Volume 3, Issue 5, May 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Object Extraction and Boundary Tracing Algorithms for Digital Image Processing: Comparative Analysis: A Review

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Abstract- Adaptive Histogram Equalization and Edge detection techniques for particle analysis, a comparative study have been shown and a new algorithm is proposed for removing the problem of non-uniform background illumination in biological images such as visualizing and estimation of growth of a fungus in a particular sample to transform the input image to its indexed form with maximum accuracy involving morphological openings and structuring element design using Morphological Opening. For applications, including particles/objects to be studied or analyzed, these techniques give faulty results due to changes in actual shapes and sizes of the particles in the resulting image. Morphology is related to the shapes and digital morphology is a way to describe and analyze the shape of a digital object. In biology, morphology relates more directly to shape of an organism such as bacteria. Morphological opening is a name specific technology that creates an output image such that value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. Other techniques include edge detection using sobel and canny filters, and other sharpening filters that enhance the edges of the objects present in the image. A new algorithm for object extraction, boundary tracing and image enhancement have been proposed based on combination of Morphology, Weiner filters and thresholding techniques.

Keywords: Boundary detection, Morphology, Weiner Filters, Smoothing and sharpening filters

I. INTRODUCTION

Image Enhancement improves the quality (clarity) of images for human viewing. Removing blurring and noise, increasing contrast, and revealing details are examples of enhancement operations. This paper deals with enhancement of images with poor contrast and detection of background. Proposes a frame work which is used to detect the background in images characterized by poor contrast. Image enhancement has been carried. The first method employs information from image background analysis by various techniques such as histogram equalization and edge detection algorithms, while the second transformation method utilizes the opening operation, closing operation, which is employed to define the multi-background gray scale images using morphology. A new method is proposed in which image enhancement is attained using weiner filters for image sharpening and morphology. The complete image processing is done using MATLAB simulation model. Image Processing basically includes analysis, manipulations, storage and display of graphical images from sources such as photographs, drawings and so on. Image processing spans a sequence of 3 phases, which are the image acquire, processing and display phase. The image acquires phase converts the differences in colouring and shading in the picture into binary values that a computer can process. The enhancement phase can include image enhancement and data compression. The last phase consists of display or printing of the processed image. The term **morphology** means form and structure of an object. Sometimes it refers to the arrangements and inter-relationships between the parts of an object. Morphology is related to the shapes and digital morphology is a way to describe and analyse the shape of a digital object. In biology, morphology relates more directly to shape of an organism such as bacteria. Morphological opening is a name specific technology that creates an output image such that value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, one can construct a morphological operation that is sensitive to specific shapes in the input image. Morphological functions could be used to perform common image processing tasks, such as contrast enhancement, noise removal, thinning, skeletonization, filling and segmentation. The image enhancement problem in digital images can be approached from various methodologies, among which is mathematical morphology (MM). Such operators consist in accordance to some proximity criterion, in selecting for each point of the analyzed image, a new grey level between two patterns (primitives)[4]. Even though morphological contrast has been largely studied, there are no methodologies, from the point of view MM, capable of simultaneously normalizing and enhancing the contrast in images with poor lighting. On the other side, one of the most common techniques in image processing to enhance dark regions is the use of nonlinear functions, such as logarithm or power functions ; otherwise, a method that works in the frequency domain is the homomorphism filter. However, the main disadvantage of Histogram equalization is that the global properties of the image cannot be properly applied in a local context, frequently producing

a poor performance in detail preservation. In a method to enhance contrast is proposed; the methodology consists in solving an optimization problem that maximizes the average local contrast of an image.
Contrast operators are based on the logarithm function in a similar way to Weber's law the use of the logarithm function avoids abrupt changes in lighting. Also, two approximations to compute the background in the processed images are proposed. The first proposal consists in an analysis by blocks, whereas in the second proposal, the opening by reconstruction is used given its following properties:
· It passes through regional minima, and
· It merges components of the image without considerably modifying other structures.
Finally, this paper is organized as follows [8]. Morphological transformation presents a brief background on some morphological transformations. Image background approximation to the background by means of block analysis in conjunction with transformations that enhance images with poor lighting. The multibackground notion is introduced by means of the opening by reconstruction. A comparison among several techniques to improve contrast in images.

II. LITERATURE REVIEW

[1] organized image enhancement algorithm as follows as Morphological transformation and Weber's law. Image background approximation to the background by means of block analysis in conjunction with transformations that enhance images with poor lighting. The multibackground notion is introduced by means of the opening by reconstruction shows a comparison among several techniques to improve contrast in images. Finally, conclusions are presented [4] M Rama Bai has Introduced a novel algorithm based on multi-scale morphological method for the purpose of border detection. Standard morphological border detection methods use single and symmetrical structure elements. [2] YanFeng Sun,et al. has proposed a Multi-scale Fusion TV-based Illumination Normalized (MFTVIN) model. In this Illumination effects in the large-scale part are removed by region-based histogram equalization and Homomorphic filtering.[6] Emerson Carlos Pedrino,et al.has proposed an original reconfigurable architecture using logical, arithmetic, and morphological instructions generated automatically by a genetic programming approach. They also presented Binary, gray, and color image practical applications using the developed architecture. [10] Yan Wan,et al.has proposed a dual threshold calculating method to obtain accurate and continuous fiber edge, as well as to control the image noise.[11] M. Kowalczyk, et al. has proposed conception of effectively working groups of morphology functions in particular image cases. [12]David Menotti has proposed two methodologies for fast image contrast enhancement based on histogram equalization, one for gray-level images, and other for color images. For gray-level images, technique called Multi-HE has been proposed.[13] Ley,et al.has proposed a simple background illumination correction based approach for improving matting problems with uneven or poor lit blue-/green screens.[14] Joanna Sekulska,et al.has proposed general methods of biological images processing. These techniques are oriented to better image interpretation.[7] has proposed an automatic method for estimating the illumination field using only image intensity gradients.[15] has proposed a novel model-based correction method is proposed, based on the assumption that an image corrupted by intensity inhomogeneity contains more information than the corresponding uncorrupted image.[9]has proposed a new approach to the correction of intensity inhomogeneities in magnetic resonance imaging (MRI) that significantly improves intensity-based tissue segmentation.[3] Yadong Wu,et al. has proposed an image illumination correction algorithm based on tone mapping. The proposed algorithm combined color space decomposition and tone mapping based image brightness adjustment, which can improve the image contrast while maintaining the better color of the original image, and cannot increase noise.

III. BACKROUND PROBLEMS IN IMAGE PROCESSING AND AQUISITION

Background problems due to non-uniform illumination can have many sources: aging filaments, faulty reference voltages, contaminated apertures, or non-uniform support film fabrication. Subtle electron illumination asymmetries are more evident at moderate-to-low magnifications and are often inadvertently enhanced by digital contrast adjustment. This Effect is similar to the intensity inhomogeneity problem observed in MRI. The MRI Intensity inhomogeneity problem is manifested as a slowly varying multiplicative effect in the acquired images. Similarly, the non-uniform illumination can be modelled as a multiplicative effect. The observed image is given as $f(x; y) = s(x; y) I(x; y) + n(x; y)$; (1.1) , where s is the true signal, I is the non-uniform illumination field and n is additive noise. The I-field varies slowly over the image; in other words, it does not have any high frequency content. Removal of non-uniform illumination effects is important for later processing stages such as image registration based on correlation metrics and segmentation based on intensity thresholding. For example, an image might be taken of an endothelial cell, which might be of low contrast and somewhat blurred. Reducing the noise and blurring and increasing the contrast range could enhance the image. The original image might have areas of very high and very low intensity, which mask details. The image could have been taken in a non-uniform illumination environment which might make the details of the image less visible, our problem is to solve the issues of background illumination and enhance the image with the help of morphological operations for applications of particle analysis in microscopic images. Particle Analysis is a technique that helps to compute the details of the components present in the image, their shape, size (area) and number and other characteristics of the particles or objects present in an image.

IV. IMAGE ENHANCEMENT AND BOUNDARY DETECTION TECHNIQUES

Various common techniques such as Histogram equalization and edge detection have been studied by editing the input picture of microscopic bacteria as shown in figure 1. Related problems with these existing technologies are studied on the presence of non-uniform illumination field in the backround of the image and an algorithm based on morphological opening and structuring element design have been studied in order to remove the problems of non-uniform backround by backround approximation techniques. Available techniques are listed below.

A. HISTOGRAM EQUALIZATION AND CONTRAST ENHANCEMENT

Histogram of an image represents the relative frequency of occurrence of grey levels within an image. Histogram modelling techniques modify an image so that its histogram has a desired shape. Histogram equalization is used to enhance the contrast of the image such that it spreads the intensity values over full range. Under Contrast adjustment using histogram equalization, overall lightness or darkness of the image is changed, i.e. in this technique, pixel values below specified values are mapped to black and pixel values above a specified value are mapped to white. The result is linear mapping of a subset of pixel values to entire range of display intensities.

By implementing the above commands in Matlab editor, following image named 'pout.tif' as in figure 2. Histogram plot of the corresponding image is shown in fig.3.

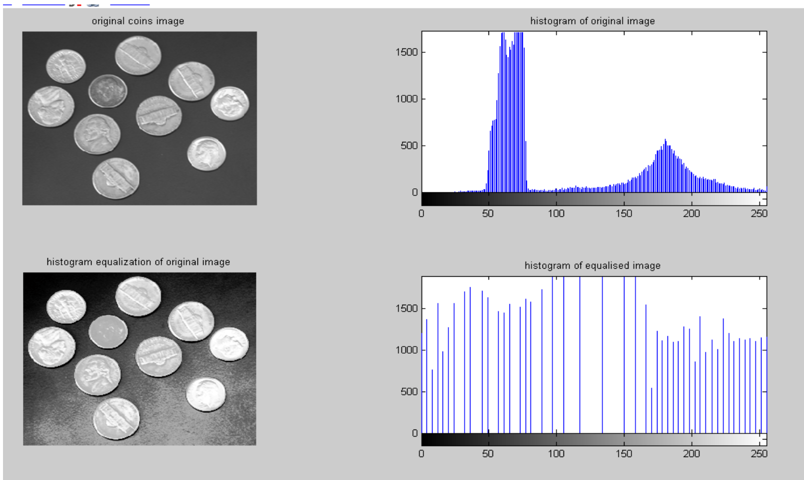


Fig 1: Image and its histogram and equalized version of original image

Performing histogram equalization on the above image using histeq function to spread the intensity values over the full range of the image improving the contrast and brightness of the overall image. So, histogram equalization technique basically compares every pixel in the input image with a predefines pixel value that sets all the pixel values above the threshold values to be 1 i.e. white in colour and others below this value to be 0, or black. Histogram equalization is applicable to the gray scale images where the main target is to enhance the image in order to see the details in the image clearly for future processing and this is achieved by increasing the dynamic range of the entire histogram.

B. EDGE DETECTION AND BOUNDARY EXTRACTION

[7] and [4] have studied the particle analysis based upon boundary tracings and edge detection techniques. To find edges, this function looks for places in the image where the intensity changes rapidly, using one of these two criteria: Places where the first derivative of the intensity is larger in magnitude than some threshold. Places where the second derivative of the intensity has a zero crossing. Edge provides a number of derivative estimators and each one these derivatives implement on any one of the criteria mentioned above. Operation sensitive area could also be defined in edge detection such that it includes places like detection across horizontal edges, vertical edges, or both. This technique when used returns a binary image of the input, i.e. 1's and 0's. Consider the images of coins in an image that need to be extracted using boundary extraction techniques. Following is an example of using image of coins from daily life for edge detection of the coins. This image is having a uniform background.

Fig 2: Image of coins to be used for boundary extraction purposes

Now, applying the sobel and canny edge detectors to the above image, resulting image obtained is shown in figure 3 and figure 4.

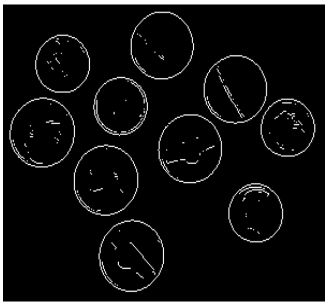


Fig 3: Edge Detection through Sobel filter

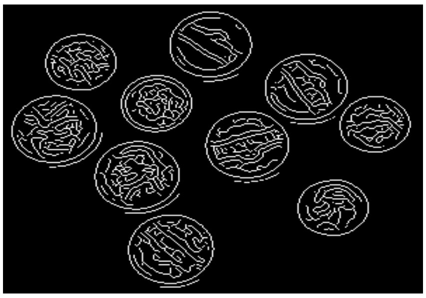


Fig 4: Edge Detection through canny filter

Above figures indicate effective boundary extraction for the images of coins using linear filtering approach.

C. MORPHOLOGY

Morphology is a technique of image processing based on shape and form of objects. Morphological methods apply a structuring element to an input image, creating an output image at the same size. The value of each pixel in the input image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighbor, you can construct a morphological operation that is sensitive to specific shapes in the input image. The morphological operations can first be defined on grayscale images where the source image is planar (single-channel). The definition can then be expanded to full-colour images.

Mathematical morphology (MM) is a theory and technique for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random functions. MM is most commonly applied to digital images, but it can be employed as well on graphs, surface meshes, solids and many other spatial structures, Topological and Geometrical space concepts such as size, shape, convexity,and geodesic distance, can be characterized by MM on both continuous and discrete spaces. MM is also foundation of morphological image processing, which consists of a set of operators that transform images according to the above characterizations.

Denoting an image by *f(x)* and the structuring function by *b(x)*, the grayscale dilation of *f* by *b* is given by:

$$(f \oplus b)(x) = \sup_{y \in E}[f(y) + b(x-y)] \quad -1$$

where "sup" denotes the supremum. Similarly, the erosion of *f* by *b* is given by

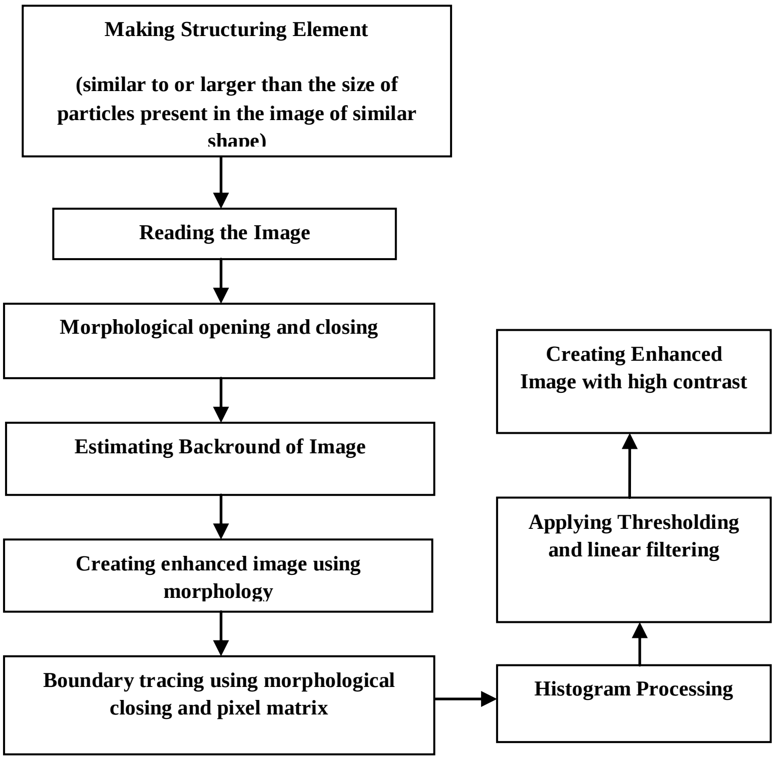
$$(f \ominus b)(x) = \inf_{y \in E}[f(y) - b(y-x)] \quad -2$$

MM was originally developed for binary images, and was later extended to grayscale functions and images. The subsequent generalization to complete lattices is widely accepted today as MM's theoretical foundation. In binary morphology, an image is viewed as a subset of a Euclidean space Rd or the integer grid Zd, for some dimension *d*. Some of the basic elements of binary morphology includes Structuring Element, Basic Operators: Euclidean Distance and Shift Invariant, Erosion and Dilation and Opening and Closing of binary Images. The basic idea in binary morphology is to probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image. This simple "probe" is called structuring element, and is itself a binary image. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. In greyscale morphology, images are functions mapping a Euclidean space or grid *E* into R U {∞, -∞}, where R is set of reals, ∞ is an element larger than any real number, -∞ is an element smaller than any real number. Grayscale structuring elements are also functions of the same format, called "structuring functions". Various techniques and common approaches to solve the problem of particle identification are Image Filtering, Boundary detection, Edge Detection, Linear Filtering, Segmentation, Morphological operations: Dilation and Erosion etc. But most of these techniques alone fail to accurately determine the objects real boundaries due to the problem of non-uniform illumination in the backround of the image due to which most of the particles appear to be either dark or light in an image and using techniques such as segmentation, edge detection and general image processing algorithms based on 'region of interest' could not differentiate between some of the particles and their backround or neighboring pixels. Even when the particles are extracted, there are changes to their shape and size which leads to faulty readings in the computations of area of such particles. So, advanced image processing and image enhancement tools have to be used for maximum accuracy of the results and to identify the particles accurately from the image without even missing a single object.

D. PROPOSED ALGORITHM FOR IMAGE ENHANCEMENT AND BOUNDARY TRACING

We have proposed an algorithm with morphological opening IN COMBINATION WITH linear filters such as weiner filters and then remove the non- uniform backround illumination by using morphological opening of the image with this structuring element. Backround approximation have been taken as the criteria to determine the close proximity to the non-uniform backround extraction using various techniques such as weiner Filtering and our new technique based on morphological processes and successive dilation and erosion followed by contrast enhancement for the accurate particle extraction for lateral image processing in concatenation with weiner filter and thresholding at the end to improve the image contrast.

Algorithm



V. CONCLUSIONS AND FUTURE WORK

It has been concluded that due to non-uniform background illumination, most of the particles appear to be either dark or light in an image and using techniques such as segmentation, edge detection and general image processing algorithms based on 'region of interest' could not differentiate between some of the particles and their background or neighbouring pixels. In future, it is plan to perform the simulations and analysis of an image and its enhancement to correct for non uniform illumination, then use the enhanced image to identify discrete objects/particles present in the image.

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