

# Grantha Palm Leaf Manuscript Image Processing and Study the Effectiveness of the Thresholding and Preprocessing with an GUI Application

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**Abstract** : Comparing the thresholding methods like Otsu's, Adaptive Gaussian, Niblack and Sauvola on a Grantha Palm leaf manuscript with preprocessing technique manually and test them are time consuming. A GUI tool "Manuscript Processing" is developed using Python to make the image processing easier. It combines preprocessing techniques like denoising, filtering, edge preservation and CLAHE (Contrast Limited Adaptive Histogram Equalization) with required Thresholding method. This software takes a palm leaf manuscript image and processes it to display output.

## 1. INTRODUCTION

Grantha Palm manuscripts are preserved using Digitization. Grantha script is a writing system used in South India to write Sanskrit and Tamil works. There is a need to decipher the contents. Manuscript is prone to degradation, faint texts and damages. For the identification of the contents, different techniques like preprocessing and thresholding are applied to the image. Image thresholding is an important technique in the image processing. In fields like medical imaging, detection of objects, document analysis and in OCR preprocessing, thresholding are applied to process the image. Selection of the suitable techniques are important.

Earlier for every technique we have to write a separate code and perform these operations manually, which is time consuming and involves human effort. To address these challenges a GUI Application tool is developed. Using this tool various preprocessing techniques and thresholding can be tested and checked quickly.

There is no single thresholding method which is suitable for processing all images. Depending on the characteristics of the image like non uniform lighting, noise, fading texts and other issues, different preprocessing techniques and thresholding methods are used. To test them we have to code for individual requirements which requires a lot of coding work and time consuming.

This study overcomes these difficulties by developing a tool where we can load an image then apply different preprocessing and thresholding techniques quickly and identify the suitable techniques

for a particular image. Metrics like Mean Squared Error, Peak Signal Noise Ratio, Structural Similarity Index (SSIM) are also displayed. Processed Image can be also saved to a local folder. In this starting version limited filters and Binary strategies are included.

## 2. LITERATURE REVIEW

Processing a Palm leaf manuscript image requires different preprocessing like denoising, filtering and thresholding methods from standard global methods to advanced adaptive and hybrid methods applied. There are works related to the application of different techniques for processing to obtain text visible good image output.

### 2.1. Preprocessing with denoising, Illumination and Filtering

Pattnaik et al[1] address the non uniform lighting issue in two stages, initially they estimate the illumination surface using Multiple linear Regression method then they achieve uniform lighting and then Otsu's global thresholding is applied. This method is tested on different images with different shades. Six types of binarization are checked and this approach scores better than the other approaches. The output is also validated by qualitative and quantitative measures.

Alexander et al. [2] use anisotropic bilateral filtering which removes noise while maintaining the edges then Otsu's Global threshold is applied. The authors achieve good PSNR and MSE metrics.

Unnikrishnan [8] et al discuss about physical damages and application of denoising and binarization by combining Gaussian filter, CLAHE (Contrast limited Adaptive Histogram Equalization) and Sauvola technique and Edge Validation. Punch hole mark removal is also applied with circular Contour Analysis. This study discussed about results of various binarization applied to the image and result is backed by quantitative metrics. This work concentrates on complete noise removal from the image.

## 2.2. Thresholding Approaches

Shoba Rani et al. [5] introduce three levels of degradation removal. A pre and post enhancement processing and application of global thresholding. Main focus is on faint text. Initially image is divided into RGB color channels and arithmetic process is done and multi thresholding are used here. Palm leaf Manuscript and DIBCO documents are tested here. Results achieved with readable text to an extent.

Abdul Rehman and Haroon [7] focus on image segmentation achieved by thresholding and edge detection and compare them. Adaptive Gaussian Thresholding is applied to images with non uniform illumination and results are good. It can be used in medical images like identification of cancer in an image where every pixel is important. Canny edge detection is also applied here where it can be used for recognizing cracks.

I. Yuadi, I., Yudistira, N., Habiddin, & Nisa, K. [4] This study includes five image processing methods to three Javanese manuscripts Gaussian blur, Adaptive Thresholding, Canny Edge detection, Sobel and Morph algorithms. SSIM (Structural Similarity Index measure, Normalized Cross Corelation (NCC) are used to compare the original and enhanced images. This study discussed that Gaussian Blur can be combined with Adaptive Thresholding and morphological operations applied to the manuscript. The framework enhances the readability of manuscripts.

Now recent studies involve neural architecture for processing the image.

Paulus et al. [10] This work has a Convolutional Autoencoder for separating foreground text from background. It has an encoder to compress the image and decoder to reconstruct the image. It uses several Convolution layers with skip connections. The image is treated as small segments for processing. Five parameters like window size, number of convolution layer, kernel size, filters and encoder decoder are used in this paper to achieve the results.

Maheswari et al. [3] In their study they handle the punch hole in a manuscript image in a way that it is identified as a noise. Median filtering is used along with Sauvola thresholding for handling non uniform illumination. Segmentation also used here to achieve good accuracy. A modified CNN is used to identify characters.

Periyasamy et al. [6] used Gaussian Filtering to reduce noise and Sauvola 's Adaptive local threshold

handled binarization. This study achieves good accuracy. CNN with ResTANet is used here. It recognizes character but if characters are continuous which cannot be segmented by ResTANet. Damaged manuscript is handled.

Goyal S [9] et al, removed noise while maintaining the edges. It used a hybrid binarization. It used Nonlinear filter for removing noise. Threshold selection is done by using fuzzy logic. The performance is tested with different type of images. A detailed comparison study done to support the performance of this method.

## 2.3. Summary

The reviewed literatures detailed preprocessing steps like denoising, filtering, Illumination, then classical thresholding, hybrid processing and Global thresholding. For each preprocessing and thresholding, all techniques are to be coded and tested for output. Depending up on the characteristics of the image, each issue in the image needs to be handled correctly, there are lot of techniques available which are to be considered and a code to be developed. Which takes more time and human effort.

A GUI application was created which include a set preprocessing and thresholding techniques along with metrics. In this application manuscript image can be loaded and different techniques are tested and viewed quickly.

## 2.4. Research Gaps and Limitations

The gap in this study

- lack of research addressing Grantha Palm leaf manuscripts which are limited.
- Palm leaf manuscript specific damages, issues in the manuscript image are not listed.
- Difficult to apply Generalization in this field. Obstacle for new researchers.

## 3. METHODOLOGY

This application follows below steps approach

- Step-1. Initially the image is loaded and converted to grayscale. CLAHE can be checked or unchecked enhancing the visibility of the loaded image.
- Step-2. In this stage four noise filters are available Gaussian, Non Local Means, Median and Bilateral
- Step -3 Canny Edge Validation is applied to the output as required.
- Step- 4 Hybrid (Otsu + Sauvola), Otsu, Sauvola, Niblack and Adaptive Gaussian are listed and the required method can be selected

This study developed a GUI Manuscript Application to process Grantha palm leaf manuscript images with different techniques by selecting and applying them. Result can be viewed and saved.

In the GUI Manuscript Application tool an image of palm leaf manuscript can be loaded using the button load.

### 3.1. Metrics Used

Metrics used are [12] Mean Squared Error MSE) computes mean squared error between two images. Peak Signal Noise Ratio (PSNR) computes a peak signal noise ratio for an image. Structural Similarity Index calculates structural similarity index between images.

### 3.2. Thresholding

Thresholding [13][14][15][16], A process to create a binary image from grayscale image.

Adaptive Thresholding Here the threshold for a pixel based on a small region around is obtained, so we get different thresholds for different regions of the same image which gives better result.

Otsu chooses the threshold value automatically. Niblack and Sauvola are local thresholding techniques used for images where background is non uniform. It uses several threshold for every pixel by using a formula.

Hybrid thresholding combines both Otsu and Sauvola thresholding methods.

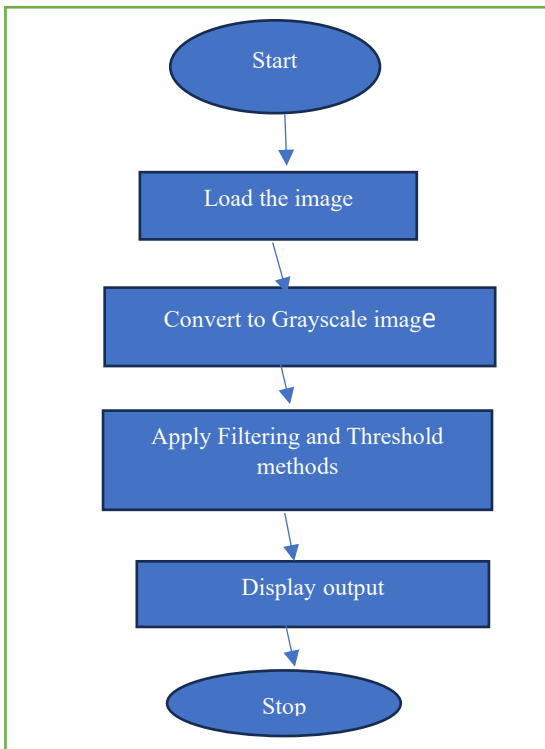


Fig. 1. Processing of the Application

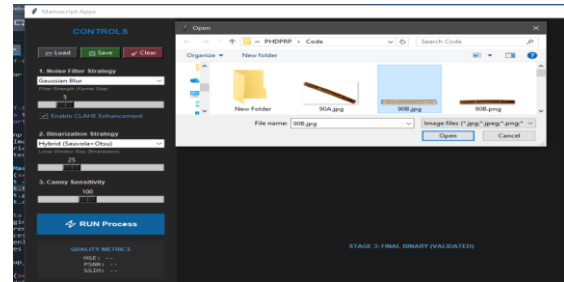


Fig.2. image is loaded

After loading the image, required values for noise filter, CLAHE enhancement, binarization method, canny sensitivity is selected accordingly. Run process button clicked to start the processing. After completion the original image, grayscale image and output image are displayed.

The output image is enlarged when a user clicks the image. The displayed enlarged image can be checked.

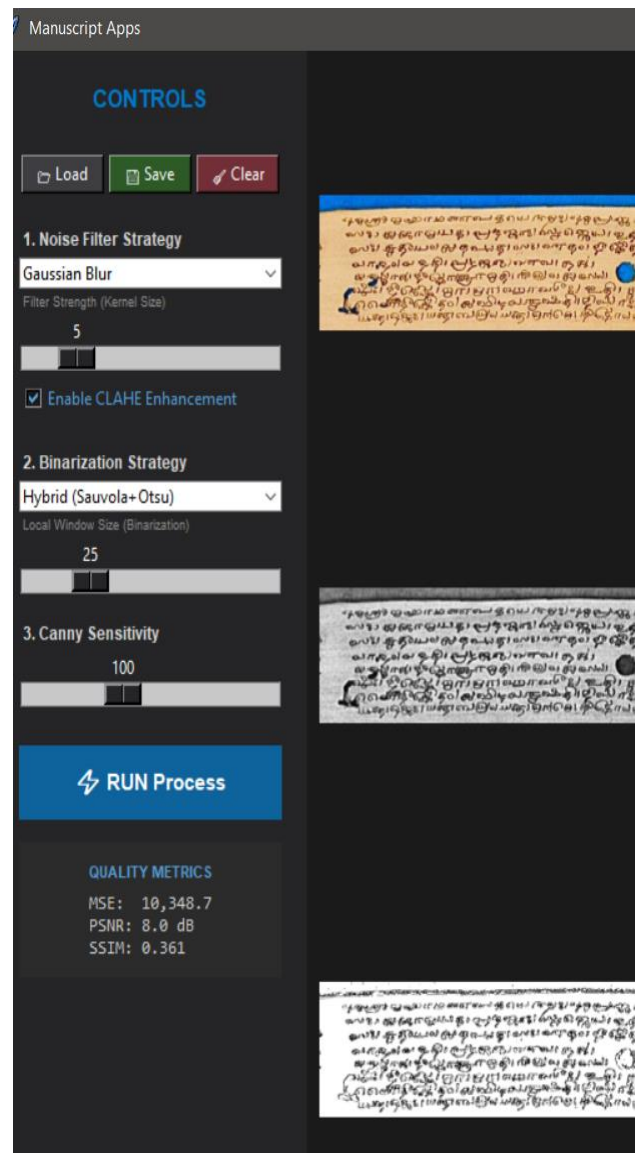


Fig. 3. Output after processing

Restore All views restore the original image, Grayscale image and output image.

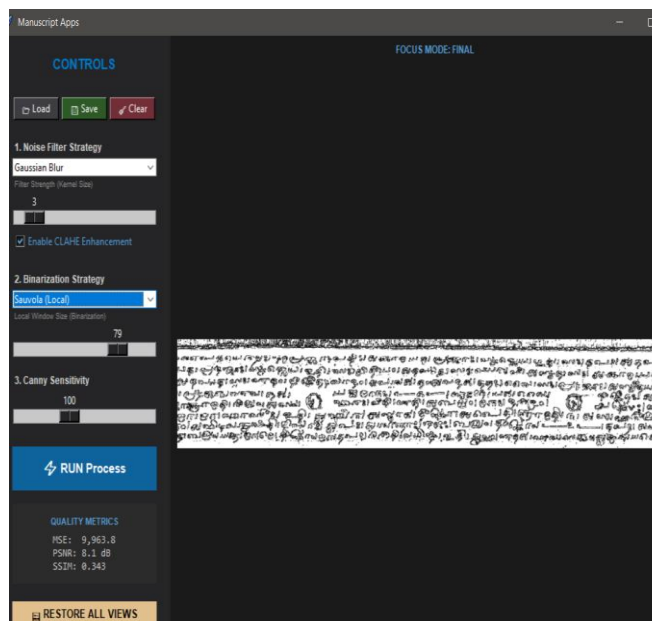


Fig. 4. Enlarging of the output

Save button saves the output image to a selected local folder. Metrics displayed.

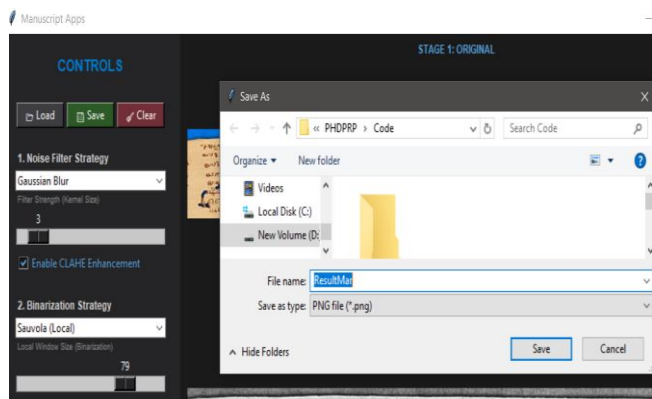


Fig. 5. saving the output

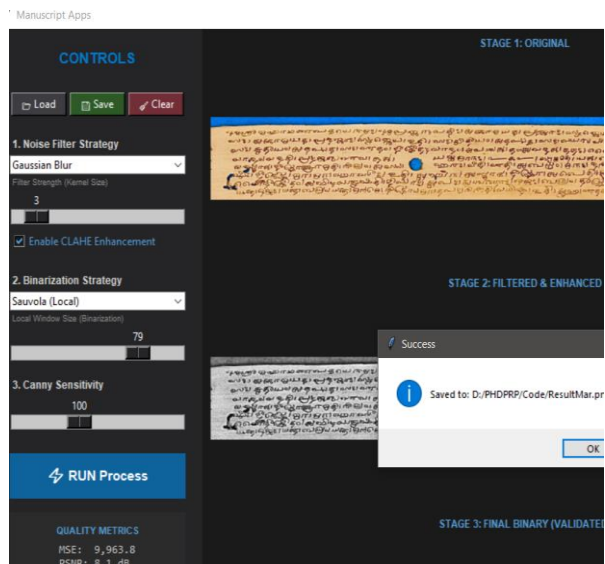


Fig. 6. Clear button clears the screen

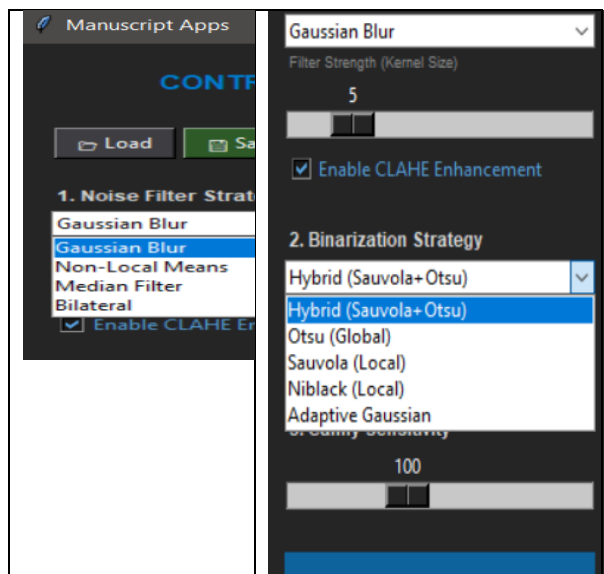


Fig. 7. Noise Filtering and Binarization available

### 3.3. Details of Software Used

Python 3.x Libraries - OpenCV, Tkinter, Scikit-Image, PIL are used.

Enlarged Output, Metrics Calculation are also displayed

### 3.4. Testing

The blow palm leaf manuscript is loaded and processed with the application with values for, Noise Filter- Gaussian Blur, CLAHE - enabled local window size - 40 and Canny Sensitivity -100. Output displayed along with the metrics values.

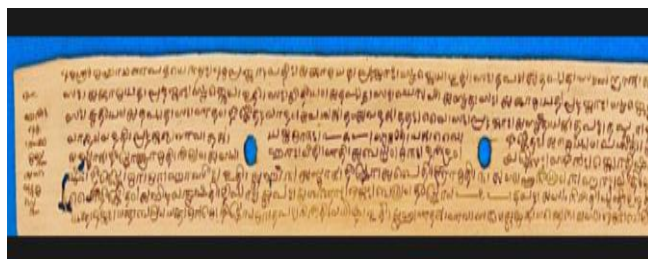


Fig. 8. Image used for testing. [11]

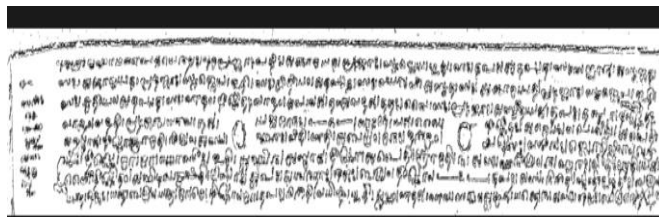


Fig. 9. processed output image

Table 1. Resultant metrics

	<b>Binarization</b>	<b>MSE</b>	<b>PSNR</b>	<b>SSIM</b>
1	Hybrid (Sauvola + Otsu)	10,414.8	8.0 dB	0.346
2	Otsu(Global)	10,226.2	8.0dB	0.313
3	Sauvola	10,761.7	7.8dB	0.328
4	Niblack	11,523.0	7.5dB	0.263
5	Adaptive Gaussian	12,646.4	7.1dB	0.167

#### 4. RESULTS

The application combines preprocessing with binarization strategy to apply, different values can be chosen and tested efficiently. Output image is also displayed and it can be analyzed.

The application also includes quantitative feedback of PSNR (Peak Signal to Noise Ratio) and SSIM (Structural Similarity Index) and Mean Squared Error (MSE) values.

Visual Inspection also needed for verification of the output.

#### 5. CONCLUSION AND FUTURE WORKS

Manuscript processing application tool integrates the Preprocessing techniques for noise removal with thresholding methods. Then thresholding are applied to display an output which can be saved and it is going to be an input of OCR (Optical Character Recognition).

Instead of a slider for adjusting Canny sensitivity automatic calculation can be added. As required some more methods can be included in the list. This tool speeds up the image processing. This work can be integrated with Deep learning, OCR (Optical Character Recognition). OCR can be also used to proceed further with text extraction and identification successfully.

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### **Palm leaf used for Testing**

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