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HMM based Historical Document Binarization for Document Image Analysis

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Abstract: *Document binarization plays important role to preserve the historical document. Recently number of researcher present numerous techniques of document binarization that can vary in sensitivity, quality and some more control parameters. Document digitization is an elderly but still a difficult task. Appearance of historical handwritten document varies with quality of ink and periodic shadings that leads to degrade quality of image. Quality of binarization may also vary within single document with light and view angle of different portion of physical document. Recently numerous of image binarization techniques have been proposed and achieved high milestone. But researcher still try to binaries, degraded document images with satisfactory level and needs further study. The major challenge lies with the modeling of the document foreground/background that often suffers from various types of document degradations such as uneven illumination, image contrast variation, bleed-through, and smear. In this paper a framework for digitations of historical physical document has been proposed. This framework suggests to use Markov random function to evaluate contrast of pixel and try to overcome the problem of appearance of a single document that can vary greatly depending on factors such as lighting, viewing angle. Following that proposed framework uses this energy to differentiate foreground and background ink. Final binaries image document has significant enhance in PSNR (db.) value. Proposed scheme use DIBCO (2013) for evaluation and validation.*

Keywords: *Digital Image Processing, Document Image Analysis , Document Binarization, PSNR Ratio, DOCBCO 1017.*

1. INTRODUCTION

Historical Document binarization is an old but still a challenging and mind hunting task [1]. In the real world, appearance of printed documents may vary with quality of printing color and shadings, which degrade significantly quality of different binaries documents. Whereas the quality of pixels of a document may vary with light and view angle. Earlier one of the main goal of document digitalization is to differentiate the pixel of document image on the basis of their quality and take a proper treatment for them. But it is a very ambiguous process.

Digitations of physical documents are usually use a representation of 24-bit color, or may be 8 bits of grayscale [2]. In most of recent application, these representation techniques do not include all of the data available in original physical document, but retaining more than enough. Recently research leads to retain a single bit per pixel document. Loyalty of digitations of physical document is relatively low, since information is loss, which is very much related to the primary content of the document. Many documents are produced using a monochrome ink for writing, and their meanings are incorporated exclusively for distribution of ink, a bit pattern representing the document explicitly of course, the deduction of correct digitations of a document from color or grayscale representation can be difficult. The physical deterioration of the document, image illumination conditions and limits of the unfavorable resolution can contribute to obscure the original pattern. Now these days many researchers proposed numerous algorithms for digitations of physical document towards this dispute. In fact standard document image binarization contest (DIBCO-11) held in-

order to gather an deep researcher [3]. However, the results of these competitions prove that there is always room for enhancement in the quality of automatic binarization.

2. IMAGE BINARIZATION

Academic institutions and libraries and historical museums pile-up or documents kept in storage areas. Image binarization [30,26,27] contributes to maintaining a safe and effective exploitation of researchers in the original condition through the years and unconditional, which is important collections of historical documents that have been preserved badly problem is likely that the deterioration of the documents and processes, see Fig. 1. Scan the document, allows access to the general public, while the cultural heritage institutions and organizations create local or national digital libraries that are accessible through the Internet. This paper provide a bird eye over the basic techniques used to improve the image and restore, eliminating noise and focuses binarization.

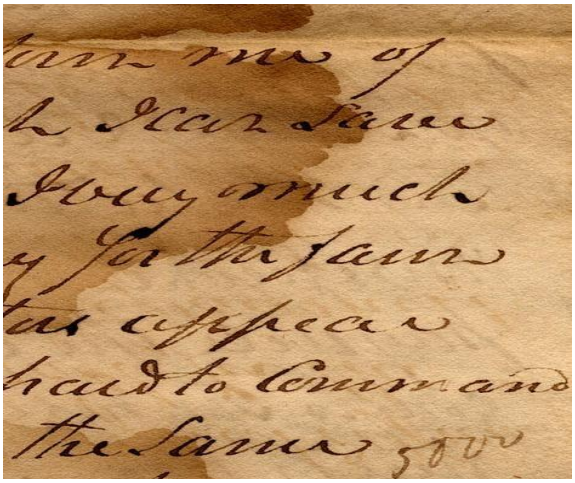

Figure.1: Original image

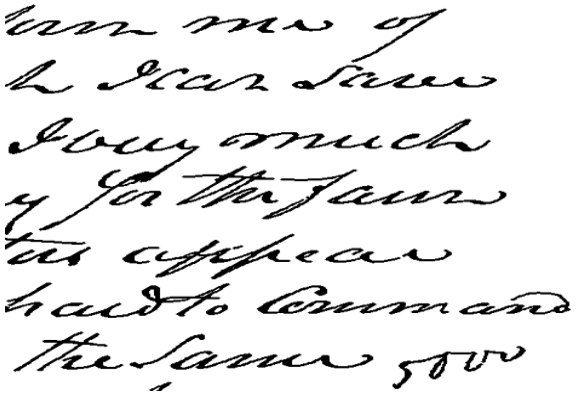

Figure 2: After Binarization

Binarization process of image is the separation between the pixel values in a double groups, presented in black and white and the background. Threshold has been created to be known and used for technical document image binarization [28,29,30]. The threshold of the largest gap in the global and local threshold technique. In a document with a uniform background and contrast delivery front, has proved the best overall threshold technique. In documents degraded, where there is noise in the background and a large-scale or the difference in the contrast and brightness that is, there are a number of pixels that cannot be easily categorized as front or rear. In such cases, the local threshold is important for BAT. The main goal of this chapter is to evaluate the different techniques of image binarization to find the gaps in the existing techniques.

Binary image is a digital image that has only two possible meanings of the values of each pixel. Typically, the use of two colors binary image and the black, which is white, but any two colors can be used. The color used for the objects in the picture is the foreground color while the rest of the image is the background color. Binary [2] images occur often in image processing as masks or as a result of some processes such as fragmentation threshold. A few I / O, for example, laser printers entry, computer displays two levels, is able to deal with the images simply a two-tier. Binary images from the color image segmentation is made up.

3. DOCUMENT IMAGE BINARIZATION CLASSIFICATION

Document Image Binarization is usually performed in the image Binarization [30,31] requests pre distinctive image processing relevant file processing, for example, the

character distinguishment optical (OCR) and self-image recovery. Change with the light of the high level of the image in black image linked file also encourages the following tasks, for example, the report also estimated from the shape bias test report. As more content records, and reporting binarization fast and accurate image has become increasingly crucial verification. Although the stock image binarization threshold has been considered for a long period of degraded images recorded remains a problem yet to be solved. This may be seen from the way the offer submitted registration / background is very problematic due to the different types of degradation of the report, for example, lighting degrees, the photo collection by contrast, dying over and swabs. We are trying to create a strong and productive report image binarization methods that have the ability to handle large archival purposes pictures. Generally severely degraded, which can be classified into three main types: binarization global, local binarization and methods of binarization hybrids.

(a) The global thresholding technique : Calculates the optimal threshold for the entire image; these techniques require some calculations, and can work well in simple cases. But failure in complex backgrounds such as uneven color and poor backgrounds illuminated. These methods are generally not suitable for document images degraded because they have a clear pattern separates foreground and background text.

(b) The local binarization techniques : Set different thresholds for different target pixel based on the district / local information. Generally, these techniques are sensitive to background noise due to the great variation in the case of a poor document or luminous deterioration bleed through.

(c) Hybrid binarization approach : Combines global and local threshold. The first step is to conduct a global threshold for the classification of the bottom of the document image and keep only the part that contains the foreground. The second step aims to improve the image obtained by the previous step to get the result more clearly through the application of adaptive threshold technique.

(d) Dynamic Threshold Binarization : Such as redundancy and knows how the threshold of pixels with gray level values of their own and neighboring pixels and pixel format. This method is used usually binarization images of poor quality, particularly with images graph one peak. However, due to the expense of the dynamic threshold, and the method has a high computational complexity and slow speed**.**

4. CURRENT SCENARIO

Document binarization image is an important technique for image analysis and document pre-treatment to the text segments money from Google Docs. Many of the techniques proposal and successfully applied in various applications, such as document retrieval image. Zemouri, E.T.T Chibani et.al [5] propose the conversion contourlet to assess the quality of a historical document deteriorating. To facilitate binarization, to improve the quality and document the first image by applying a conversion contourlet, to identify large transactions. After reconstruction, and uses the local threshold method to extract plain text. Hebert, D. Nicolas [6]propose a CRF based to explore the capabilities of this combined model by combining many of the outstanding output binarization algorithms known framework. Frame models 1D CRF on the horizontal and vertical directions that are associated to each pixel of the by-product of the marginal probabilities calculated from both models used. The experiments were conducted on two sets of image data of document Binarization Contest (Dibco) for 2009 and 2011, and the show is better than most of the methods presented in Dibco 2011 performance.Nafchi, H.Z[7] processing and analyzing the results of steps to significantly improve the performance means binarization, especially in the case of severely degraded historical documents. Based maintained in this document, is to present the way for further processing image uncensored without mismatch and phase noise from extracted from the input image features stage. Essence of the method consists of two powerful mask can be used to delete the false positive output pixel in the way binarization. First, get a mask value of high recovery of the image without noise using morphological operations. In parallel, is obtained on the second mask based on the characteristics of phase mismatch. Then, the average filter is used to remove the noise in these two masks, which are then used to correct the output of any method of binarization. This approach has been tested with many of the previous methods in the art DIBCO'09 binarization, H-DIBCO'10, and data sets DIBCO'11 H-DIBCO'12 promising and powerful results. Moreover, high-performance proposals masks appear likely to use as a generator uncensored truth almost ground for ways binarization based learning.Milyaev [8]demonstrate the OCR engine still work well in this task more difficult, as long as the application of appropriate binarization image of the input images. This binarization, and the performance of binarization 12 methods are evaluated new binarization algorithm we propose here systematically. This includes our assessment of the various standards and criteria prescribed uses text recognition from natural images (ICDAR ICDAR

2003 and 2011). So our main conclusion is that the image binarization methods along with additional filtering of connected components generated and the engine off the shelf OCR can achieve the return of the prior art to understand the end to end text in natural images.Bolan Su [9]proposes a novel image binarization that addresses these problems using adaptive image contrast. Adaptive contrast of the image is a combination of local image contrast and the local gradient of the image, which is tolerant to the text and the background variation caused by different types of document degradation. In the proposed technique, is constructed the first map contrast image input degraded documents adaptation. By contrast map is then digital, and along with a map to determine the edge of the sage text stroke edge pixels. And fragmented text by local threshold is estimated on the basis of the severity of detecting the edges of the text stroke pixels within the local framework. The proposed method is simple, powerful, and involves a minimum set of standards. It has been tested in three public data sets used in the recent tender documents image binarization (Dibco) for 2009 and 2011 and written handwriting Alid- Dibco in 2010 and achieved accuracy of 93.5%, 87.8% and 92.03%, respectively, which are much higher than or close to the roads reported better performance in all three competitions. Experiments on daily data Beckley Group, which consists of several difficult images of documents of poor quality and superior performance show the proposed method compared with other techniques. Bolan Su, Shijian Lu[10]propose a learning which makes use of methods to improve the performance of Markov random field image and document binarization list of images degraded documents framework. Large-scale experiments on modern document image data Binarization contest show that significant improvements of the current methods of binarization in the application of the framework of the proposed work.Yinghui Zhang[11]proposes an improved algorithm based on the background of gray image binarization QR lighting irregular code. First, through the sub-block processing according to the image size QR Code. On this basis, using the gray level estimation formula for calculating the value of the gray level of each block. Second, using full interpolation algorithm to build a background image in gray. Then, using the image of the gray background to adapt to the original image to get the corrected image. Finally, using the Otsu algorithm for imagebinarization corrected. Experiments show that the algorithm can make effective image correction varying lighting QR code, and get a good binary image.Bolan Su.[12]propose a classification framework combining different threshold methods and produce better performance of document image binarization. Given the results of binarization of some media reported, the proposed framework divides the document image pixels into three groups, a pixel in the foreground, the background pixels and pixel of uncertainty. Is then seeded application again to arrange a pixel is uncertain in the foreground and background, based on the groups and rear froeground preselected. Large-scale experiments on different data sets, including document image Binarization Contest (Dibco) 2009, and a handwritten document binarization of competition image (H-Dibco) 2010 show that our proposed framework outperforms most of the methods technology state dramatically.Bolan Su[13]propose a classification framework combining different threshold methods and produce better performance of document image binarization. Given the results of binarization of some media reported, the proposed framework divides the document image pixels into three groups, a pixel in the foreground, the background pixels and pixel of uncertainty. Is then seeded application again to arrange a pixel is uncertain in the foreground and background, based on the groups and rear froeground preselected. 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Rdquo propose a new technique to verify algorithms and document binarization. Our style is simple to implement, and can be done in any binarization algorithm since doesnpsilat require anything more than a binarization stage. Then we apply this proposed 30 technical binarization existing algorithms. The results are displayed and experimental findings.Gatos [16]presents a new adaptive binarization and the promotion of historical documents and deteriorating approach. The proposed method is based on (i) pre-processing efficiently. (Ii) the combination of several methodologies binarizing the results of the prior art. (Iii) the integration of information from the end and (iv) the application of effective image post-processing on the basis of mathematical morphology to improve the final result. Demonstrate superior performance

of the proposed method against six well-known techniques in many handwritten and machine print historical basis of the Library of Congress file documents. The performance is based on a fixed and concrete assessment methodology.He, J. Do[17]compares several alternative binarization algorithms for historical archive documents, by evaluating their impact on the performance of the recognition of the end-to-end word to identify and archive documents a complete system using commercial OCR engine. Algorithms evaluated are: global threshold; Niblack algorithms and Sauvola of. Adaptive versions of the algorithms and Niblack Sauvola. And Niblack and Sauvola algorithms applied to background images removed. We found that we have the archive documents, Niblack algorithm can achieve better performance than Sauvola of (allegedly evolution of Niblack) algorithm, and also achieved better than the internal binarization provided as part of the commercial OCR engine performance.

5. PROPOSED WORK

The first step of physical document analysis system is to digitalize the physical document. Recently number of researcher present numerous techniques that can vary in sensitivity, quality and some more control parameter. Document binarization plays important role to preserve the historical document. The document image binirization focused on the extracting the text and background of the image. In doing this the edge detection approach also play the crucial role. In this paper a framework for digitations of historical physical document has been proposed. This framework suggeststo used Markov random function is used to evaluate contrast of pixel and try to overcome the problem of appearance of a single document that can vary greatly depending on factors such as lighting, viewing angle. Follow with that proposed framework use this energy to differentiate foreground and background ink. It incorporates advanced discontinuities in terms of regularity of the overall function of the power, distorting ink limits to align the edges and allow harder smoothing incentive other image. The following paragraphs describe all these points in more detail below with taking example of handwritten document i.e. HW3 from the dataset DIBCO-13.

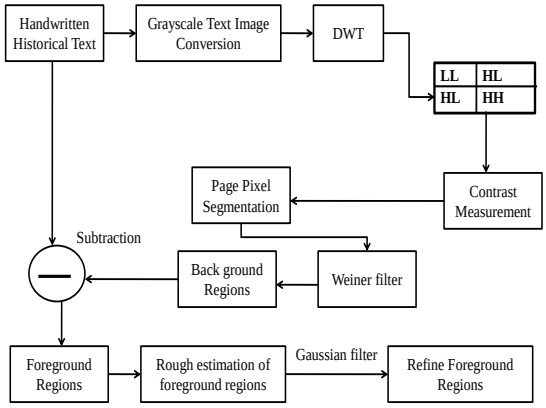

Figure 1: Proposed Frameworks for Document Binarization

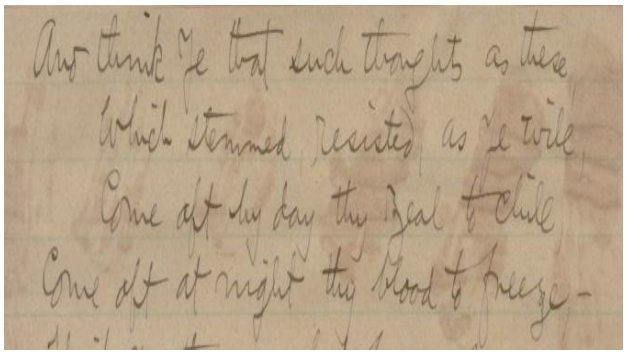

Figure 2: HW3 from DIBCO-13

Proposed algorithms for handwritten historical document binarization is show in figure 1. Proposed framework consist color to gray conversion, contrast measurement, pixel segmentation based back ground elimination and refine fore-ground image by filter out rough foreground image.

Grayscale Conversion: - Proposed framework initially applies grayscale conversion [b8] for eliminating noisy areas, smoothing of background texture as well as contrast enhancement between background and text areas as show in figure 2.

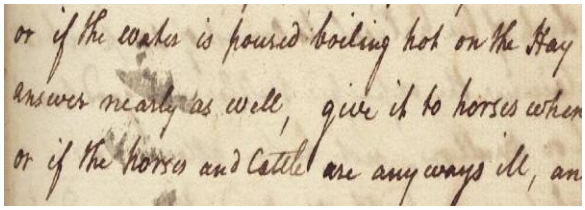

Figure 3: - Input Handwritten Image

Discrete Wavelet Transform: - The discrete wavelet transform (DWT) is an implementation of the wavelet transform using a discrete set of the wavelet scales and translations obeying some defined rules. In other words, this transform decomposes the signal into mutually orthogonal set of wavelets, which is the main difference from the continuous wavelet transform (CWT), or its implementation for the discrete time series sometimes called discrete-time continuous wavelet transform (DT-CWT).

The proposed techniques use the DWT transformation scheme for the digital watermarking. Which decomposes the input image in four components, namely, LL, HL, LH and HH, where the first letter corresponds with frequency offset of the row either low or high and second latter refer to filter applied to the columns.

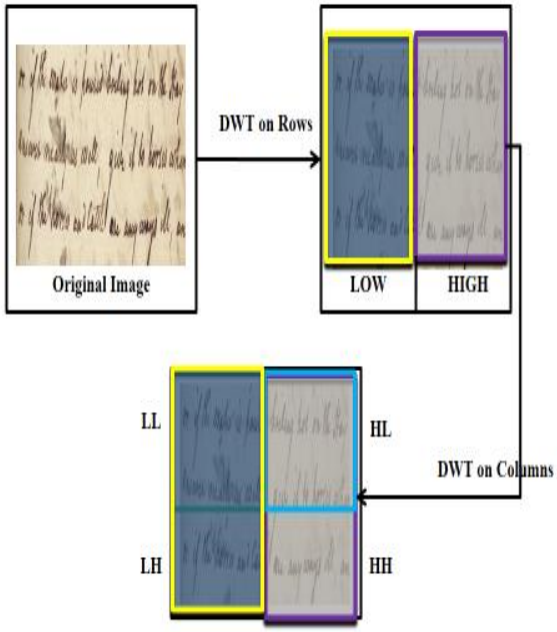

Figure 4: DWT Transform of Image

The lowest resolution level LL refer to approximate part of the host image whereas rest three refer to detail parts and give the vertical high (LH), horizontal high (HL) and high (HH) frequencies.

DWT decomposes the host image into four frequency sub-bands namely LL, HL, LH, and HH band. LL band deals with approximate details, HL band deals with horizontal details, LH gives vertical details and HH band contain diagonal details of the image.

Proposed document digitization scheme apply contrast Measurement and pixel segmentation over each band separately to obtain better horizontal, vertical, diagonal and approximate detail. Whereas noise filter uses different threshold for different band.

Figure 4 illustrates the basic, one-level, two-dimensional DWT procedure. First, we apply a one-level, one-dimensional DWT along the rows of the image. Second, we apply a one-level, one-dimensional DWT along the columns of the transformed image from the first step. As depicted in Figure 5.5 (left), the result of these two sets of operations is a transformed image with four distinct bands: (1) LL, (2) LH, (3) HL and (4) HH. Here, L stands for low-pass filtering, and H stands for high-pass filtering. The LL band corresponds roughly to a down-sampled (by a factor of two) version of the original image. The LH band tends to preserve localized horizontal features, while the HL band tends to preserve localized vertical features in the original image. Finally, the HH band tends to isolate localized high-frequency point features in the image. As in the one-dimensional case, we do not necessarily want to stop there, since the one-level, two-dimensional DWT extracts only the highest frequencies in the image. Additional levels of decomposition can extract lower frequency features in the image; these additional levels are applied only to the LL band of the transformed image at the previous level. Figure 7 (right) for example illustrates the three-level, two-dimensional DWT on a sample image.

In Fourier analysis, the Discrete Fourier Transform (DFT) decompose a signal into sinusoidal basis functions of different frequencies. No information is lost in this transformation; in other words, we can completely recover the original signal from its DFT (FFT) representation. In wavelet analysis, the Discrete Wavelet Transform (DWT) decomposes a signal into a set of mutually orthogonal wavelet basis functions. These functions differ from sinusoidal basis functions in that they are spatially localized – that is, nonzero over only part of the total signal length. Furthermore, wavelet functions are dilated, translated and scaled versions of a common function φ, known as the mother wavelet. As is the case in Fourier analysis, the DWT

is invertible, so that the original signal can be completely recovered from its DWT representation.

Contrast Measure: - Subsequently proposed frame apply Markov random field for contrast measure of a pixel against its background. And statically calculate threshold that's lead to segment out pixel into three category document background pixels, document foreground (text) pixels, and uncertain pixels. Foreground pixel (darker) usually has a positive value of contrastmeasure, and mostbackground pixels (lighter) have negative, zero or small positive values. A larger window size yields a better detection of thicker lines patterns while it is difficult to separate very close lines.
Intuitively, this tends to separate the ink from the bottom due to the divergence of the gradient of Markov measurement. Therefore, it will be positive intensity valleys (ink) and negative current peaks or plateaus (bottom). The image contrast is evaluated by the following equation 1

$$p_c(i,j) = \frac{p_{c,max}\ (i,j) - p_{c,min}\ (i,j)}{p_{c,max}\ (i,j) + p_{c,min}\ (i,j) + \epsilon} \text{.....1}$$

Where Pc, max (i, j) and Pc, min (x; y) refer to the maximum and the minimum image intensities within a local neighborhood window. The term ϵ is a positive but infinitely small number to avoid dividing zero problems.

The probability of label L0 and L1ij should be invariant to the contrast measure of the work area, and therefore are trapped in the Markov of the contrast measure:

$$\text{L0ij} = \nabla 2\text{Iij}$$
$$\text{L1ij} = -\nabla 2\text{Iij}$$

Weiner filter: -Wiener filter is the MSE-optimal stationary linear filter for images degraded by additive noise and blurring. Calculation of the Wiener filter requires the assumption that the signal and noise processes are second-order stationary. Proposed scheme use statically threshold calculated by using Markov model is being use to filter out background image as noise. As show in equation 2.

$$W_f(i,j) = \frac{t_{image}\ * c_{foreground}}{|t_{image}\ |\ ^2 * c_{foreground}\ + c_{background}} \text{.....2}$$

However, if the image contains non-uniform background or too much noise, the contrast of the image may contain several peaks. Using a single threshold value to binaries the entire image would not produce a good binary image.

Rough estimation of foreground regions: - For rough estimation of fore ground regions, proposed framework operator for image pixels with Wiener filter, it smoothest the image and reduces noise, however, the result of smoothing image causes the fuzzy edge.

Gaussian smoothing is very effective for removing Gaussian noise. The weights give higher significance to pixels near the edge (reduces edge blurring). They are rotationally symmetric, linear low pass filters with higher computationally efficient. The degree of smoothing is controlled by σ (larger σ for more intensive smoothing). The weights are computed according to a Gaussian function:

$$G(i,j) = c.e^{\frac{i^2+j^2}{2\sigma^2}} \text{.....3}$$

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6. RESULT ANALYSIS

The proposed concept has been implemented in MATLAB. In this simulation there is a use of handwritten data set DIBCO13- has been used. PSNR is Factor of an image which is use to know the quality of the picture or image. It is calculated by using mean squire error of MSE. The PSNR will calculate the original image and resulting image. Both parameters are calculated by the following formulas.

$$PSNR = 10\log_{10}\left(\frac{MAX^2}{MSE}\right)$$
$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

The experimental results shows that the proposed algorithm gives the batter performance with compared to previous approaches.

Table 1: PSNR Comparison Results

Image Name	Proposed					Existing				
Year	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
HW1	24.49	59.40	60.55	47.42	32.43	21.45	21.67	27.84	27.49	20.84
HW2	35.67	37.16	43.55	41.97	56.63	31.45	22.46	26.56	27.54	26.49
HW3	47.34	57.52	33.20	50.05	45.90	41.32	27.87	20.01	32.18	26.78
HW4	29.75	46.41	60.05	45.25	46.77	25.75	31.24	29.12	31.20	25.87
HW5	50.23	46.97	33.94	39.09	32.34	46.87	27.17	22.67	21.56	23.07

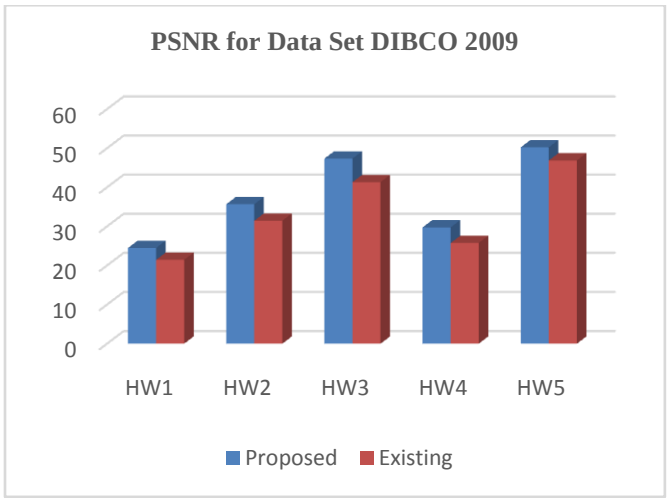

Figure 5: PSNR Comparison Graph.

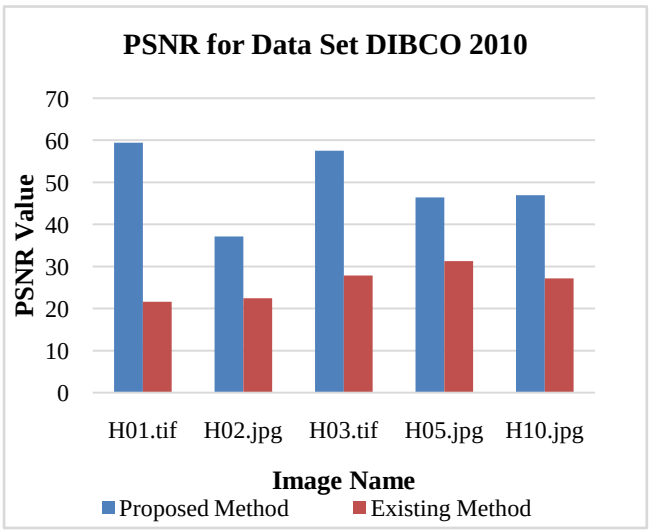

Figure 6: PSNR Comparison Graph

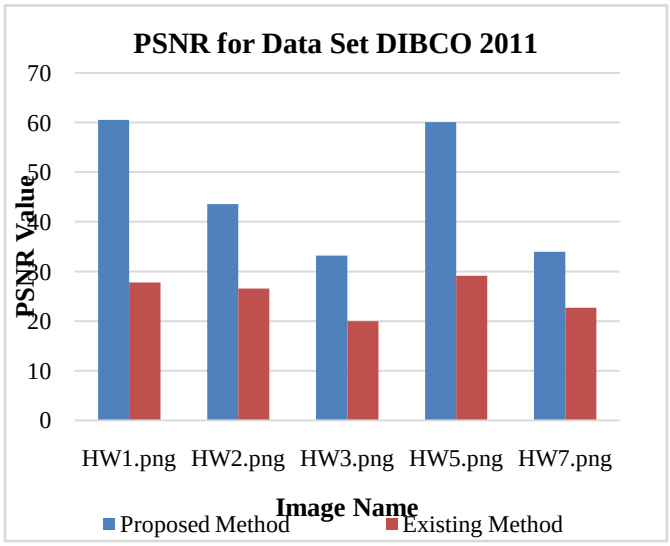

Figure 7: PSNR Comparison Graph

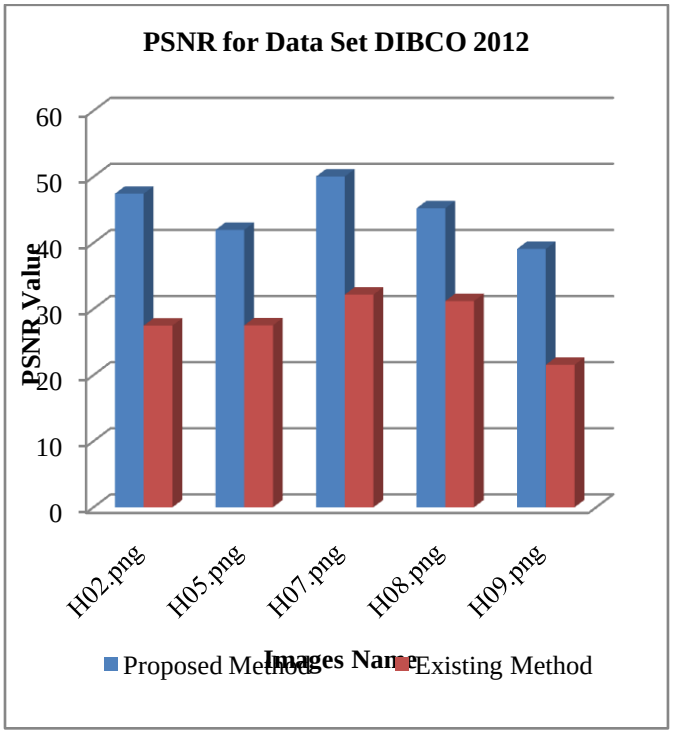

Figure 8: PSNR Comparison Graph

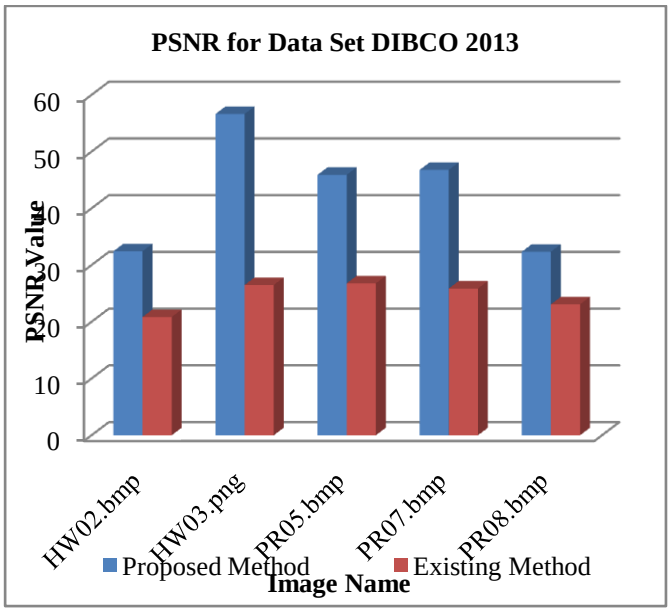

Figure 9: PSNR Comparison Graph

7. CONCLUSION

In this paper an adaptive binarization method inspired by Markov random field model is introduced. The first step was to labels the pixels which comprise the global energy function. With that energy, the binarization inclined to conform to the contours of intensity while smoothing unevenness resulting because of noise sources. It then introduces a method which calculates the Laplacian of the image intensity to distinguish between the inks from the background. Further it uses the proposed algorithm to link the distorted edges and biasing the ink boundaries. Practically, this approach seems effective, because it gives best location precise ink background transition intensity differences tend to be large everywhere after a few pixels the border real, so that it becomes very easy to select the place. Markov random field is specially designed for fast classification of objects into two classes. It has successfully been used for demising of images. We combined the global energy function with the edge detection to recover document images suffering from bleed through or intensity degradation. The number of single edges is reduced by almost half in the case of canny, thanks to its ability to recover weak and low intensity parts of the strokes on the edges. The method was evaluated on the DIBCO'09-13 datasets with promising results. The work done in this thesis has overcome the drawbacks of detecting the distorted edges by using edge

detection. This framework suggests to use luminous intensity of pixel and try to overcome the problem of appearance of a single document that can vary greatly depending on factors such as viewing angle, shadow.

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