancement (EME) as compared to other existing works.

Fan et al. [16] proposed shearlet transform domain for the infrared image contrast enhancement by using edge details of the input images. For target region detection and recognition, the input image is enhanced for noisy region detection. The experimental result shows better result as compared to existing algorithms.

Tong and Chen [17] proposed an algorithm based on non-subsampled shearlet transform for a multi-scale image adaptive enhancement algorithm. The result analysis is performed over the different image set and outperforms better result.

Favorskayaa and Savchinaa [18] used discrete shearlet transform for image enhancement of dental images. The proposed algorithm was tested on 40 images which was taken in grayscale with different resolution. Rotation, scaling, translation and compression are also performed using this algorithm. He performance parameter used is SSIM. According to these parameters the proposed algorithm gives better performance for rotation and scaling distortion in the input images.

Wu et al. [19] proposed wavelet-based contourlet transform image enhancement algorithm that reduces the redundancy of the existing wavelet transform as well as contourlet transform. So, in order to reduce these redundancies, proposed algorithm outperforms better for enhancement of the image and also reduces the background flecked of the edges of the image.

Premkumar et al. [20] designed a color image enhancement technique for RGB images. The RGB image is converted into HSV color space. DST decomposition is applied and Hue is extracted out of HSV color space. For reconstruction of image the lower sub-band is selected and further HSV is converted back to RGB color space and finally enhanced image is obtained. From experimental result proposed algorithm gives enhanced result.

3. PROPOSED METHODOLOGY

In this technology era, there are several improvements as well as developments in the field of image sensors and cameras. In near future, this technology will be as much developed that how human visual system perceives natural scenes, cameras can capture similar images. However, the range of light intensity that any camera can capture is in between 28 −214. This intensity is measured in term stop which is base 2 logarithm of the dynamic range. It is known that the DSLR camera can capture with an about 8 to 12 stops dynamic range whereas the human visual system can perceive the dynamic range more than 24 stops. With the high dynamic range of the camera, there may causes the underexposed as well as over-exposed conditions which needs to be adjusted [3]. The dynamic range of the cameras are quite low as compared to the natural scenes [19].

In order to gain above mentioned objectives, images are collected with low contrast image sequences of natural scenes.

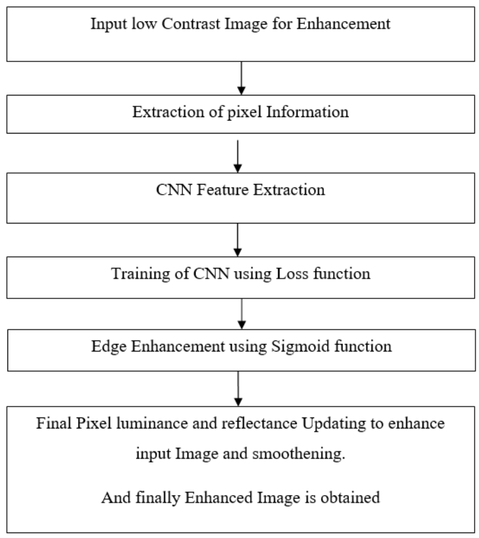

Figure 1. Flowchart of Proposed Methodology

Following Steps are performed while enhancing the contrast of images:

Step 1: Input the low contrast image

Step 2: : Extraction of Pixel Component out of low contrast image

Step 3: Training the proposed CNN network and generate CNN features with smallest DSSIM loss function

Step 4: Updating of low contrast image pixel intensity as well as global gradient value according to CNN features and smoothening with edge aware filtration method.

Step 5: Evaluation of Performance Parameters such as SSIM, FSIM and PSNR values.

4. IMPLEMENTATION DETAILS

This chapter comprises with an analytical and numerical description of proposed algorithm for image enhancement which is simulated to obtain the performance of the proposed algorithm. The image processing toolbox provides a complete set of standard algorithms, functions and reference applications for processing, analysis, visualization and algorithm development. You can perform image analysis, image segmentation, image enhancement, noise reduction, geometric transformations and image recording. Many Toolbox features support multicore processors, GPUs and C code generation. Image Tool Toolbox supports various types of images, including high dynamic range, gigapixel resolution, integrated ICC profile and tomography. Using visualization features and applications, you can explore images and videos, explore a range of pixels, adjust color and contrast, create contours or histograms and work on areas of interest (ROI). The toolbox supports workflows for processing, displaying and navigating large images. The Neural web Pattern Recognition app leads you through finding an information classification problem employing a two-layer feed-forward network. It helps you choose data, divide it into training, validation, and testing sets, outline the network architecture, and train the network. In addition to function fitting, neural networks are also good at recognizing patterns. For example, suppose you want to classify a object region in image using features such as edge, pixel intensity value, contrast value, etc then such image data can be correctly classified using neural network. As with function fitting, there are two ways to solve this problem: Use the nprtool GUI or by using Command-Line Functions. It is generally best to start with the GUI, and then to use the GUI to automatically generate command-line scripts. Before using either method, the first step is to define the problem by selecting a data set. The next section describes the data format.

5. RESULT ANALYSIS

The experimental result is performed and tested on different exposure images. All these images, are collected from different resources such as some images are of indoor and some are outdoor, with or without a lighting fixture. The under exposed as well as overexposed images are created for references. After result analysis, the proposed method is compared to the existing methods on the basis of image quality measure such as SSIM and PSNR. Table 1 shows the performance of proposed methodology with respect to average PSNR, SSIM and FSIM indices for low contrast image with reference to under-exposed image as well as over-exposed image.

Table 1: Performance Evaluation of Proposed Methodology

Input Image	SSIM	PSNR
Image_1	0.921	17.65
Image_2	0.907	17.50
Image_3	0.852	18.82
Image_4	0.883	18.64
Image_5	0.932	18.32
Image_6	0.89	17.47
Image_7	0.854	18.76
Image_8	0.861	18.44
Image_9	0.86	17.13
Image_10	0.91	17.64
Image_11	0.88	18.00
Image_12	0.90	19.18
Image_13	0.89	18.15
Image_14	0.90	17.76
Image_15	0.892	18.80
Average Values	0.8888	18.15067

6. CONCLUSION

In this research, work is focused on designing of low light image enhancement technique. For this dataset is taken with different natural scene images. For processing, a high-quality reference image is generated and used for enhancement of the input low contrast images. Additionally, tests are run on various input photos. The Deep Edge contrast enhancer was used to create the suggested work (DECE). The low contrast input images can adapt to high quality enhancement by using CNN and Edge Enhancement utilizing the Sigmoid operator technique. The experimental result is performed on different images, are collected from different resources such as some images are of indoor and some are outdoor, with or without a lighting fixture. After result analysis, on the basis of picture quality metrics as SSIM and PSNR values, the suggested technique is contrasted with the existing methods. The average SSIM obtained is 0.89, as is seen. Similar to that, the average PSNR was 18.69. The outcome analysis demonstrates that the produced DECE performs roughly 1-2% better than the existing work.

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