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**International Journal of Computer Science and Mobile Computing**

**A Monthly Journal of Computer Science and Information Technology**

**ISSN 2320–088X**

***IJCSMC, Vol. 4, Issue. 6, June 2015, pg.354 – 360***

**RESEARCH ARTICLE**

# Height Map Construction for Ancient Palm Leaf

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***Abstract— Conservation and spread of archaeological material has always been a key challenge. With the most recent headway in innovation, digitalization is currently used to preserve these antiquated documents. The primary goal of the work is to build up a productive image processing framework that could be utilized to retrieve knowledge. The proposed model comprises of two stages: 1) Image binarization 2) Height Map. In Image binarization step we propose hybrid binarization method which involves in segmentation of background and foreground of digitalized ancient document. Output of hybrid binarization step is processed using median filter to improve the performance of hybrid binarization method. Height Map construction step is involved in ascertaining pixel information that would create a shadow in the material. Thus a bump is generated. In the proposed model we integrate image binarization method and construction of height map as an application that could provide a platform to study ancient documents in a digital format, effectively and efficiently.***

***Keywords— Image binarization, Image Filtering, Height Map or Surface Elevation***

## I. INTRODUCTION

The study of ancient inscription, artefacts and monuments is the science of distinguishing clearing up their implications, arranging their uses as indicated by dates and cultural contexts. There are numerous conventional techniques to protect all these artefacts. On the other hand, such material is housed in historical centres, libraries, and establishments around the world, something that fundamentally foils their accessibility. Technology, 2D pictures, and electronic databases have endeavoured to overcome the limitations.

The digital images of archaeological materials been captured requires automatic processing and enhancement. A key venture in all document image processing work processes is binarization. A binary image is a digital image that has just two conceivable values for each pixel. Normally the two colours used for a binary image are black and white; however any two colours can be utilized. The colour used for the object(s) in the image is the foreground colour while the rest of the image is the background colour. Document image binarization is of incredible significance in the document image investigation and distinguishment pipeline since it influences further phases of the distinguishment process. A height map or height field is a raster image used to display surface elevation. A height map can be used in bump mapping to compute where this data would create shadow in a material.

In this undertaking we are planning to incorporate image binarization and construction of height map as a solitary application that could give a stage to study ancient artefacts and preserve it in a digital format, adequately and efficiently.

 

Numerous studies have been done to take care of the issues that emerge in the binarization of old document pictures portrayed by numerous sorts of degradation including blurred ink, drain through, show-through, uneven illumination, variations in image contrast. To the best of our insight, none of the proposed systems can manage a wide range of documents and degradation. The few straightforward accessible thresholding systems can't be applied to numerous binarization issues. Keeping in mind the end goal to enhance the nature of historical document images, we propose a joined methodology taking into account global and local thresholding methods and filtering technique that could manage with all kind of documents and degradations.

Binarization plays a key role in degraded document processing. Its execution influences successfully in the level of achievement in character segmentation and recognition. At the point when processing degraded document images, binarization is not a simple undertaking actually; image binarization alludes to the conversion of a gray-scale image into a binary image. It is the beginning venture of most document image analysis. Usually, it distinguishes text areas from background areas, so it is used as a text locating technique. Predominantly, degradations show up habitually and may happen because of a few reasons, for example, the presence of variable background intensity caused by non-uniform intensity, strains, shadow impacts and low contrast. A height map development is by and large used to build surface elevation for territories.

A height map is used in bump mapping to calculate where this data would create shadow in a material. In this system a network of light sources lights up the material from an arrangement of known lighting direction. The proposed system utilizes a shape-from-shading system to recreate in 3D the shape of the inscribed surfaces.

Here we integrate Image Binarization method and surface elevation as a single application that could provide a platform for an archaeologist to study ancient artefacts and preserve it in a digital format, effectively and efficiently. And there is no one platform that could generate a surface elevation on ancient digitalized images for the study of archaeological materials.

## II. RELATED WORKS

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### *A. Image Binarization*

Distinctive methods for binarization are studied and applied to the images of degraded documents to get the binary image. These binary images are then applied to OCR to study the efficiency of each of the binarization techniques. In an OCR, one of the principle handling stages is binarization of document images, i.e. separation of foreground from background. Binarization of a text image ought to issue us, in a perfect case, the foreground text in black and noisy background in white. In spite of the fact that diverse thresholding techniques as of now exist in literature, they don't give immaculate results for a wide range of documents. A few calculations may work better for one kind of documents where there are marks of strain while they may give poor results for different sorts where there are to a great degree of low intensity variations. Different binarization methods have been assessed in for different types of documents presents an evaluation of eleven locally adaptive binarization methods for gray-scale images with low contrast, variable background intensity and noise. In that assessment, Niblack's system was discovered to be the better of every one of them. Distinctive enhancements have following been made to the first Niblack strategy to enhance the outcomes, one of these incorporate Sauvolas calculation. The binarization calculations that are applied here for contrasting the outcomes and that of the proposed system are Otsu's strategy, Niblack's Method and Sauvola's Method. Segmentation is made as the first stride in image analysis. The design is to subdivide an image into significant areas which don't overlap, which can be utilized for further analysis. In general, autonomous segmentation is one of the hardest issues in advanced digital image processing. All the image segmentation methods assume that:

1. The intensity values are different in different regions.
2. Inside every locale, this represents the corresponding object in a scene, the intensity values are comparative.

The binarization techniques for gray scale documents can be grouped into two general classifications: global thresholding binarization and local thresholding binarization. Global methods find a single threshold value for the whole document. Then each pixel is assigned to page foreground or background based on its gray value comparing with the threshold value. Global methods are quick and they give good results for scanned documents. For a long time, the binarization of a grayscale document was based on the global thresholding statistical calculations. These measurable systems, which can be considered as grouping methodologies, are unseemly for complex documents, and for degraded documents. On the off chance that the light over the document is not uniform in global binarization methods which have a tendency to deliver marginal noise along the page borders. To beat these complexities, local thresholding techniques have been proposed for document binarization [3]. These strategies gauge an alternate threshold for every pixel as per the gray scale data of the neighbouring pixels.

### *B. Height Map construction on Ancient Artefacts*

In archaeology a crucial field of research is the study of antiquated engravings. A few inquiries that archaeologists are called to answer relate to the dating of the engravings, the endeavour to recognize the spot of root, and the analysis of the lettering procedures. So far the system that has been ordinarily utilized for the study of engraved pieces is the accompanying: the

 

archaeologists utilize an extraordinary sort of saturated paper (crush) which they push on the inscribed surface using a brush uniquely adjusted for the purpose. At the point when the letters are formed on the crushed paper, the archaeologists let it dry, making that way an impression of the engraving. This is a sort of filter paper got from research facility suppliers and it may change in thickness. A more slender paper needs less taking a shot at the stone, yet may deteriorate all the more effectively. Other media have been likewise utilized as a part of literature for this purpose, for example latex, or fluid elastic, whose properties are examined in. By utilizing the above system, vast accumulations of crushes have been made, including presses of engravings that are presently lost, that can be discovered and studied over in different libraries and organizations far and wide. In spite of the fact that crushes are duplicates of engraved surfaces, there are a few issues that may climb amid their utilization. First and foremost, their availability is still restricted; archaeologists need to go with a specific end goal to study a variety of presses. Their conservation likewise constitutes an issue in that collapsing and unfolding them a few times may bring about their disintegration. The previously stated issues have driven us to search for a strategy to store and protect presses all the more proficiently and make them likewise more open to archaeologist and epigraphists.

## III. SYSTEM DESIGN

The steps involved in proposed system:

1. An image of an ancient palm leaf is captured with a Digital SLR Camera. This image is taken as an input to our project.
2. If required, certain area of an image is selected and cropped. This image is converted into gray scale by calculating the pixel (RGB) value, finding the average and replacing this average value to the original pixel (RGB).
3. Input RGB image can be directly made used to construct height map or surface elevation.
4. To improve the robustness, the image is pre-processed through image binarization technique.
5. The gray scale image obtained can be converted into binarized image as an output.
6. A hybrid approach i.e, global method and local method can be implemented to obtain binarized image.
7. Filters are used to eliminate the noise for more robustness.
8. Finally image is binarized.
9. This binarized image further can be made used to construct surface elevation.

The flow chart of proposed framework is shown in Figure 1- Describes flow of framework how a degraded document is digitalized into image binarization and construction of surface elevation.

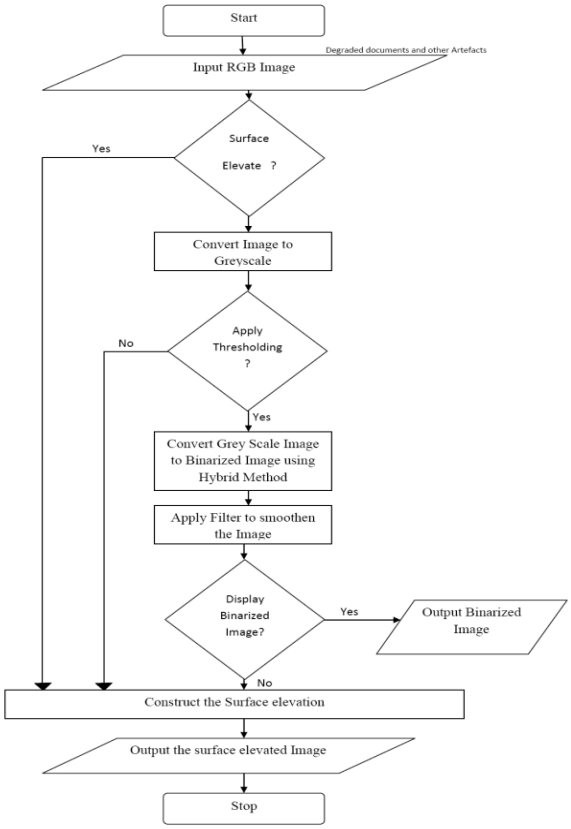


Figure 1: Flowchart of proposed framework

 

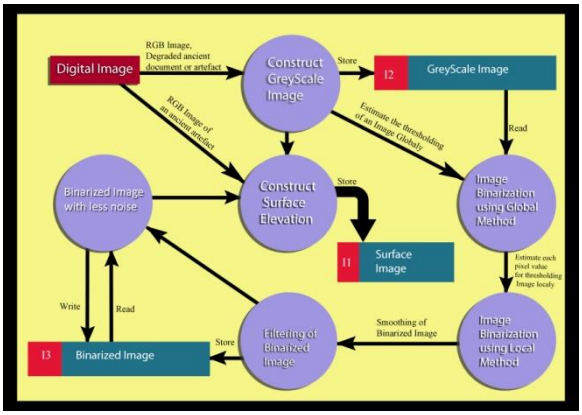


Figure 2: Data flow Diagram of proposed framework

*A. Image Binarization*

Robust binarization gives the likelihood of a right extraction of the portrayed line drawing or text from its background. For the binarization of images numerous calculations have been implemented.

Thresholding is a sufficiently accurate and high processing speed segmentation approach to monochrome image. This paper portrays an adjusted consistent thresholding technique for binarization of degraded and very poor quality gray-scale document images. This technique can manage complex signal dependent noise and variable background intensity caused by non-uniform illumination, shadow, smear or smudge and very low contrast images. The outcome binary image [6] has no obvious loss of useful information.

We propose a modified logical thresholding method to extract the binary image adaptively from the degraded gray-scale document image with complex and inhomogeneous background. It can adjust the size of the local area and logical thresholding level adaptively [4][5] according to the local run-length histogram and the local gray-scale in-homogeneity.

1) *Global Binarization:*

The simplest implementation of thresholding is to choose an intensity value as a threshold level and the values below this threshold become 0 (black) and the values above this threshold become 1 (white).

Otsu's [1] method is the most successful global thresholding method. It automatically performs histogram shape-based image thresholding for the reduction of a gray-level image to a binary image. The algorithm assumes that the image for thresholding contains two classes of pixels (e.g., foreground and background) and then calculates the optimum threshold separating those two classes so that their combined spread (intra-class variance) is minimal. It exhaustively searches for the threshold that minimizes the intra-class variance, defined as the weighted sum of variances of the two classes.

Steps involved in Otsu Global Method:

Step1: Calculate Weight ($M_b$), Mean ($\mu_b$), Variance ($V^2_b$) :Background of Grey Scale Image.

Step2: Calculate Weight ($M_f$), Mean ($\mu_f$), Variance ($V^2_f$) :Foreground of Grey Scale Image.

Step3: Calculate Within Class Variance (White)

$(V^2_W) = (M_b)(V^2_b) + (M_f)(V^2_f)$

Step4: Calculate Between Class Variance (Black)

$(V^2_B) = M_b M_f (\mu_b - \mu_f)^2$

The output of global method is given as input to local thresholding technique.

2) *Local Binarization:*

Modified Niblack's [2] algorithm is based on the threshold over the image by using local mean value, "*m*" and the standard deviation, "*s*", of gray level in a small neighbourhood or window of each pixel. A threshold for each pixel can be calculated from

$T(x,y) = m(x,y) + s(x,y)$

where T(x,y) is the threshold value for pixel at (x,y), m(x,y) and s(x,y) are the mean and standard deviation of the neighbourhood of (x,y).

 

Once the image is binarized using global method and local method [3], the resultant of the hybrid technique is subjected to filtering to remove noise. Median filter [7] removes unwanted pixels from the image and smoothens the binarized image. Filtering [8] improves the performance of hybrid binarization method.

Smoothened binarized image can be used to construct the surface elevation or a bump on the image. In the proposed framework surface elevation can be constructed to any kind of image. RGB image can be used to construct surface elevation; binarized image can also be used to construct surface elevation.
Framework helps to store the document in digital format and improves the readability of ancient document for an archaeologist.

*B. Height Map Construction*

Surface remaking utilizing photometric stereo methods has been considered broadly in PC vision literature. In those routines the data of a 3D surface [9] is recuperated by utilizing an arrangement of fix-postured pictures of the subject taken under diverse known brightening conditions. The impediment of the previously stated strategies lies in the way that the outcomes rely on upon the Bidirectional Reflectance Distribution Function of surface's material. For example, non-Lambertian surfaces with specularities oblige an extensive number of obtained images so as to prompt reasonable results. In our application the portrayed subject is a paper crush, whose specular segment is approximately zero and in this manner its BRDF [10][11] can be well spoken to by the diffusive parameter of the reflectance model In this way, precise results can be gotten by applying a shape-from-shading strategy utilizing just two filtered pictures of every press, which are sufficient to recreate the obscure parameters in this reflectance model.

A height map is used in bump mapping to calculate where this data would create shadow in a material.
Steps involved in construction of Surface elevation:
Step1: Taking a pixel on one side of the center, and subtracting one of the other sides from it.
Step2: Pixels can get either a positive or a negative result.
Step3: To use the negative pixels as shadow Positive ones as light, for a bump map.
Step4: A bias of 128 is added to the image.

## IV. EXPERIMENTAL RESULTS

The proposed model can handle almost all kind of degraded ancient documents and other artefacts. The results of experiments are as shown.

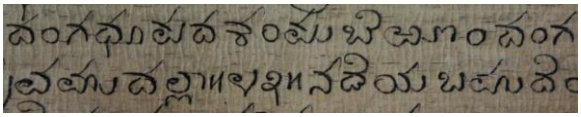

Figure 3- Original Image

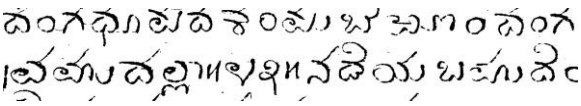

Figure 4- Binarized Image using Hybrid Method

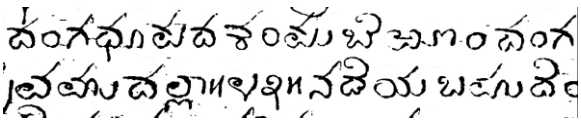

Figure 5- Image Filtering

 

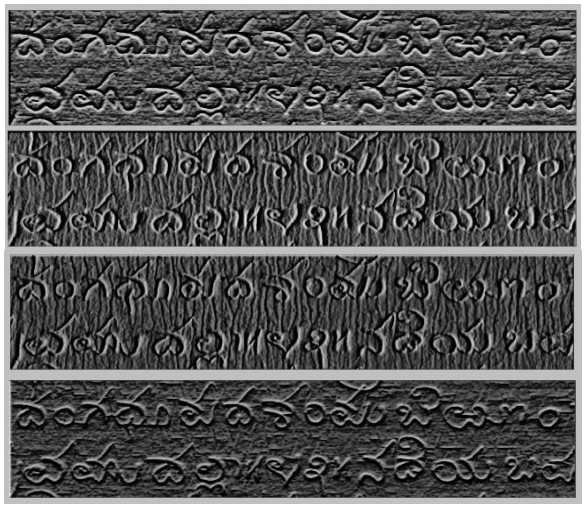

Figure 6- Bidirectional Reflectance: Height Map Construction for Original Image

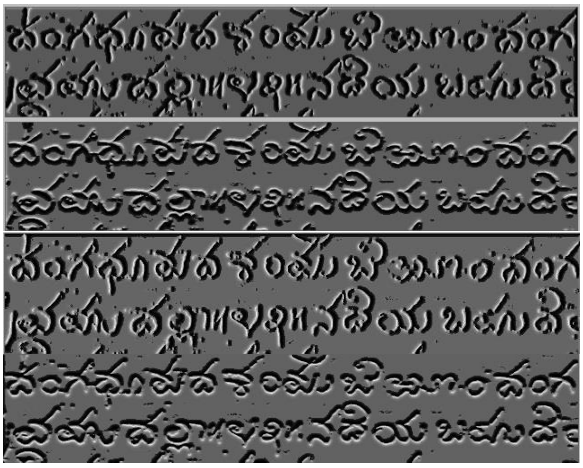

Figure 7- Bidirectional Reflectance: Height Map Construction for Binarized Image

## V. CONCLUSION

The few simple available thresholding methods cannot be applied to many binarization problems. In order to improve the quality of historical document images, we propose a combined approach based on global and local thresholding methods and edge detection technique that could deal with all kind of documents and degradations. A heightmap construction is generally used to construct surface elevation for terrains. Here we integrate these two methods as a single application that could provide a platform for an archaeologist to study ancient artifacts and preserve it in a digital format, effectively and efficiently.

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