Multispectral Image Enhancement of Historical Document Images

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***Abstract*: The culture and heritage in our country is preserved through various traditions and customs in daily life. There are certain aspects in our daily life that we maintain through written transcriptions which is carried to future generations. The degradations can be removed and further enhanced through some operations. In this paper, the morphological operations such as dilation and closing are carried out in order to enhance the noise and increase the contrast of the images. Morphological opening operation is applied to compensate for non uniform background intensity and suppress bright details smaller than the structural element, while closing suppresses the dark details**

Keywords: Opening, closing, binarization, multispectral imaging, image fusion.

1. INTRODUCTION

Historical documents are that documents which contains information about person, place.A collection of rare books and manuscripts, including early copies of works by Aristotle, Dante, Euclid, Homer, and Virgil, are available in the Vatican Library in Rome. A beautiful work on medicine, religion and science written by the scholars, called Vedas, is preserved in India. The histories of civilizations are stored in libraries and museums. Around the world, there is a treasure of excellent literature, which cannot be accessed by most of the people in the world because of time and travel cost. By improving access to scientific, educational and historical documents and information, digital libraries can create powerful opportunities for revamping education, improving knowledge and providing historical background..

In India, it is approximately estimated that more than 5 million of documents/manuscripts are available and uncountable inscriptions, documents are spread across the country in form of stone carving, metal inscriptions, palm leaf manuscripts, clothes and paper scripts. Many organizations are working to find, record, preserve and deliver these to connect India's past with its future, its memory with its aspirations. As these documents are degraded in nature, digitization process alone is not sufficient. Hence, it is very important to develop suitable algorithm to enhance these documents for deciphering. It is observed that from the literature survey, many authors have presented a lot of work in the enhancement of the degraded documents using various methods.

Figure.1 Example of Historical document images

In recent years, multispectral (MS) imaging has established its usefulness in several fields such as remote sensing, geo observation, etc .MS imaging is a non-destructive optical analysis technique with the advantage that it can extract information from cultural heritage patterns that conventional color photography cannot. In addition to visible light (blue, green, red), MS imaging uses the ultraviolet (UV) and near infrared (NIR) light ranges to distinguish and recognize material, to enhance the visibility of latent patterns in a palimpsest, and to detect signs of degradation in historical documents.

2. LITERATURE SURVEY

The need for efficient image restoration methods have grown with the massive production of digital images of all kinds, often taken in poor conditions. Even though good cameras are available, images may not be in a condition to directly use for the analysis. From the literature survey, it is observed that, there are several techniques like medianfilter, Gaussian filter for noise suppression are available. However, the techniques effectively suppress the noise but fail to preserve many useful details.

[1]In this paper the old degraded historical documents carry various important information regarding our culture, economics etc. Proper restoration of these documents is very necessary. They proposed a novel approach to enhance ancient historical documents. To enhance these digital format documents a two way approach is

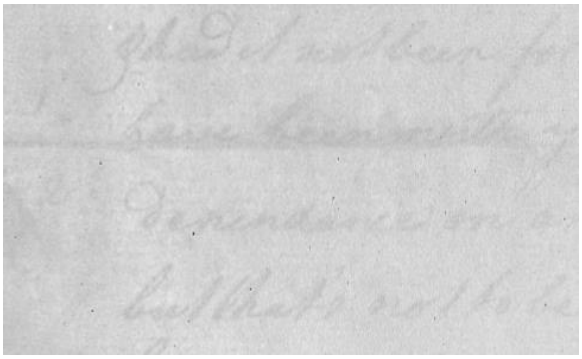
considered. At first Particle Swarm Optimization (PSO) and bilateral filter is applied. At second level Non-Linear Enhancement with bilateral filter is applied. Both the approaches are then tested visually and quantitively to show the effectiveness of the approach.

[2]In this paper K. Shirai (2013) presented a method which performs anisotropic morphological dilation via implicit smoothing for the purpose of restoring the degraded character shapes of binarized images. Exploiting the idea of geodesic morphology that the binary image and its distance transformed image are interconvertible, they applied a smoothing method not to the binary image but to the distance transformed image, and then reconvert it by binarization. This allows us to apply conventional smoothing methods for continuous intensity, i.e., gray scale, images to the discrete intensity, i.e., binary, image implicitly. For instance, by using anisotropic diffusion together with geodesic dilation, anisotropic dilation along the stroke direction is obtained and brings better results.

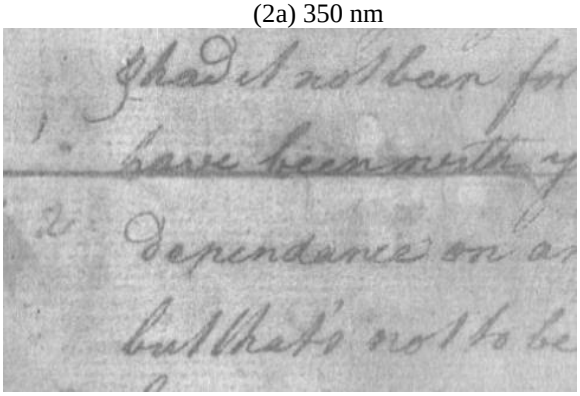
3. PROPOSED WORK

A multispectral camera Chroma CX3 C1600E, equipped with a monochrome CCD (Charge Coupled Device), a 35 mm lens and a 6-filter wheel, is used to acquire images in different spectral bands (infrared, visible, ultraviolet). Using different filters allows to capture a gray-level image for each band by selecting a different wavelength range of the spectrum. An infrared filter (IR) selects the band with wavelengths between 720 nm and 880 nm, while the visible spectrum is covered by three filters(Red, Green, Blue). Each RGB channel is digitized separately, so the colorimetric accuracy is greater than the one obtained by three-channel devices . While IR and RGB images are acquired by reflectography, the ultraviolet (UV) wavelengths are acquired by fluorescence of UV light, in the range 350 – 400 nm, using a Wood lamp. In this latter case the acquisition is performed without the use of filters. The infrared and ultraviolet imaging can reveal details undetectable through common RGB capture. In multispectral images of an ancient manuscript affected by degradations are shown. The diversity of information spread across the different channels is apparent.

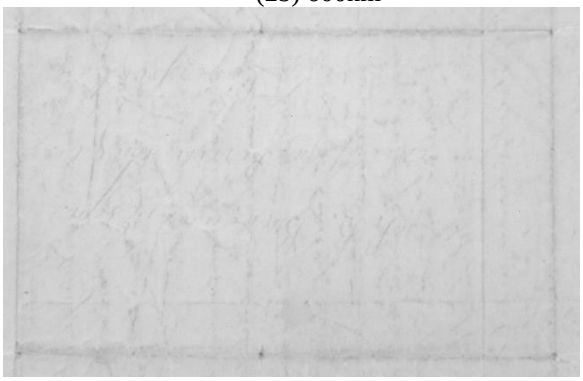
The binarization process separates foreground text from background. If the histogram of the image is bimodal or sparsely distributed, then binarization process separates text from background. Degraded historical document as poses low contrast and noise accumulation. It will be difficult to separate text from background using simple thresholding technique. The result of thresholding using Otsu
method. Histogram equalization will be used in contrast stretching for low contrast images. There are two types of histogram equalization, one global and other local. Global histogram can be used to enhance the contrast of the image by computing single histogram and redistributing the intensities across the image. This works better for low contrast image with fairly uniform background. Adaptive Histogram Equalization (AHE) is used to overcome uneven background and illumination and uses local histograms for each sub image, unlike global histogram equalization



(2a) 350 nm



(2b) 600nm



(2c)1100nm

Figure 2. Examples of various wavelengths

At this step, we obtain a rough estimation of foreground (text) regions. Our intention is to proceed to an initial segmentation of foreground and background regions that will provide us a superset of the correct set of foreground pixels.

Sauvola approach for adaptive thresholding using $k = 0.2$, is suitable for this case . At this step, we process image $I(x, y)$ in order to extract the binary image $S(x, y)$, where 1's correspond to the rough estimated foreground regions.

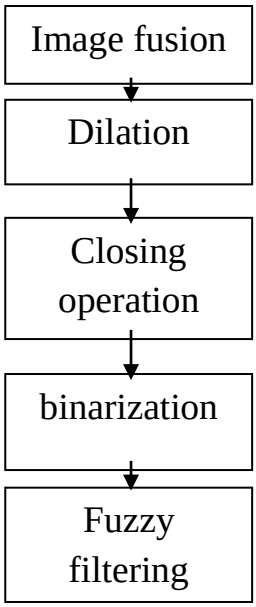


Figure 3. block diagram of proposed system

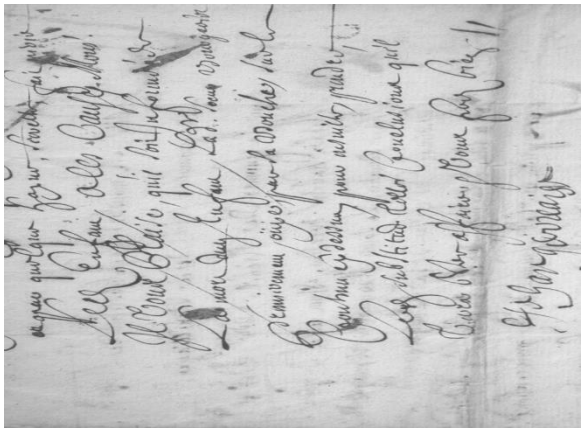
Image-processing techniques such as digital multimedia and computer vision have been developed tremendously during the past five decades and among them, mathematical morphology has received a great interest because it provides a quantitative description of geometric structure and shape as well as a mathematical description of algebra, topology, probability, and integral geometry. Mathematical Morphology is a tool used for extracting image components that are useful for representation and description of region of shape, such as boundaries, skeletons and the convex hull. It can also be used as a tool for pre or post processing such as, morphological filtering, thinning, and pruning [Rafael C Gonzalez 2008]. It is a set-theoretic method of image analysis providing a quantitative description of geometrical structures. Most morphological operations are based on simple expanding and shrinking operations. The primary application of morphology occurs in binary images, though it is also used ongray level images. It can also be useful on range images.

The two basic morphological set transformations are erosion and dilation. These transformations involve the interaction between an image *A* (the object of interest) and a structuring set *B*, called the structuring element. Typically the structuring element *B* is a circular disc or rectangle in the plane, but it can be of any shape and any dimension.

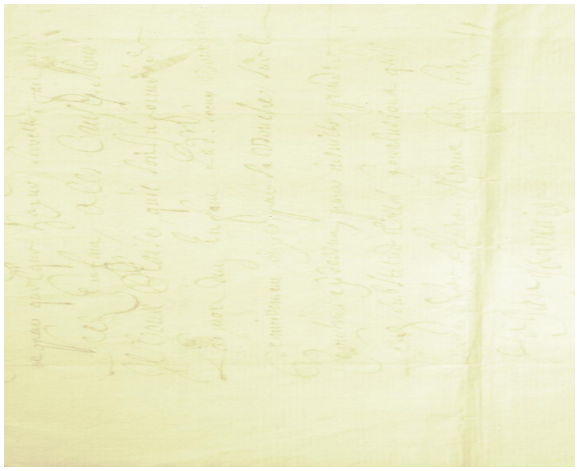
Opening and Closing**:** Erosion and dilation can be used in a variety of ways, in parallel and series, to give other transformations including thickening, thinning, skeletonization and many others. Two very important transformations are opening and closing. Opening generally smoothes contour in an image, breaking narrow isthmuses and eliminating thin protrusions. Closing tends to narrow smooth sections of contours, fusing narrow breaks and long thin gulfs, eliminating small holes, and filling gaps in contours. Opening operation smooth the object from the outside. Holes are filled in and narrow valleys are closed in closing operation. Because opening suppresses the bright details smaller than the structuring element and closing suppress dark details, they are used in combination for image smoothing and noise removal. Opening can be used to compensate for non uniform background illumination. Also subtracting opened image from Original image produces even background [Rafael C Gonzalez 2008].

4. RESULTS AND DISCUSSION

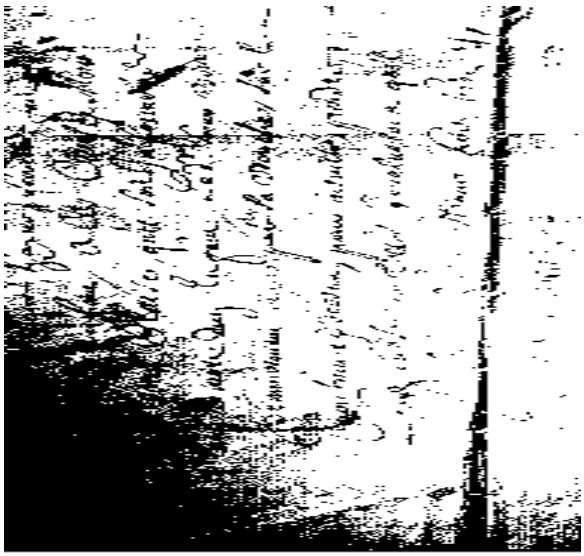
From the simulated plot of spectral signatures for different patterns obtained above, the comparison can be easily done for the different ink patterns, interference and degradations. Then the fusion for the degraded images are done based on the correction process and further enhanced using morphological operations and fuzzy filters.



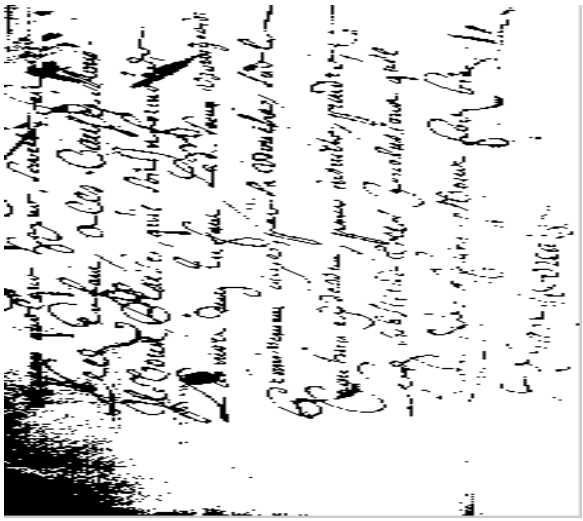
(4a) foreground extraction



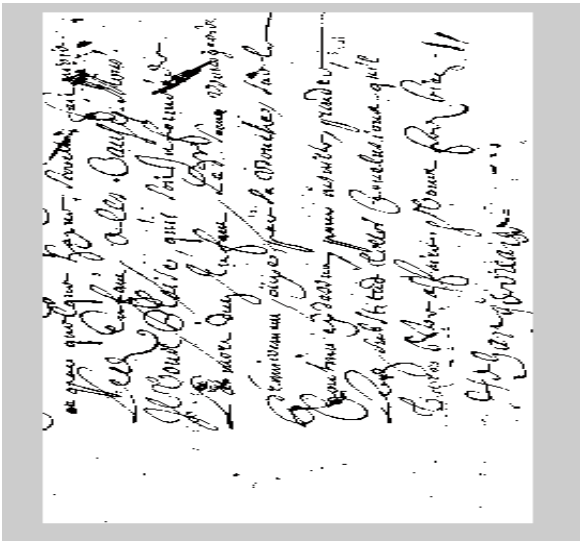
(4b) background extraction



(4c) Otsu method



(4d) niblack method



(4e) Proposed method

5. CONCLUSION

Simple and efficient method for enhancement of degraded historical document has been proposed. This method enhances the degraded document image mathematical morphological operations that are developed to quantitatively describe the shape and size of images. The proposed method uses adaptive histogram equalization for contrast enhancement followed by morphological operations as these are simple and powerful tool to eliminate noise, remove background and produce an enhanced image with pure foreground contents. The proposed method involves the image fusion, morphological operation and binarization produces the enhanced image with less noise and increased contrast

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