ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 4, Issue 8, August 2017

Hybrid Model for Image Classification and Analysis of Best Enhancement Technique

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Abstract:- **With the advent of technology and devices, information from various media are emerging in the form of images and videos. These images get distorted due to various reasons such as motion blurring, compression, sensor inadequacy, error that may occur during transmission or the combination of various other factors. Image Enhancement is one among the most important techniques used to address these distorted images by improving the visual appearance of an image. There are wide varieties of techniques available to enhance quality of an image. Choice of suitable technique is a critical task which is application specific and objective to which images are being used. The objective of this paper is to identify the category of image based on its texture features and analyze the best enhancement technique. The paper reviews and analyses various available enhancement techniques. The possible better enhancement technique is assessed using image quality metrics such as Mean Average Error (MAE) and Peak Signal To Noise Ratio (PSNR) values.**

Keywords **– Feature Extraction, GLCM, Image Classification, Image Enhancement, Quality Metrics, Probabilistic Neural Network.**

I. INTRODUCTION

Image enhancement is a process used to enhance or improve quality of an image by altering the intensity of pixel. There are plenty of fields where image enhancement techniques plays a major role such as medical , agriculture field, remote sensing, satellite images, biometric, object recognition, face recognition and many more.

Quality of an image is of high concern as image quality might get distorted due to various factors such as blurring due to motion, some noise added during image acquisition, loss of data, insufficient light source and inappropriate aperture settings etc.

There are several techniques available to improve the visual appearance of an image. These are broadly classified into two domains, namely;

- Spatial Domain Enhancement Techniques and
- Frequency Domain Enhancement Techniques.

Spatial Domain Techniques deal directly with pixel values of image whereas Frequency Domain Techniques works on Fourier transform of an image. Numerous techniques are available in both domains, but there is no single acceptable technique for all categories of images. Hence, selection of best technique is a critical task as each category of image demands different detailing and each image is different. It is purely subjective and application specific.

This paper addresses the issue by providing a platform where most appropriate enhancement technique is chosen for each image by analyzing various techniques available .

The present paper is organized in five sections. Section 1delivers a brief introduction about topic, Section 2 contains a brief overview of related work done in this field. Section 3 provides information about design and implementation. Section 4 contains Observation and section 5 concludes this paper.

II. LITERATURE SURVEY

Work done by various researchers in the field of Enhancement techniques are as follows.

P. Janani , J.Premaladha and K. S. Ravichandran [2] discussed about various Noises that image may come across such as Salt & Pepper Noise, Gaussian Noise, Poison Noise and many more and also discussed about filters used to remove these noise. Also concluded that Median filter is best suitable for salt and pepper noise whereas Weiner filter does the same for other kind of noise.

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Nisha, Sunil Kumar [3] discussed about importance of Image Quality Assessment. Listed subjective and objective methods in assessing quality of an image. Subjective methods are dependent on expert opinion whereas objective methods follows quantitative approach by using mathematical formulae such as image metrics to calculate values based on pixel intensity. Suggested that Full Reference methods may become unstable if image has significant amount of degradation.

Histogram Equalization Technique and its variations such as Brightness Preserving Bi-Histogram Equalization, Multi-histogram Equalization and Clipped Histogram Equalization methods are discussed and their efficiency is calculated by image metrics AMBE to assess preservation of Brightness in image and PSNR to assess contrast enhancement were discussed by Raju.A, Dwarakish G.S, Venkat Reddy D [4].

Quality of Satellite Image can be improved efficiently by using Wavelet Transforming & Morphological Filtering [5]. Median filtering and Weiner filtering method provide best result for fingerprint images [8]

P. Mohanaiah, P. Sathyanarayana, L. GuruKumar [7] workedon application of gray level co-occurrence matrix (GLCM) to extract second order statistical texture features for motion estimation of images. The Four features namely, Angular Second Moment, Correlation, Inverse Difference Moment, and Entropy are computed using Xilinx FPGA.

Gaussian filter and Median Filters effectively removes salt & pepper noise and Gaussian Noise in case of Agricultural images ([9],[10]). Medical images are best enhanced by applying Median filter to remove noise followed by Unsharp Mask Filter and then by applying Contrast Limited Adaptive Histogram Equalization technique (CLAHE)([11],[12])

Rati and S S Bedi [13] done a detailed review of Enhancement techniques both in Spatial and Frequency Domain and suggested that based on type of the image and noise in image enhancement techniques can be applied with little modification or by applying these methods in combination one after other can yield best result. They also tabulated images and their applications along with suitable enhancement techniques. Discussed advantages and disadvantages of these techniques in their paper.

III. DESIGN AND IMPLEMENTATION

The project is done with the help of MATLAB R2013b and database MYSQL. Four categories of images are considered for preparation of training examples. Namely, Fingerprint images, Agricultural images, Medical images and Satellite images. Fig 1 shows different stages involved in the project.

The model consists of following phases;

A. Extracting Texture Feature from Gray Level Co-occurrence Matrix (GLCM)

B. Image classification

C. Image Enhancement and

D. Analysis of Best Enhancement Technique

A.Extracting Texture Feature from Gray Level Co-occurrence Matrix (GLCM)

GLCM is a popular statistical method for extracting textural features of grayscale image. The GLCM is a tabulation of how often different combinations of pixel brightness values occur in an image. Texture features are calculated based on the values of GLCM and stored in database.

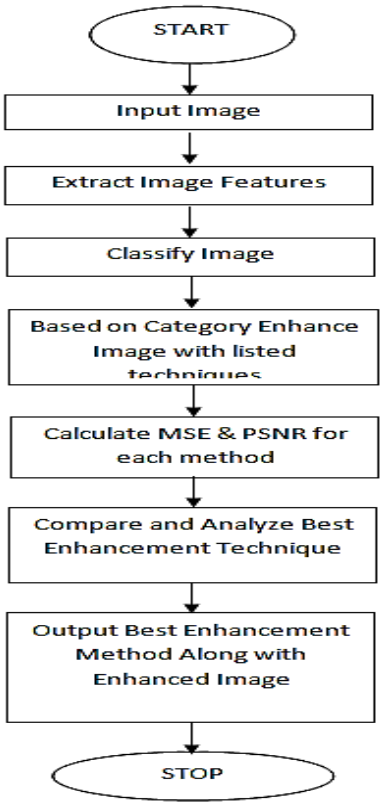

Fig. 1 Control Flow

ISSN (Online) 2394-2320

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B. Image Classification

Training examples are prepared by calculating values for features of image and stored in a database table. Feature for new image is calculated and then fed as an input to Probabilistic neural network to identify the category of image. newpnn() method is used to build probabilistic neural network.

C. Image Enhancement

For each category of images suitable enhancement techniques are listed with the help of research papers referred. Based on the category to which image belongs to, image is enhanced with listed techniques.

Fingerprint images are enhanced with three techniques:

a. Histogram Equalization

b. Negative Transformation and

c. Contrast Enhancement Agricultural images are enhanced with three techniques:

a. Median Filter

b. Contrast Limited Adaptive Histogram Equalization(CLAHE) and

c. Sharpening

Medical images are enhanced with four techniques:

a. Median filtering -> Unsharp Mask -> CLAHE

b. Brightness Preserving Dynamic Histogram Equalization(BPDHE)

c. Histogram Equalization(HE) and

d. Median filter

e.

Satellite images are enhanced with three methods:

a. Discrete Wavelet Transform(DWT)

b. CLAHE and

c. HE.

D.Analysis of Best Enhancement Technique

Quality of enhanced image from each technique is assessed with quality metrics. Metrics considered Mean Average Error(MAE) and Peak Signal To Noise Ratio(PSNR).

Mean Average Error(MAE): measures the average magnitude of the changes or the difference between input and processed images.

$$MAE = \frac{1}{MN}\sum_{m=1}^{M}\sum_{n=1}^{N}\left|F(m,n)-\hat{F}(m,n)\right| \quad \text{.....(1)}$$

Peak Signal To Noise Ratio (PSNR): used to measure similarity between the input image and enhanced image used to evaluate contrast enhancement.

$$PSNR = 20.\log_{10}\left(\frac{255}{MSE}\right) \quad \text{.....(2)}$$

The one with high PSNR value and lesser value of MAE indicate better technique

IV. EXPERIMENTAL RESULTS

1)Fingerprint Image : fp_01.tiff

Fingerprint image Fig 2a. is tested with all three listed techniques and related calculations are tabulated in Table 1. Calculations shows that Contrast enhancement method yields best result.

Fig 2a. Original Image

Fig 2b. Enhanced Image

TABLE 1. IMAGE METRICS FOR fp_01.tiff

	HE	NT	CE
MAE	1.861	3.567	2.784
MSE	5.176	1.761	7.752
PSNR	6.099	5.567	5.924

2)Agricultural Image : ag_01.tiff

Agricultural image Fig.3a is tested with all three listed techniques and related calculations are tabulated in Table 2. Calculations shows that BPDHE yields best result.

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Fig 3a.Original Image *Fig 3b. Enhanced Image*

TABLE 2. IMAGE METRICS FOR ag_01.tiff

	Median	CLAHE	Shaprening
MAE	1.048	8.557	5.414
MSE	7.087	6.791	4.890
PSNR	5.311	1.050	7.123

3) Medical Image :md_01.tiff

Medical image Fig 4a is tested with all four listed techniques and calculations are tabulated in Table 3. Calculations shows that BPDHE yields better result.

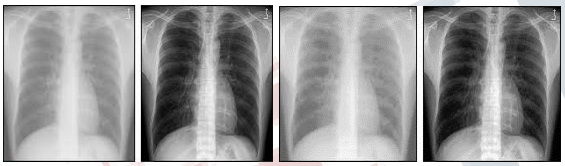

Fig 4a. Original Image *Fig 4b. Enhanced Image*

TABLE 3. IMAGE METRICS FOR md_01.tiff

	Median Filter-> Unsharp Mask-> CLAHE	BPDHE	HE	Median Filter
MAE	1.395	9.311	7.875	8.734
MSE	2.906	1.893	8.765	1.921
PSNR	6.350	8.535	6.870	7.531

4) Satellite Image :st_01.tiff

Satellite image st_01.tiff is tested with all three listed techniques and calculations are tabulated in Table 4. Calculations shows that DWT yields best result.

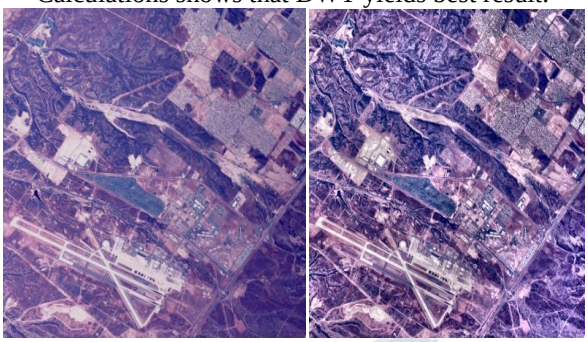

Fig 5a Original Image *Fig 5b Enhanced Image*

TABLE 4. IMAGE METRICS FOR st_01.tiff

	DWT	CLAHE	HE
MAE	4.489	9.105	1.071
MSE	2.361	6.680	6.659
PSNR	5.439	1.358	1.423

V. CONCLUSION

Each image is unique and objective for which image is used is also different. Hence, it is very difficult to specify precisely a suitable enhancement technique as a whole. Analysis of these enhancement techniques with four categories of images namely, Fingerprint images, Agricultural images, Medical images and Satellite images are done. Objective of providing a platform for analyzing and giving possible best enhanced image is achieved. Analysis is done for four categories of image and future scope of this project can be extending the same for more categories of image.

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