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ENHANCEMENT OF REAL TIME DOCUMENT IMAGES USING FUZZY LOGIC AND MACHINE LEARNING APPROACH

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Abstract:

Enhancement of document images is a very essential and important stage in document image analysis, otherwise, recognition accuracy will be reduced. Hence in this work, we have proposed an effective approach to enhance the document images i.e. using fuzzy logic and a machine learning approach. The performance of the proposed method is compared with the other enhancement approaches i.e. spatial domain and frequency domain, here we have considered seven quantitative methods to evaluate the performance. Experimentation carried out on five different datasets each containing 1000 document images. Results show that the proposed method achieves good results.

Keywords: Document Images, Histogram Equalization (HE), Fuzzy Logic (FL), Linear Transformation (LT), Non Local Means (NLM), Image Enhancement.

1. INTRODUCTION

The goal of image enhancement is to make an image more effective for a certain jobs, such as making a more individually pleasant image for human sight. The quality of an image as perceived by a person can be improved using image enhancement techniques. Because many real time document images on a color display provide insufficient information for image interpretation, these techniques are quite beneficial. There is no conscious effort to improve the image's integrity in comparison to some ideal form. Image quality can be improved using a variety of approaches. The most widely utilized techniques are contrast, stretch, density slicing, edge enhancement, and spatial and frequency domain. After correcting for geometric and radiometric distortion, image improvement is tried. Image enhancement procedures are applied separately to each band of a multispectral image. Because of the precision and variety of digital processes, digital techniques have been proven to be more satisfying than photographic procedures for image enhancement.

Image enhancement techniques are frequently ad hoc, with little or no attempt to anticipate the real image deterioration process. This procedure has no effect on the data's fundamental information content. Gray level and contrast adjustment, noise reduction, edge sharpening, filtering, interpolation and magnification, and pseudo coloring are all included. Frequency domain methods and spatial domain methods are the two types of image enhancing techniques. The former transforms the image into a two-dimensional signal and enhances using the images two-dimensional Fourier transform. The low-pass filter approach removes noise from the image, and high-pass filtering enhances the edge, which is a type of high-frequency signal, and clarifies the fuzzy image. The local mean filtering–based approach and the median filtering (take intermediate pixel value of the local neighborhood)–based methods are two common spatial domains–based algorithms that can be used to eliminate or weaken noise.

A document image is first preprocessed with decolorizing, denoising, filtering, or gray boosting, among other things, in a standard OCR system. The gray scale image is then converted to a binary image using a threshold value for ease of usage in the following phase. Characters in the document picture are then separated and normalized during the character segmentation procedure. Furthermore, specific character feature statistics can be extracted and utilized in the final recognition stage, which results in the production of ultimate character strings as the text content in that image. Marginal noise is found and removed using the suggested strategy, which involves three iterations of block identification using the Hu moments method and converting the neighbour pixel to the background pixel. Marginal noise is commonly found towards the edges of document images, resulting in a non-uniform lighting gradient. In geosciences, astronomy, facial reconstruction, multiple-description coding, resolution enhancement, and geographic information systems, interpolation is a common approach for image scaling.

Even-though Real time office document images enhance method has more advantages, it has limitation that technique is produce low contrast images. Analysis of these low contrast images is a difficult task for collecting govt. office and some departments. Increasing the contrast of an image will ease analyzing the well-equipped high definition scanners and camera. Thus enhancement is an important stage in office document image analysis and different spatial domain, frequency domain & other learning techniques are used for enhancing of collecting Real-time office document images. Enhancement is a process where in visual quality of an image is improved so that the resultant image is move suitable for specific application. The spatial domain refers to the image plane itself and methods in spatial domain are based on directly modifying the value of the pixels. Document image enhancement is required in many situations when analyzing the quality of documents like handwritten/printed text documents, answer booklets, Street Boards and inauguration board images that have become noisy and low-contrast after scanning. One of the most important issues in document image analysis is contrast enhancement. Various types of need-based analysis tasks become more difficult as a result of high or low contrast on images. The solution for such images is to improve them by reducing the noise and increasing text contrast. This is possible by incorporating point operations [1], [2], [3], [4], [5].

Here we have compared three different methods for image enhancement [4]. For document Images (i) Contrast stretching and (ii) Histogram Equalization. A number of contrast measures were proposed for complex images as document images [2]. During image acquisition [1].

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the images are affected due to poor illumination, lack of dynamic range in the imaging sensor, or even wrong setting of a lens aperture etc., To overcome this, we have to increase the dynamic range of the gray levels in the image being processed.

The interpolation and fuzzy logic technique are used in this letter to present a method for enhancing document images. The document image to be enhanced is a fuzzy binary picture that has been distorted by additive noise and received from a scanner. This type of image appears when documents such as cheques and credit card receipts are scanned and become noisy, low-contrast images, reducing their quality. Our goal is to improve the readability of these images by decreasing noise and boosting text sharpness. The interpolation, fuzzy logic, and contrast enhancement operators are used to accomplish this. One of the most difficult problems in image processing is image enhancement. The goal of image enhancement is to process an image so that the end result is more suitable for a given application than the original image. There are many options for increasing the visual quality of images using digital image enhancement techniques. It's essential to select the right techniques for the work. This study will provide an overview and analysis of various image enhancement techniques that are regularly employed. In computer vision applications, image augmentation is extremely important. Much work has recently been made in the field of image improvement. Many strategies for improving digital images have been proposed in the past. A survey of numerous image enhancement techniques has been conducted in this study.

In this work, we propose a method i.e. Fuzzy Logic approach to enhance the real time document images and the proposed method is compared with spatial domain and frequency domain methods. Based on the quantitative metrics result is measured and result shows the superiority of the proposed method.

This paper is organized as follows: In section 2 details of different enhancement methods are addressed. In section 3, proposed method is discussed. In section 4 we discuss the experimentation and also result are given and finally conclusion is given in section 5.

2. RELATED WORK

This section briefly discusses some of the existing methods for enhancement of document images and focused on focus on strengths, limits, and application areas [3, 4, 5, and 6].

During transmission, scanning, or conversion to digital form, noise can taint document images. Authors can classify sounds by defining their characteristics, then search for comparable patterns in a document image to determine the best strategy for removing them. This paper examines noises that may exist in scanned document images, as well as potential noise removal methods, after a brief introduction. The author has provided a novel method for upgrading many types of degraded binary handwritten document images. The results show that the method is robust, effective, and efficient when compared to photos from the DARPA (Defense Advanced Research Projects Agency)

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and MADCAT (Multilingual Automatic Document Classification Analysis and Translation) challenge sets [7, 8, 9, and 10].

Making an image darker or lighter, or decreasing or increasing contrast is straightforward. The author suggests a transform-based strategy for improving palm leaf manuscript digital images. The method uses a dynamically picked pivoting backdrop color in a linear transform to improve the legibility of the foreground text [13, 14]. Picture enhancement has been identified as one of the most essential vision applications due to its capacity to improve image visibility. So far, different approaches for increasing the quality of digital images have been offered. One of the most important challenges with high-quality images, such as those taken with digital cameras, is image augmentation. Because lighting, weather, and the equipment used to capture the image can all have an impact on image clarity? [15].

Histogram equalization is a common technique for image contrast enhancement, brightness preservation etc., [18]. The recent works proposed a novel nonparametric and unsupervised strategy for compensating for unwanted document picture distortions with the goal of improving OCR accuracy. It involves adjusting local brightness and contrast to handle lighting fluctuations with irregular distribution of image illuminations. Using this Un-sharp Masking approach, sharpening of useful information with the resultant grayscale images [19]. The approaches of enhancing antique document images with damaged backgrounds discussed with are three sorts of enhancement methods, there are image enhancement with binarization / thresholding, image enhancement using a hybrid and non-threshold based methods. [20].

Using multiple filtering approaches, the preprocessing technique utilized here reduces unnecessary noise also enhances image quality [21]. It involves fine-tuning each pixels of an input image to make them more appropriate for analysis. So that it can be used as a starting point for further analysis. Decorrelation stretch, Anisotropic Diffusion, Partial Differential Equation method, Histogram Equalization, Filtering and Principal Component Analysis were implemented on image. Enhancement which improves image visibility by increasing contrast and reducing noise at the same time. [22].

Ancient document images require specialized processing in order to reduce background noise and improve legibility. Noise can contaminate document images during transmission, scanning, or conversion to digital format. It is used a hybrid binarization method for improving the performance of ancient documents. As a result, it can be utilised as a preprocessing step in document picture analysis systems and in libraries that seek to allow public access to their historical document collections [23].

The goal of image enhancement is to process an image in such a way that the end result is better suited to a given application. Image enhancement is one of the most important image enhancement techniques for grayscale images. The computing costs of enhancement approaches were not discussed in this study, but they may be an important factor to consider [29]. The image's contrast is enhanced while using point processing. Image negative is a popular technique where certain brighter regions embedded in darker regions represent as the ROI. Power law transformation is used to

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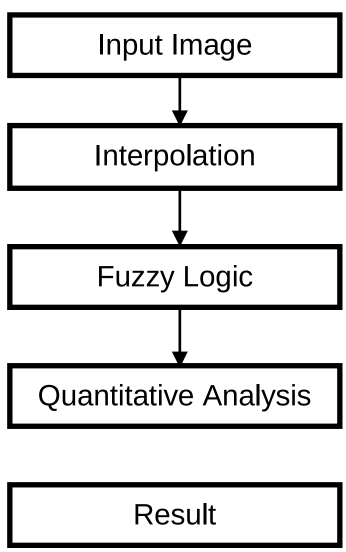
manipulate contrast and dark images. To overcome the shortcomings of spatial domain enhancement, frequency domain enhancement methods are used. The contrast of the image is increased during histogram equalization. Spatial filtering is used to remove image noise [30]. Weak contrast enhancement is used to magnify the difference between the foreground and background in significant areas. In the meanwhile, weak contrast enhancement can reduce noise in the results. Strong contrast enhancement is used in comparatively significant areas to adjust grey values so that the method can easily distinguish between foreground and background and separate clear characters [32].

The goal of image enhancement is to process an image so that the outcome is more suitable for a given purpose than the original image. The word specific is crucial since it establishes right away that the strategies are problem-oriented. Image enhancement, regardless of the approach utilised, is one of the most exciting and visually appealing areas of image processing. Spatial domain methods and frequency domain methods are the two basic types of image enhancing techniques. The picture plane itself is referred to as the spatial domain, and methods in this category are based on direct manipulation of pixels in an image. Frequency domain processing approaches work by altering an image's Fourier transform. In this research, we looked at how spatial coordinates can be used to improve document images. We chose three distinct ways for contrast enhancement under point operations in the spatial coordinates. Contrast stretching (ii) Bit plane slicing (iii) Histogram Equalization technique are the three main point processing methods. We tested the algorithms using a common database of document pictures.[33, 34, 35,36,37,38,39,40,41,42,43,44,45,46].

3. PROPOSED METHOD

In this section, we discuss the proposed method for enhancing real time document images and the block diagram of the proposed method is shown in the Fig. 1.

Figure 1: Block diagram of the proposed method



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Initially, we take grayscale real-time office document images, and interpolation is used to improve an image's visual appearance, i.e., its quality. The visual appearance of such an image is obtained by resizing it with the bilinear interpolation method [42]. When the interpolation is concluded, we use the fuzzy logic approach to improve it. In fuzzy logic, an image is partitioned, and each partition is considered a fuzzy window. The fuzzy window is enhanced by using mean and variance. Similarly, all fuzzy windows are enhanced, and finally, all fuzzy windows are summed. Fuzzification, inference engines, and defuzzification are the three main parts of fuzzy logic [43], which are given in the equation 1 and 2.

Here fuzzification is required to map the input image with fuzzy plane, vice versa for defuzzification i.e., the membership of a point Pij (x, y) Є D to the window Wij (x, y) are given by the equation 1.

$$\text{Wij} = \frac{\left(P_{ij}(x,y)\right)^{\gamma}}{\sum_{i=1}^{n}\sum_{j=1}^{m}\left(P_{ij}(x,y)\right)^{\gamma}} \tag{1}$$

Where, W_{ij}: D → [0; 1]

Wij describe the membership and (x, y) describe the pixel value.

γ Є (0, ∞) and controls the fuzzification and defuzzification.

The transform ψ is built as a sum of the transformed W_{ij} weights with degree of membership. The enhanced image is given by equation 2.

$$\psi\ \text{enh}(\text{f}) = \sum_{i=1}^{n}\sum_{j=1}^{m} w_{ij} X\ \psi_{ij} \tag{2}$$

Where, (f) is image (f) before enhancement. ψ (f) is image (f) after enhancement.

After the Fuzzy Logic process is completed, we compute quality of an images by using quantitative measure like Entropy, Peak Signal Noise Ratio (PSNR), Michelson Contrast (MC), Structure Similarity Index Measurement (SSIM) and Absolute Mean Brightness Error (AMBE), Mean Squared Error (MSE), Normalized Root Mean Squared Error (NRMSE) as parameter. Obtained results are tabulated in Table. [11-15] and corresponding the images are shown in the Figure [22-26].

In the next section, experimentation and results are discussed.

4. EXPERIMENTATION

The outcome and discussion are presented in the following sections.

4.1 Result

For the purpose of experimentation, we have used considered, real time scanned document images and captured images produced by the devices may have distortions such as blurred or noisy images. Blurred document images, handwritten/printed text documents, answer booklets, Street Boards and inauguration board images, among other things. To enhance the real time document images, the different spatial domain enhancement methods are used like Histogram Equalization (HE), Adaptive Histogram

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Equalization (AHE), Gamma Correction(GC), Linear Transformation(LT), Log Transform (Log T) and Contrast Stretching(CS). Frequency domain methods focus on the image orthogonal transform instead of the image itself. Low Pass Filter (LPF), High Pass Filter (HPF), Gaussian Filter (GF), Non Local Means (NLM), Constrained Least Squares (CLS), Pseudo Inverse Filter (PIF) are used. After the experimentation, the results are shown in Spatial and Frequency domain the Fig. 2.to Fig. 26.

4.2 Discussion

To measure the performance of the images, we have considered quantitative parameters. They are Entropy, MC, PSNR, SSIM, AMBE, MSE and NRMSE. Table.1 to Table.10.

Various evaluation metrics were using NLM, LT and Fuzzy Logic (FL) processed image their respective spatial domain, frequency domain and fuzzy logic. The evaluation metrics used are described as follows.

From Table.1. to Table.5., it is observed that the different real time dataset gives good result for Entropy, PSNR, AMBE and quantitative metric values are show in the Figures.3,5,7,9,11,13,15,17,19 and 21, where the lower AMBE and higher Entropy, MC, SSIM, PSNR values indicates good quality image. Further, we need to extend our proposed method to improve MC and SSIM matrices.

Table.1 to Table.5 spatial domain and Table.6 to Table.10. Frequency domain and Finally, Fuzzy Logic summarizes the various methods available in literature along with the proposed one. It is understood that unlike other, ours works on enhanced real time document images.

The ideal data collection would enable researchers to generalize experimental results to the application domain represented by the dataset.

Researchers can use datasets to train and test algorithms on large amounts of data and evaluate performance on specific images. Off-line documents and On-line documents are the two main areas of OCR study, and they can be handwritten or printed. Text and non-text elements are common in office documents; text may contain alphanumeric letters, while non-text elements include logos, images, and other graphics.

The data sets that were acquired for Off-line document processing are given below.

I. Office Documents: Office documents are records that contain information about sales and purchases that an organization performs. Invoices, credit notes, debit notes, receipts, delivery notes, catalogues, user guides, spread sheets, invoices, and financial statements are just a few examples. Mark sheets, transcripts, theses, paper charts, journals, and manuscripts are examples of academic documentation. Real time office documents collected from various offices which contain both printed and also and handwritten (bilingual contain logos, signatures, graphs, tables et,) totally about 1000 document.

II. Advertisement Boards: There are many different types of boards, such as advertising boards and retail boards that include information in a variety of languages

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and may also feature logos, which are non-text information. Advertisement boards captured by using mobile camera.

III. Inauguration Boards: An inauguration board is a huge common location for knowledge workers to collaborate. Through the use of a digital camera, the system we propose in this study proposes to replicate the inauguration board content as a fair, yet enhanced and easily manipulated, opening ceremony document. However, images are usually taken at an angle to prevent flash highlights, which introduce undesired perspective distortion. They also include areas that are distracting, such as stone boards.

IV. Sign boards: Sign boards are found on street corners and contain a variety of information in multiple languages. The analysis of boards and their conversion into digital forms aids the user in understanding the board, which may be written in a different language. To understand its meaning, the user can translate it into another familiar language and which helps to move towards destination easily they contain arrow marks.

V. Answer scripts: these contain the student's registration number, which can be a combination of numbers and alphabets, as well as questions and answers submitted by students in one or more languages. The analysis and processing of answer scripts aids in the computerized review of answer scripts, reducing the need for human interaction even further.

For experimentation purpose, we have created our dataset. Totally we have collected 5000 document images from all categories. Here we have a proposed fuzzy logic approach which gives a good results and the proposed method compared with other two methods. Experimentation is discussed in these cases i.e., spatial domain and frequency domain methods.

$$\text{Entropy} = \sum_{i=1}^{C} -p_i * \log_2(p_i) \tag{3}$$

$$PSNR = 10\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \tag{4}$$

$$\text{SSIM}(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_1^2 + \mu_2^2 + c_1)(\sigma_1^2 + \sigma_2^2 + c_2)} \tag{5}$$

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1}\|f(i,j) - g(i,j)\|^2 \tag{6}$$

In the next section, experimentation and results are discussed.

4.3 Case I. Spatial Domain Approach

In this section we have taken five real time datasets.

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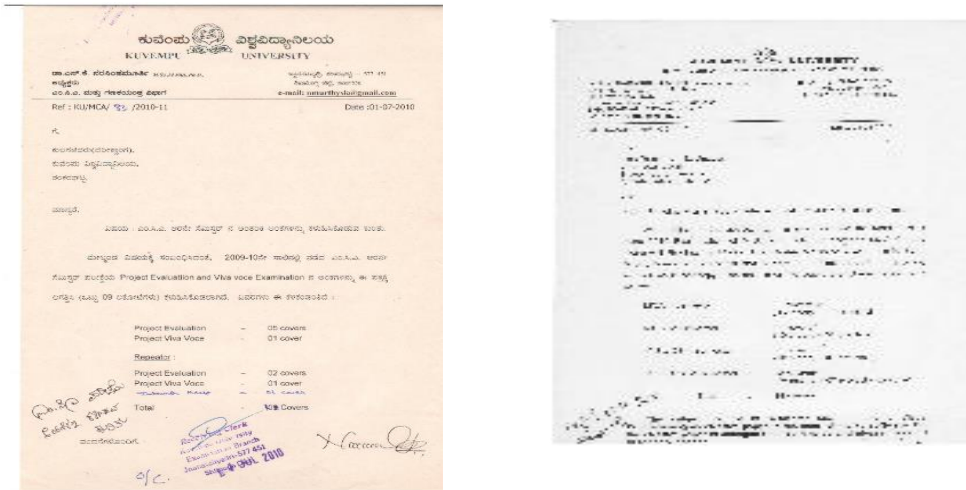
Data set-1 Office Documents:

Fig 2: (a) Input Image (b) Output Image

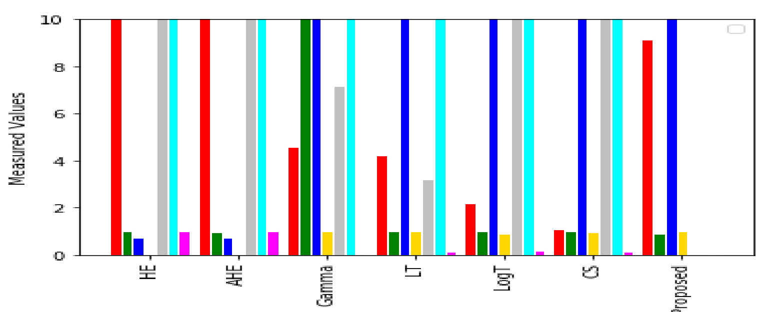


(a) (b)

Table1: Comparison of different quantitative methods.

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	16.88	1.0	0.7	0.0	233.27	55337.99	1.0
AHE	21.12	0.95	0.71	0.01	233.03	55225.44	1.0
Gamma	4.6	15.93	29.13	0.99	7.17	78.32	0.04
LogT	2.18	1.0	15.72	0.9	11.84	1744.02	0.18
CS	1.07	1.0	20.01	0.93	13.33	649.3	0.11
LT	4.23	1.0	17.97	0.98	3.21	1038.6	0.14

Fig 3: Graphical representation of different quantitative measures



In this dataset, LT gives best result among all the remaining methods which is shown in Table 1.

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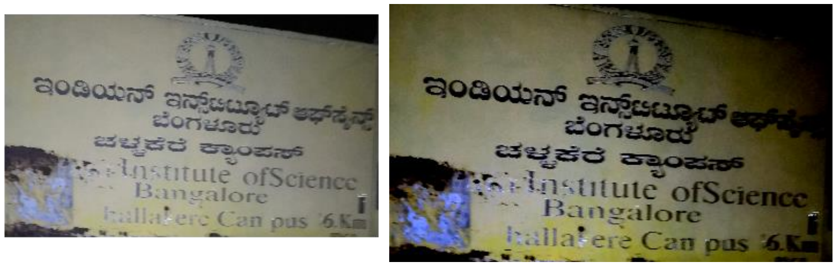
(b) Data set II- Advertisement Boards

Fig 4: (a)Input Image (b)Output Image

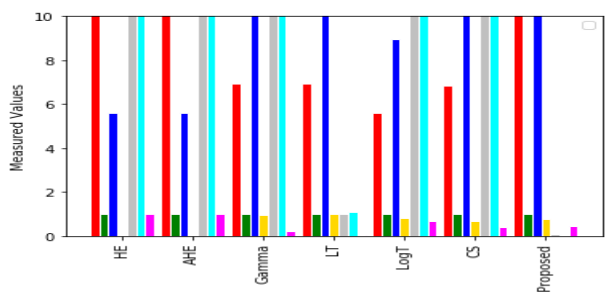


(a) (b)

Table 2: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	21.08	1.0	5.58	0.02	128.34	17997.54	1.0
AHE	21.77	1.0	5.58	0.02	128.3	17996.24	1.0
Gamma	6.94	1.0	18.93	0.94	28.31	831.39	0.21
LogT	5.61	1.0	8.96	0.8	88.8	8268.83	0.68
CS	6.86	1.0	13.49	0.69	48.14	2909.86	0.41
LT	6.93	0.99	47.68	1.0	1.0	1.11	0.01

Fig 5: Graphical representation of different quantitative measures



In this dataset, LT gives best result among all the remaining methods which is shown in Table 2.

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(c) Data set –III Inauguration Boards

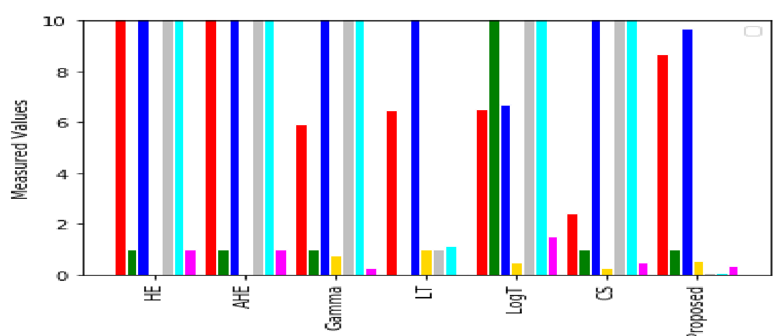
Fig 6: (a) Image Input (b) Output Image

(a) (b)

Table 3: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	20.56	1.0	10.21	0.02	57.75	6196.11	0.99
AHE	21.78	1.0	10.2	0.02	57.87	6212.64	0.99
Gamma	5.92	1.0	21.86	0.77	19.89	423.31	0.26
LogT	6.51	49.8	6.71	0.47	115.23	13860.67	1.49
CS	2.4	1.0	16.72	0.24	32.02	1385.38	0.47
LT	6.47	0	47.52	1.0	1.0	1.15	0.01

Fig 7: Graphical representation of different quantitative measures



In this dataset, LT gives best result among all the remaining methods which is shown in Table 3.

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(d) Data set –IV Direction Boards

Fig 8: (a) Input Image (b) Output Image

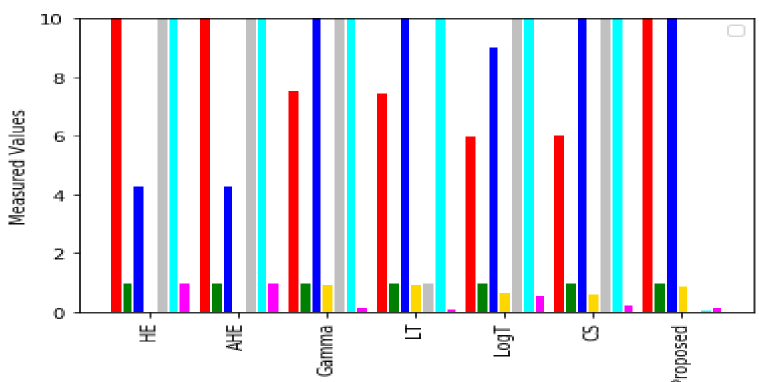
(a) (b)

Table.4. Comparison of different quantitative methods.

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	21.29	1.0	4.33	0.0	144.69	2397.28	1.0
AHE	21.78	1.0	4.33	0.0	144.69	2397.28	1.0
Gamma	7.57	1.0	19.64	0.95	24.94	706.26	0.17
LogT	6.0	1.0	9.06	0.68	77.76	8070.99	0.58
CS	6.04	1.0	15.14	0.65	30.31	1992.29	0.28
LT	7.47	1.0	22.49	0.97	1.0	366.53	0.12

In this dataset, LT gives best result among all the remaining methods which is shown in Table 4.

Fig 9: Graphical representation of different quantitative measures



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(e) Data set - V Answer Scripts

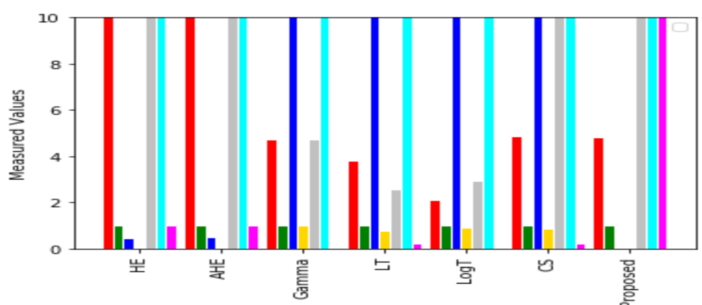
Fig.10 (a) Input Image (b) Output Image

(a) (b)

Table 5: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
HE	15.4	1.0	0.46	0.0	240.26	58486.09	1.0
AHE	21.02	0.99	0.47	0.01	239.99	58361.84	1.0
Gamma	4.71	1.0	29.83	0.99	4.73	67.66	0.03
LogT	3.82	1.0	13.22	0.76	2.56	3097.1	0.23
CS	2.12	1.0,	26.64	0.91	2.92	141.0	0.05
LT	4.87	1.0	13.95	0.87	12.21	2615.77	0.21

Fig 11: Graphical representation of different quantitative measures



In this dataset, LT gives best result among all the remaining methods which is shown in Table 5.

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4.4 Case II. Frequency Domain Approach

In this section we have taken five real time datasets.

Data set-1 Office Documents

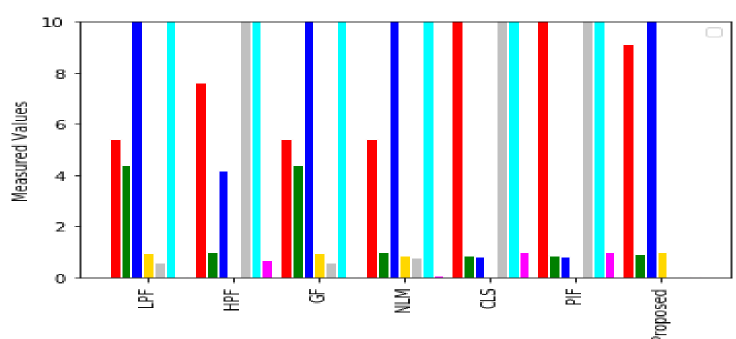
Fig 12 (a) Input Image (b) Output Image

(a) (b)

Table 6: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
LPF	5.41	4.4	26.76	0.94	0.6	137.12	0.05
HPF	7.62	1.0	4.16	-0.01	126.62	24969.61	0.68
GF	5.42	4.4	26.78	0.94	0.59	136.53	0.05
CLS	21.81	0.85	0.82	0.01	229.81	53874.7	1.0
PIF	21.81	0.85	0.82	0.01	229.81	53874.7	1.0
NLM	5.41	1.0	20.99	0.85	0.78	517.33	0.1

Fig 13: Graphical representation of different quantitative measures



In this dataset, NLM gives best result among all the remaining methods which is shown in Table 6.

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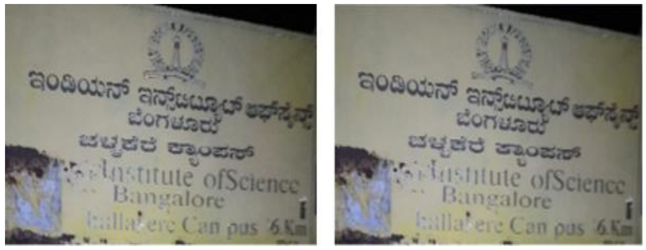
Data set II- Advertisement Boards

Fig.14 (a) Input Image (b) output Image

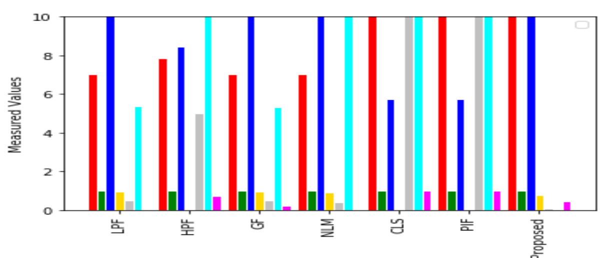


(a) (b)

Table 7: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
LPF	7.01	1.0	40.85	0.97	0.48	5.35	0.02
HPF	7.83	1.0	8.43	-0.02	5.01	9340.19	0.73
GF	7.01	1.0	40.87	0.97	0.49	5.33	0.22
CLS	21.81	1.0	5.72	0.02	126.05	17434.66	1.0
PIF	21.81	1.0	5.72	0.02	126.05	17434.66	1.0
NLM	7.0	1.0	31.96	0.92	0.4	41.4	0.05

Fig 15: Graphical representation of different quantitative measures



In this dataset, NLM gives best result among all the remaining methods which is shown in Table 7.

Data set III- Inauguration Boards

Fig 16 (a) Input Image (b) Output Image

(a) (b)

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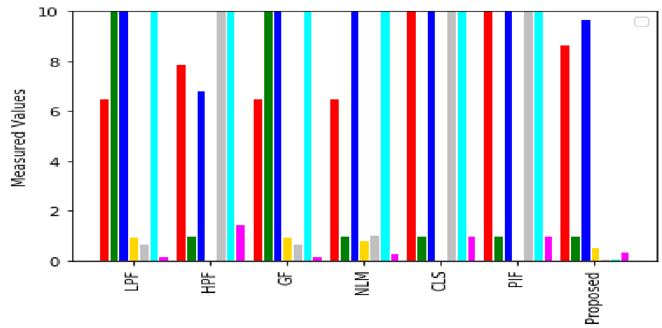
Table 8: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
LPF	6.52	251.0	26.74	0.94	0.69	137.86	0.15
HPF	7.89	1.0	6.83	-0.01	62.38	1349.65	1.46
GF	6.53	251.0	26.75	0.94	0.69	137.34	0.15
CLS	21.81	1.0	10.18	0.01	58.19	6245.49	1.0
PIF	21.81	1.0	10.18	0.01	58.19	6245.49	1.0
NLM	6.52	1.0	20.37	0.81	1.05	596.87	0.31

Fig 17: Graphical representation of different quantitative measures



In this dataset, NLM gives best result among all the remaining methods which is shown in Table 8.

Data set IV- Direction Boards

Fig.18 (a) Input Image (b) Output Image

(a) (b)

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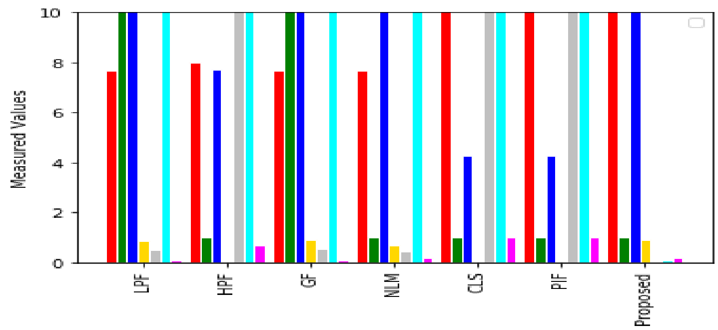
Table 9: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
LPF	7.67	126.0	26.25	0.88	0.51	154.11	0.08
HPF	7.98	1.0	7.69	-0.04	20.09	1107.41	0.67
GF	7.67	126.0	26.27	0.89	0.52	153.61	0.08
CLS	21.81	1.0	4.26	0.01	142.49	24372.7	1.0
PIF	21.81	1.0	4.26	0.01	142.49	24372.7	1.0
NLM	7.67	1.0	19.34	0.68	0.44	756.78	0.18

Fig 19: Graphical representation of different quantitative measures



In this dataset, NLM gives best result among all the remaining methods which is shown in Table 9.

Data set V- Answer Scripts

Fig 20 (a) Input Image (b) Output Image

(a) (b)

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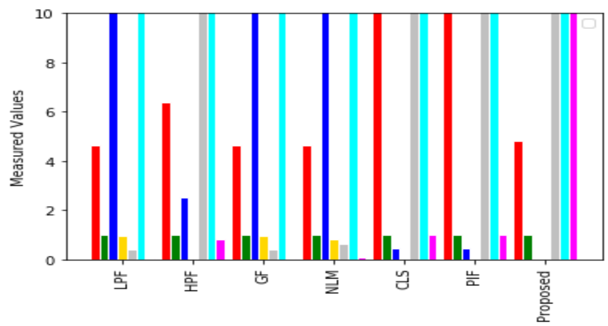
Table 10: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
LPF	4.63	1.0	31.79	0.96	0.42	43.05	0.03
HPF	6.37	1.0	2.51	-0.03	163.58	36508.69	0.79
GF	4.63	1.0	31.81	0.96	0.41	42.87	0.03
CLS	4.64	1.0	23.53	0.83	0.62	288.19	0.07
PIF	21.81	1.0	0.46	0.01	239.88	58484.44	1.0
NLM	21.81	1.0	0.46	0.01	239.88	58484.44	1.0

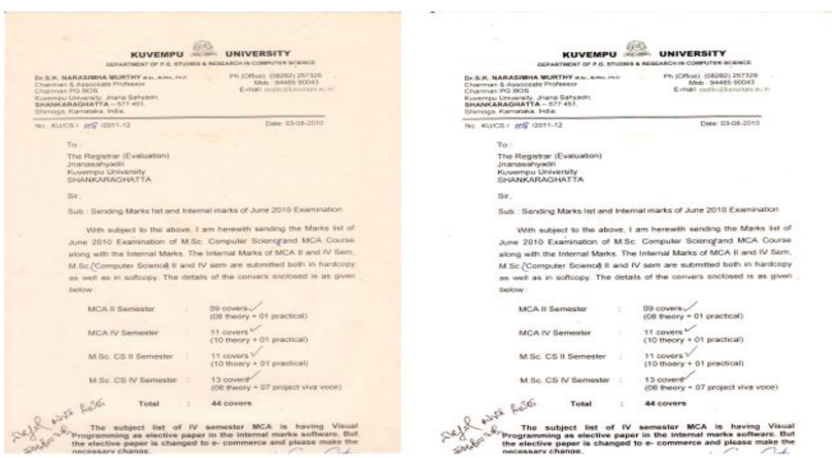
Fig 21: Graphical representation of different quantitative measures



In this dataset, NLM gives best result among all the remaining methods which is shown in Table 10.

Fuzzy Logic Method

(a) Data set -I Office Documents



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Date: 03-08-2010

To :

The Registrar (Evaluation)

Jnanasahyadri

Kuvempu University

SHANKARAGHATTA

Sir,

Sub : Sending Marks list and Internal marks of June 2010 Examination

With subject to the above, I am herewith sending the Marks list of June 2010 Examination of M.Sc. Computer Science and MCA Course along with the Internal Marks. The Internal Marks of MCA II and IV Sem, M.Sc (Computer Science) II and IV sem are submitted both in hardcopy as well as in softcopy. The details of the covers enclosed is as given below :

MCA II Semester	:	09 covers (08 theory + 01 practical)
MCA IV Semester	:	11 covers (10 theory + 01 practical)
M.Sc. CS II Semester	:	11 covers (10 theory + 01 practical)
M.Sc. CS IV Semester	:	13 covers (06 theory + 07 project viva voce)
Total	:	44 covers

The subject list of IV semester MCA is having Visual Programming as elective paper in the internal marks software. But the elective paper is changed to e- commerce and please make the necessary change.

(a) (b)

Table 11: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
FL	9.14	0.91	37.27	1.0	0.01	0.0	0.01

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(b) Data set –II Advertisement boards

Fig 23 (a) Input Image (b) Output Image

(a) (b)

Table12: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
FL	13.84	1.0	12.93	0.78	0.08	0.05	0.43

Data set -III Inauguration boards

Fig 24 (a) Input Image (b) Output Image

(a) (b)

Table 13: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
FL	8.67	1.0	9.71	0.54	0.07	0.1	0.33

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(c) Data set –IV Direction Boards

Fig 25 (a) Input Image (b) Output Image

(a) (b)

Table 14: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
FL	14.16	1.0	19.23	0.89	0.04	0.1	0.18

(d) Data set -V Answers scripts

Fig 26 (a) Input Image (b) Output Image

(a) (b)

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Table 15: Comparison of different quantitative methods

Methods	Entropy	MC	PSNR	SSIM	AMBE	MSE	NRMSE
FL	4.82	1.0	-47.39	0.0	232.14	54783.76	245.345

Table.16 Comparison of the results from proposed method for five enhancements different datasets.

Methods		**Entropy**	**MC**	**PSNR**	**SSIM**	**AMBE**	**MSE**	**NRMSE**
Balamurugan et. al.,[11]		4.23	1.0	17.97	0.98	3.21	1038.6	0.14
Antoni et.al.,[46]		5.41	1.0	20.99	0.85	0.78	517.33	0.1
Ravinder et.al.,[15]		16.88	1.0	0.7	0.0	233.27	54446.44	1.0
Spatial Domain	D1	4.23	1.0	17.97	0.98	3.21	1038.6	0.14
	D2	6.93	0.99	47.68	1.0	1.0	1.11	0.01
	D3	6.47	0	47.52	1.0	1.0	1.15	0.01
	D4	7.47	1.0	22.49	0.97	1.0	366.53	0.12
	D5	4.87	1.0	13.95	0.87	12.21	2615.77	0.21
Frequency Domain	D1	5.41	1.0	20.99	0.85	0.78	517.33	0.1
	D2	7.0	1.0	31.96	0.92	0.4	41.4	0.05
	D3	6.52	1.0	20.37	0.81	1.05	596.87	0.31
	D4	7.67	1.0	19.34	0.68	0.44	756.78	0.18
	D5	21.81	1.0	0.46	0.1	239.88	58484.44	1.0
Proposed (Fuzzy Logic)	D1	9.14	0.91	37.27	1.0	0.01	0.0	0.01
	D2	13.84	1.0	12.93	0.78	0.08	0.05	0.43
	D3	8.67	1.0	19.71	0.54	0.07	0.01	0.33
	D4	14.16	1.0	19.23	0.89	0.04	0.01	0.18
	D5	14.16	1.0	19.23	0.89	0.04	0.01	0.18

From Table 16, we have given the various approaches in enhancement of document images are given and sl.no. 8, in the spatial domain approaches which contain five documents indicates that for experimentation we have used five different datasets shown in each row similarly frequency. Domain and the proposed method in Fuzzy Logic approach.

Table 17: Comparative analysis of three different cases

Cases		**Entropy**	**MC**	**PSNR**	**SSIM**	**AMBE**	**MSE**	**NRMSE**
Spatial Domain	D4	7.47	1.0	22.49	0.97	1.0	366.53	0.12
Frequency Domain	D3	6.52	1.0	20.37	0.81	1.05	596.87	0.31
Proposed (Fuzzy Logic)	D1	9.14	0.91	37.27	1.0	0.01	0.0	0.01

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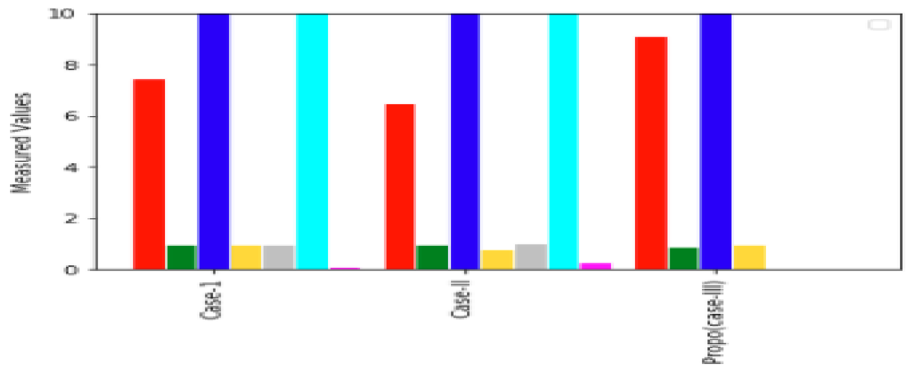
Fig 27: Graphical representation of different quantitative measures three different cases



In this work we have used five different real time datasets for three cases and we have selected the best method from each case and case three i.e. fuzzy logic approach is the best method for enhancement of document images which is shown in the graph Fig.27.

5. CONCLUSION

In this work, we have proposed an efficient approach for enhancement of real time document images. The proposed approach uses Fuzzy Logic (FL) method. Experimentation is carried out on our own five different datasets containing Five thousand complicated document images. The proposed method is compared with spatial and also frequency domain methods. Finally, Fuzzy Logic approach perform better than the existing methods.

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