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AN EFFICIENT BINARIZATION ON DEGRADED MALAYALAM HANDWRITTEN PALM LEAF MANUSCRIPT DATASET ENHANCEMENT USING 3D - DS CLAHE ALGORITHM

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Abstract: Research Area on Degraded Palm Leaf Manuscripts is a tedious task for document processing. The Proposed work has taken a dataset on the Degraded Malayalam Palm Leaf Manuscript (DMPLM). Degrading is similar to damage and deterioration that results in uneven illumination, decolorization, holes, cracks, moisture, staining, physical damage, insect bite, rodent activity, splitting, and fractionalization. The Process involves solving the complexity behind the density adjustments on the captured dataset. The Proposed work resolves complexity by applying 3D depth slicing in the CLAHE (Contrast Limited Adaptive Histogram Equalization) algorithm with a Cumulative Distribution Function (CDF) component. The proposed work shows a better result score of 98% in consecutive Efficient Recognition of Text Binarization process compared to existing methods.

Keywords: Degraded Malayalam Handwritten Palm Leaf Manuscript Dataset (DMHPLMD, 3D - Depth Slicing (DS) CLAHE, Thresholding, Binarization.

1 INTRODUCTION

In Ancient days, Palm Leaf Manuscripts were used as a writing and drawing medium to transmit the content of the author's knowledge. Information stored in palm leaf manuscripts becomes veritably useful for the present younger generation too. Preservable information is plenty such as Astronomy, Jadhaka, Medicine, Mortal discipline, Music, Earth Science, etc. Palm leaf manuscripts frequently vary in size among different regions, they seem to average 4 centimeters in width and 48 centimeters in length more than 40 centimeters thick. Narayam was the primary tool to scribe on palm-leaf manuscripts called thaliyola [1]. The earlier palm leaf manuscripts have been fully destroyed owing to the tropical climate of the region. Most of these palm leaves are nearing the end of their natural continuance and are facing destruction from elements similar to moistness, fungus, ants, silverfish insects, and cockroaches [2]. Enhancing the digitized documents by restoring deteriorated and obscured textual contents using multi-level thresholding techniques without the knowledge of labeled data. Identifying the relevant information and extracting data from a degraded manuscript is necessary to accomplish the improvement of documents that are degradation-free [3]. The interpretation of minute inter-grey level changes to classify textual to non-textual pixels demands a simple and effective document in a specific binarization technique. As documents are created with their layout and made of different material types, there is no universal binarization approach [4].

2 RELATED WORK:

Global and local thresholding methods are employed for binarization to determine whether the image pixel is the minimum fixed value or maximum the fixed value. According to the value it determines 0 and 1 by W. Niblack [5]. Non-stain degradation was used for the experiment on the

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DIBCO document and removed the non-uniformity of illumination in a document by Michalik and Okarma [6]. The Global threshold specifies a global value for all pixel intensities in an image in order to distinguish them as text objects and backgrounds for the binarization process by N.Otsu [7]. Local mean and Standard deviation of image pixel value evaluate the neighborhood-based local Niblack threshold by Bernson [8]. Performs entropic thresholding method using gray-level spatial correlation histogram by Xiao et al [9]. There are fifteen different global Thresholding methods used for the binarization of water-sensitive document images. According to the performance evaluation Otsu method gives the best result by Lipinski et al [10]. Machine learning classification that uses apriori information and spatial relationships on the image domain in addition to main data to recover weak text and strokes based on the maximum likelihood adaptive method by Rachid Hedjam. A et al [11]. Applied Otsu Threshold in Malayalam Palm Leaf Dataset to recognize confusing similarity character using IBL algorithm in Transformation Method by S.Gopinathan, I.Jailingeswari [12]. The adaptive solution is given by the local threshold method for varying background intensities according to the properties of the local region by George D.C. et al [13]. The Sauvola Threshold method calculates different threshold values for each pixel using two different algorithms based on the local method. Based on local neighborhoods of grey-level distributions, the local threshold is done by multiple predicates to all the pixels in an image, global threshold applies a unified predicate to each pixel of an image by Sauvola et al [14]. The process of overcoming the non-uniform illumination document using local and global threshold techniques that uniformize grey level distributions on the document by Gupta [15]. Adopt threshold algorithm applies parameter tuning on deteriorated palm leaf documents delivering the best result by Alexander et al [16]. Removal of signal-dependent noise and low-contrast regions on a deteriorated document using adaptive logical methods for binarization by Yang et al [17]. Existing local infrastructure and global thresholding methods are presented in a comprehensive assessment by Mehmet Sezgin et al [18]. Local patches of images are taken as training images using U-net neural networks on the DIBCO document for handling the binarization strategy by Huang et al [19]. Modified Sauvola approach applied on damaged paper photos for binarization using width transform decides label of each pixel as 0 or 1 by Kaur et al [20]. Local occurance of maps and Gaussian Mixture models are used to remove stains for damaged handwritten and printed documents for binarization by Mitianoudis et al [21]. Eliminate noise in the Degraded Tamil Handwritten Palm leaf Manuscript Dataset (DTHPLMD) using Otsu method produce binarized ground truth dataset by I.Jailingeswari,S.Gopinathan [27].A non-linear reaction-diffusion model is applied to the Persona Malik equation for bleed-through document binarization evaluated on the DIBCO dataset by Zhang et al [22]. Gabor filters are used to remove noise in a degraded document for the binarization process by Sehad et al [23].

3 METHODOLOGY OF PROPOSED SYSTEM:

3.1 DATA COLLECTION:

The collected input dataset samples are Kambaramayana and Jathaka from the Mendely dataset [24] Shown in Figures 1(a) and 1(b)

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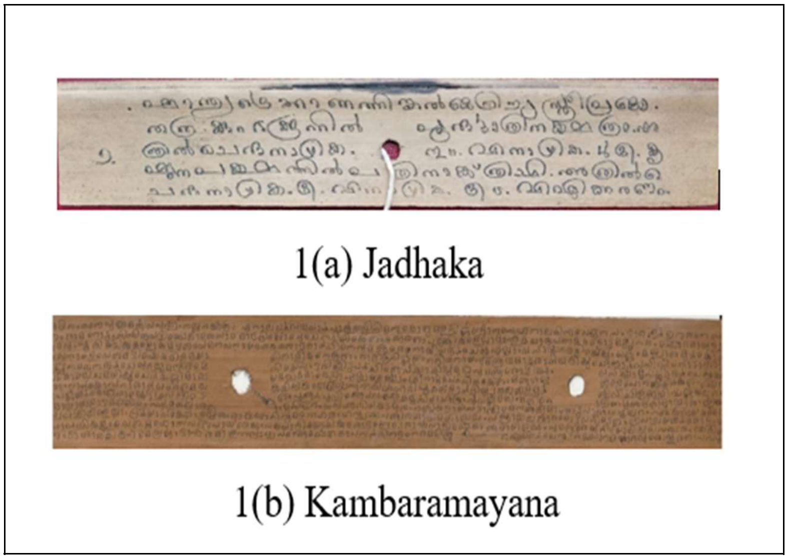

Figure 1 (a), 1(b) Palm leaf scripts in Malayalam

3.2 ALGORITHM FOR PROPOSED SYSTEM:

Step 1: Input as Degraded Malayalam Handwritten Palm Leaf Manuscript Dataset.
Step 2: Cropping Dataset images.

Step 3: Phase - I involves converting Gray level images

Step 4: Phase - II involves Normalize the Gray images from Step3
Step 5: Phase –III involves Noise Removal
Step 6; Phase –IV involves Filter the image
Step 7: Apply 3D Depth slicing in CLAHE Algorithm
Step 8: Otsu Threshold
Step 9: Post Enhancement by Morphological Operations
Step 10: Making Efficient Binarized Output Result.

3.3 ARCHITECTURE OF PROPOSED SYSTEM:

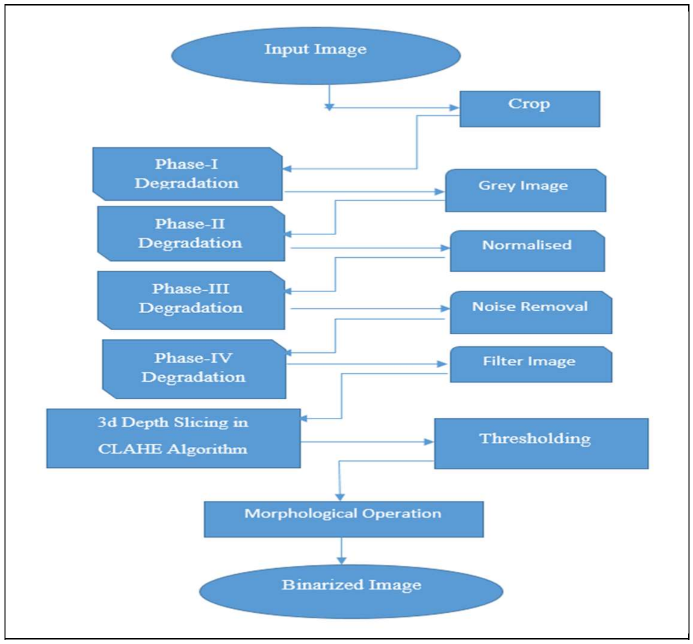

Figure 2: Architecture of proposed four phase DMPLM enhancement system

Fig. 2 shows the Architecture of Four phase Degraded Malayalam Palm Leaf Manuscript (DMPLM) applying 3D Depth Slicing in Contrast Limited Adaptive Histogram Equalization (CLAHE) and Thresholding Technique for enhancing the efficient Binarization Process. Degradation of the first phase involves a gray-level image from the colour image Dataset, taking the three components of average value from the range of minimum value to maximum value. Gray scale value = $m+o+n /3$, here m-Red; o- Green, n-Blue; **the contribution of blue to the final value should decrease, and the contribution of green should increase. The Degradation of the second phase involves, normalizing the image by** changing the pixel intensity value. The maximum intensity value is divided by 1/3rd of the desired range value so that the exact normalized image has appeared in this work. **The Degradation of the third phase involves, noise removal. Input Dataset contains** amplifier **noise such noise degraded without spoiling the quality of the image using Gaussian noise $k=k_0+N$, where k is a noisy pixel, N is noise in that pixel, and k_0 is the true value of a pixel, hence the value of k which is equalized to 0. That is removing noise from the image. The Degradation of the fourth phase involves the median Filter image. All pixels under the kernel area are replaced by a central component with a median value. Median filter blur from minimum kernel value to maximum kernel size of the image. Applying the 3D Depth Slicing CLAHE algorithm contains three parameters to even the luminance and amplified adjustments contained in the image. The process moves on the next to Otsu Threshold followed by a morphological operation to make an efficient binarization recognition.**

4 EXPERIMENT:

4.1 3D DEPTH SLICING (DS) CLAHE ALGORITHM:

3D Depth Slicing (DS) considers color channel information stored in the image, as bit depth increases, file size increases. Reduce the size of the image file without degrading the quality of the image. The color points of the boundary are fully saturated. The formula of color saturation given by equation (1)

$m = \frac{m}{m+o+n}$; $o = \frac{o}{m+o+n}$; $n = \frac{n}{m+o+n}$; *Therefore* $m+o+n = 1$. (1)[26]

Where *m* represents the Red color channel, *o* represents the Green color channel, *and n* represents the Blue color channel.

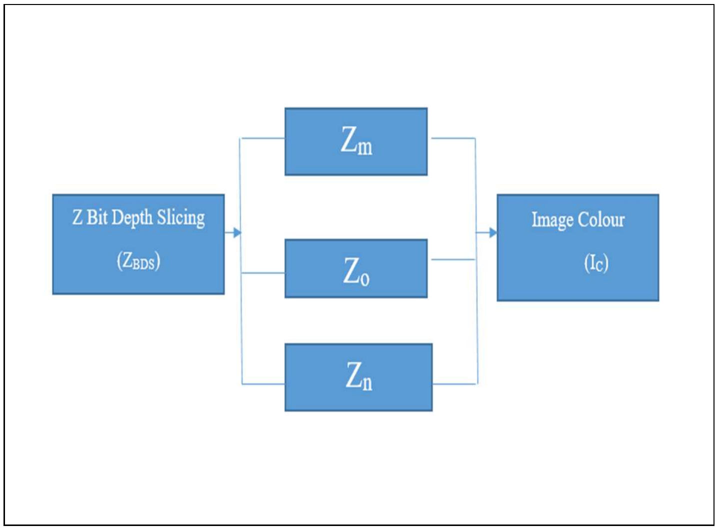

Figure 3. Z Bit Depth Slicing Color Channels (BDS) contains in Color Image.

Figure 3 shows the z Bit Depth Slicing for all three colour channels such as red, green blue the colour image. Equation (2) handling equalizes the colour channel throughout the image by adjusting the Intensity uniformly while learning the colour unchanged. Here desired set value is 0.5 for gray uniformity, if the pixel intensity is a far distance from the desired set value then consider as colour value unchanged.

$$s_k = T(r_k) = \sum_{i=0}^{k}(1)\,(p_k(r_i)) => \sum_{i=0}^{k}\frac{n(i)}{N} \quad (2)$$

[26]

Where r and s are Intensity Components of Input and Output Image p is the desired point and k is kernel size. Consider the CLAHE Algorithm to improve the image quality based on the (CDF) Cumulative Distribution Function, the block size (BS) parameter increases BS increases, the dynamic range expands, and the image contrast increases. When CL (clip limit) is increased, the image becomes brighter. A larger CL makes its histogram flatter. The two parameters determined at the point of maximum entropy curvature produce subjectively good image quality. Equation (3) below expresses the Local mean and standard deviation desired block size (BS) window computed as

$$g(x, y) = \frac{1}{nXn}\sum_{x=0}^{n-1}\sum_{y=0}^{n-1} f(x, y)$$

(3) [25]

After getting the local mean and standard deviation of the block size (BS) window, then calculate the average value of equation (3) and apply it to this CLAHE algorithm equation (4)

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$$\sigma = \sqrt{\frac{1}{nXn} \sum_{x=0}^{n-1} \sum_{y=0}^{n-1} f(x,y) - m(x-y)}$$

(4) [25]

Reducing the contrast amplification noise and making uniform luminance portions in all the windows with high accuracy and contrast limiting.

4.2 *OTSU THRESHOLD METHOD*:

The threshold value fixes the possible intensity value (t) for separating pixels into foreground (fg) and background (bg). Finding the minimum weighted variance between the fg and bg pixels until the process is iterated. Lesser than the fixed value is considered as foreground and greater than the fixed value is background. The formula within the variance is given by equation (5)

$$\sigma^2 (t) = \Omega_{bg} (t)\, \sigma^2_{bg} (t) + \Omega_{fg} (t)\, \sigma^2_{fg} (t)$$

(5) [26]

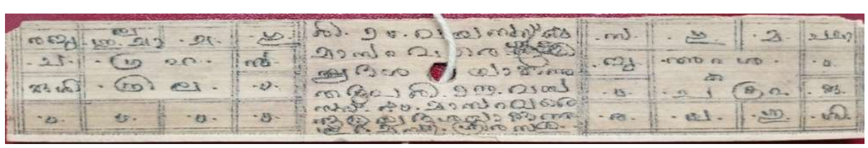
Where Ω_{fg} *and* Ω_{bg} are the probability of a number of pixels of foreground and background pixels at Threshold t, σ^2 represents the variance of colour value.

4.3 *MORPHOLOGICAL OPERATIONS*:

The erosion of a binarized image *g* by a structuring element *s* (denoted g ⊖ *s*) [26] produces a new binary image *f* = *g* ⊖ *s* with ones in all locations (*x, y*) of a structuring element origin at which that structuring element *s* fits the input image *g(x, y)* = 1 is *s* fits *f* and 0 otherwise, repeating for all pixel coordinates (*x, y*).

5 RESULTS:

Figure 4,5 shows the Proposed Binarized Outputs of the Kambaramayana and Jathaka dataset images. Figure 6 shows the Binarization result of existing work, and missed characters shape, strokes and edges fall insufficient to recognize the character from the image. Figure 7 shows the Proposed Binarized Output result obtained efficiently to recognize characters by evaluating visual perception.



(a)

(b)

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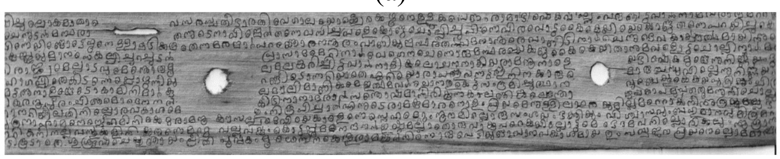
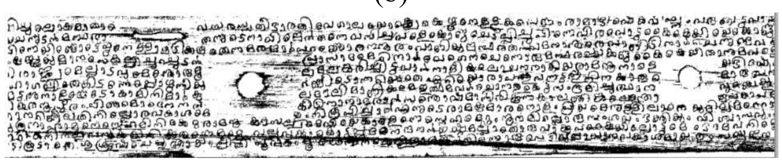
(c)

Figure 4 (a) Input Image of Jadhaga dataset, (b) 3D DS CLAHE Algorithm of (a), (c) Proposed Binarized Output of (a)

(a)



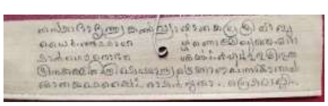
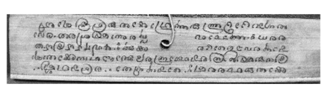
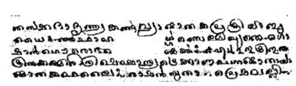
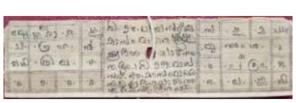
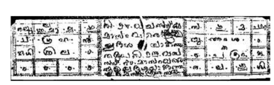
(b)



(c)

Figure 5 (a) Input Image of kambaramayana dataset, (b) 3D DS CLAHE Algorithm (a), (c) Proposed Binarized Output of (a)

Table 1 represents a few samples of Proposed two-phase Output results to the corresponding Input Images.

Input dataset Image	Applied Proposed 3D Depth Slicing CLAHE Algorithm	Proposed Binarized Output Images
 I-(a)	 I-(b)	 I-(c)
 II-(a)	 II-(b)	 II-(c)

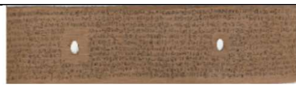
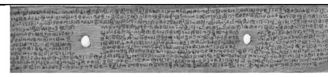
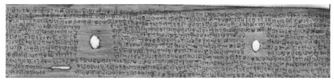
 III-(a)	 III-(b)	 III-(c)
 IV-(a)	 IV-(b)	 IV-(c)

Table1: Few samples Proposed two-phase Output results to the corresponding Input Images

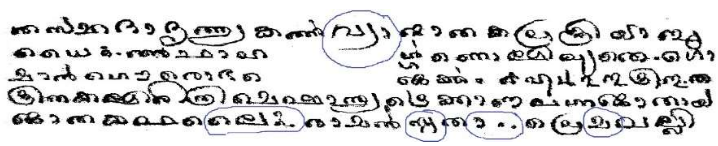


Figure 6: Existing work of Binarization.

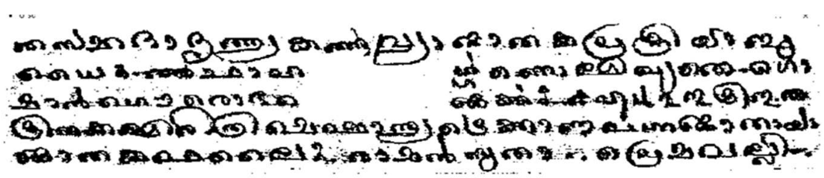


Figure 7: Proposed Binarization recovers the missed character shape, strokes, edges from existing work

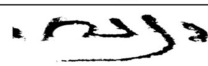
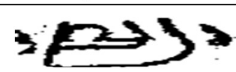
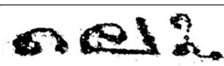
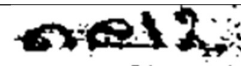
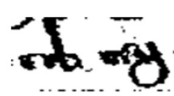
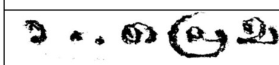
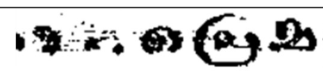
Existing work	Proposed Work
	
	
	
	

Table 2: Visual Perception Evaluation between Existing and Proposed Work

Figure 8,9 shows the histogram comparison chart of Exisiting and Proposed methods.

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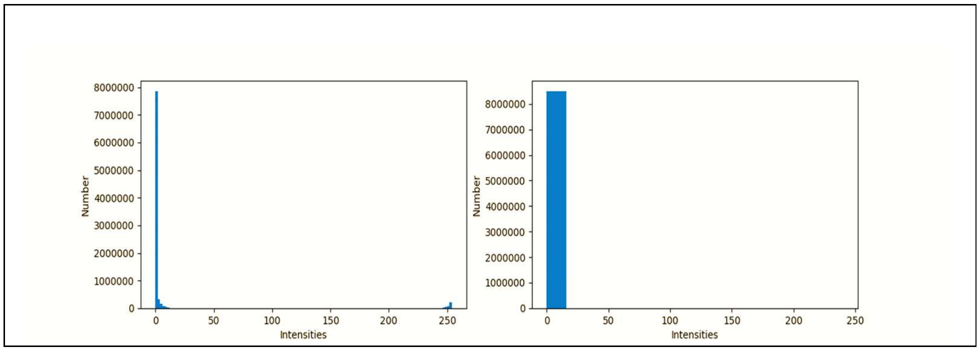


Figure 8: Evaluation of Histogram Chart for Existing Work

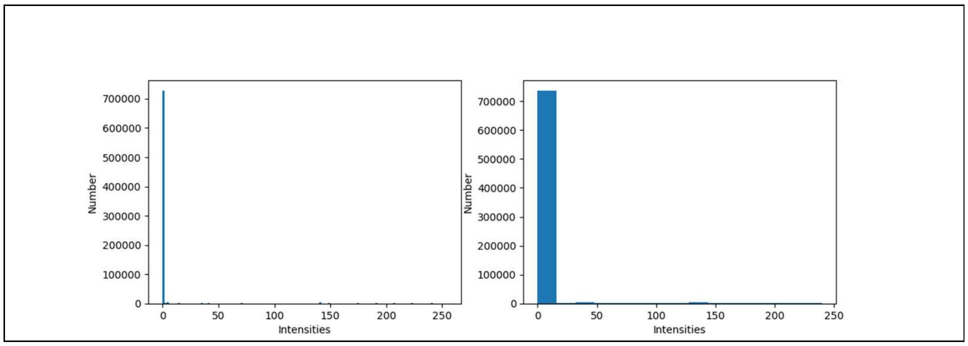
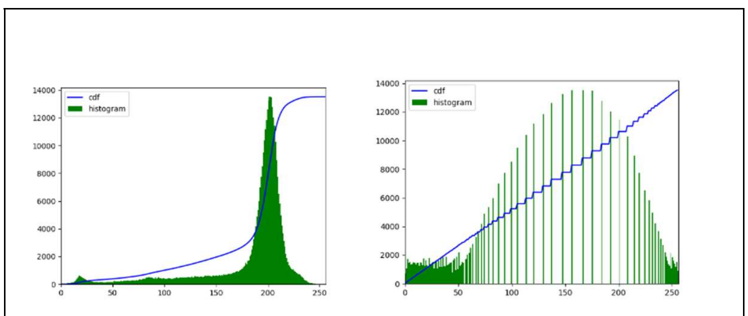


Figure 9: Evaluation of Histogram Chart for Proposed Work

Figure 10(a) represents the CDF Evaluation of the Input image Histogram, and Figure 10(b) sho ws (the CDF) evaluation of applying the 3D Depth Slicing CLAHE Algorithm on the Input Image.



(a) (b)

Figure 10(a) CDF on Input image, 10(b) CDF on proposed 3D DS CLAHE Algorithm

Table 3 represents the accuracy result of the proposed method compared with the existing meth od.

Algorithm	Methods	Successive BinarizationA ccuracy
3D DS CLAHE Algorit hm + Otsu threshold	Proposed	98%

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Sauvola Threshold [24]	Existing	61%

Table 3 Accuracy result compared with the existing method

6 CONCLUSION:

The Proposed binarization problem helps to resolve the complexity behind the contrast adjustment from captured Degraded Malayalam Handwritten Palm Leaf Manuscript. Pre-enhancement process of four Phase degradation levels shapes the input dataset. Based on the Cumulative Distributive Function 3D Depth Slicing CLAHE algorithm even the luminance and noise amplification area from uneven portion. Applying Otsu and Morphological Operation gives betterment Binarization on Degraded Malayalam Palm Leaf Manuscript. We evaluated and compared several existing methods. It gives a good result of accuracy of 98% compared to the existing one [24]. A significant improvement in recognition is better compared with the existing one. The Methodology can also implement on Medical Image Dataset and helps to facilitate deep/transfer learning, Machine Learning, ANN, and AI. Future Studies will implement other Local and global Thresholding techniques to recognize the character by structuring the elements contour specification on Degraded Palm Leaf Manuscript.

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