

Image Enhancement and Background Detection Using Morphological Transformation

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ABSTRACT

This paper deals with enhancement of images and background detection using Mathematical Morphological [MM] theory on dark images. Due to poor lightening the background of the image is not clear. This image can be enhanced by lightening the back ground with various morphological operations. Basically, Weber's Law Operator is used to analyze dark images which are carried out by two methods such as Image background detection by block analysis while second operator utilize opening by reconstruction to define multi background notion. Some Morphological operations such as (Erosion, Dilation, Compound operation such as Opening by reconstruction, Erosion-Dilation method) and Block Analysis is used to detect the background of images. Analysis of above mention methods illustrated through the processing of images with different dark background images.

Keywords - Block Analysis, Erosion-dilation method, Opening by reconstruction, Opening operation, Weber's law notion.

I. INTRODUCTION

In this Paper the concept is to detect the background in images in poor lighting. Various Mathematical Morphology [MM] is used to enhance digital images with poor lighting condition. Mathematical morphology approach is based on set theoretic concepts of shape. In morphology, Objects present in an image are treated as sets. There are standard techniques like histogram equalization histogram stretching for improving the poor contrast of the degraded image. In the First method the background images in poor lighting of grey level images can identified by the use of morphological operators. Lately image enhancement has been carried out by the application based on Weber's Law [2]. Later on erosion, dilation, Opening (erosion followed by dilation), closing (dilation followed by erosion) and opening by reconstruction method is followed. In this paper, firstly we give introduction about various morphological operators and then we apply them on a bad light image and extract the background of that image and then improve contrast of that image.[3]

1.1 Morphology

Morphology is a technique of image processing based on shapes. The 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, can construct a morphological

operation that is sensitive to specific shapes in the input image. Mathematical morphology is a set-theoretical approach to multi-dimensional digital signal or image analysis, based on shape. It is a theory and technique for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random functions. It is most commonly applied to digital images, but it can be employed as well on graphs, surface meshes, solids, and many other spatial structures. It is also the foundation of morphological image processing, which consists of a set of operators that transform images according to the above characterizations. Mathematical morphology was originally developed for binary images, and was later extended to scale functions and images. The subsequent generalization to complete lattices is widely accepted today as MM's theoretical foundation.

II. PROPOSED WORK

In this proposed work, background of the Image compute through two approximations using Matlab. The first approximations is block analysis, while the second proposal, is morphological operations.

2.1 Background Detection by Block Analysis:

In this analysis, first of all we will read an image as input image with poor lighting condition having dimension (N X N) and divide it into several blocks (say 'n' block length) and from each block we

will determine the background and apply the weber's law and thereby we obtain an enhanced image

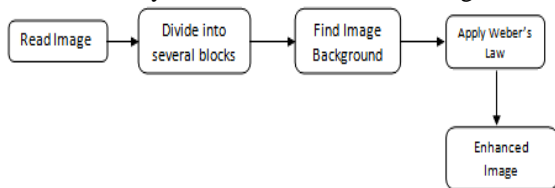


fig. 2.1.1 Block diagram of Background Detection by Block Analysis

For each analyzed block, maximum (Mi) and minimum (mi) values are used to determine the background criteria Ti in the following way:

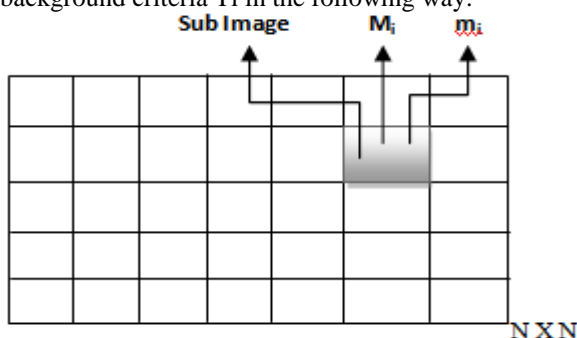


Fig. 2.1.2. Background detection by Block Analysis

Background image = $\begin{cases} f \geq \tau_i & \text{then clear region} \\ f \leq \tau_i & \text{then Dark region} \end{cases}$

$$\tau_i = \frac{m_i + M_i}{2} \quad \forall_i = 1, 2, \dots, n$$

Once τ_i is calculated, this value is used to select the background parameter associated with the analyzed block. As follows, an expression to enhance the contrast is proposed:

$$r_{\tau_i}(f) = \begin{cases} K_i \log(f + 1) + M_i, & f \leq \tau_i \\ K_i \log(f + 1) + m_i, & \text{Otherwise} \end{cases}$$

Note that the background parameter depends on the τ_i value. If $f \leq \tau_i$ (dark region), the background parameter takes the value of the maximum intensity (M_i) within the analyzed block, and the minimum intensity (m_i) value otherwise. Also, the unit was added to the logarithm function in above equation to avoid indetermination. On the other hand, since grey level images are used in this work, the constant K_i in above equation is obtained as follows:

$$K_i = \frac{255 - m_i^*}{\log(256)} \quad \forall_i = 1, 2, \dots, n$$

$$m_i^* = \begin{cases} m_i, & f > \tau_i \\ M_i, & f \leq \tau_i \end{cases}$$

On the other hand, M_i and m_i values are used as background parameters to improve the contrast depending on the τ_i value, due to the background is different for clear and dark regions.

Now an image is formed by applying the above equation. Now consider a pixel in this image and the corresponding pixel in original image. Combine them using Weber's law which can be stated as follows. Thus an enhanced image is formed.

Weber's Law:

Weber's law defines contrast and introduces the concept of Just-Noticeable difference [JND]. Weber's law are more sensitive to light intensity changes in low light levels than in strong ones. The contrast sensitivity is approximately independent of the background luminance. Relative changes in luminance are important. Weber's law tends to break down for very dark and very bright luminance levels[13]. In psycho-visual studies, the contrast C of an object with luminance L_{max} against its surrounding luminance L_{min} is defined as follows[2][4].

$$C = \frac{L_{max} - L_{min}}{L_{min}}$$

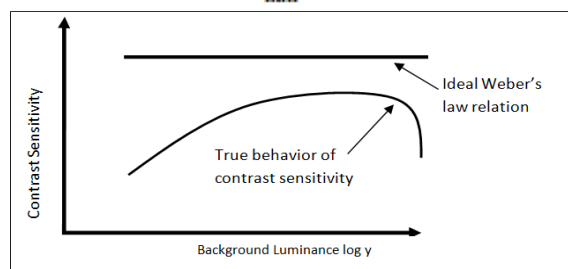


Fig.2.1.3 Weber's law Analysis

If $L=L_{min}$ and $\Delta = L_{max} - L_{min}$ so it can be written as follows

$$C = \frac{\Delta L}{L}$$

In the above Equation indicates that $\Delta(\log L)$ is proportional to C. Therefore, Weber's law can be expressed as

$$C = k \log L + b \quad L > 0$$

Where k and b are constants, b being the background. In this case, an approximation to Weber's law is considered by taking the luminance L as the grey level intensity of a function (image); in this way, above expression is written as follows

$$C = k \log f + b \quad F > 0$$

2.2 Background detection using morphological operators:

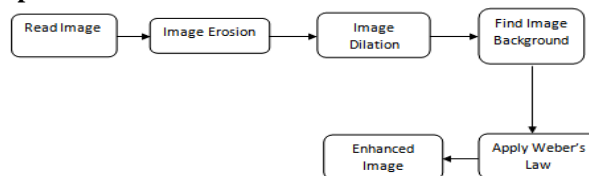


fig. 2.2.1 Block diagram of Background Detection by Erosion & Dilation

Morphological operations:

In a morphological operation, the value of each pixel in the output 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 neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image. Dilation and erosion are two fundamental morphological operations. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. Erosion and Dilation can also be interpreted in terms of whether a structuring element (SE) hits or fits an image (region) as follows

For Dilation, The resulting image $g(x, y)$, given an input image $f(x, y)$ and a SE will be

$$g(x,y) = \begin{cases} 1 & \text{if se hits } f \\ 0 & \text{otherwise} \end{cases}$$

For all x and y ,

For Erosion, The resulting image $g(x, y)$, given an input image $f(x, y)$ and a SE will be

$$g(x,y) = \begin{cases} 1 & \text{if se fits } f \\ 0 & \text{otherwise} \end{cases}$$

For all x and y ,

Morphological Operation

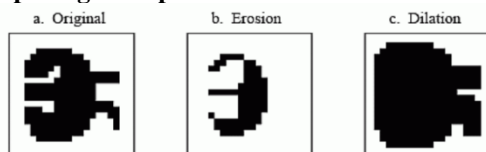


Fig.2.2.2(a) Original Image, Fig (b) Erosion Operation on Image (a). Fig(c) Dilation on image (b).

III. IMAGE BACKGROUND DETERMINATION USING THE OPENING BY RECONSTRUCTION

Opening by reconstruction is used to define multi background notion. Opening by reconstruction requires removing pixels of the foreground from an image by specified structuring element. It illustrates through morphological transformations which generate new contours when the structuring element is increased and not necessarily need to apply block analysis and morphological erosion and dilation. When morphological erosion or dilation are used with large sizes of to reveal the background, inappropriate values may be obtained. However, in MM, there is other class of transformations that allows the filtering of the image without generating new components; these transformations are called transformations by reconstruction. In our case, the

opening by reconstruction is our choice because touches the regional minima and merges regional maxima. This characteristic allows the modification of the altitude of regional maxima when the size of the structuring element increases. This effect can be used to detect the background criteria $\tau(x)$ i.e.,

$$\tau(x) = \hat{y}_\mu(f)(x)$$

When considering the opening by reconstruction to detect the background, one further operation is necessary to detect the local information given by the original function (image extremes are contained in the opening by reconstruction because of its behavior). The morphological transformation proposed for this task is the erosion size, $\mu=1$ i.e.

$$b(x) = \varepsilon_1[\hat{y}_\mu(f)](x)$$

Given that the morphological erosion tends to generate new information when the structuring element is enlarged, in this study, the image background was computed by using only the morphological erosion size 1.

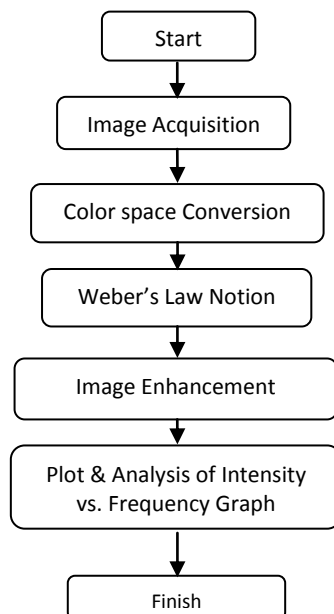
Structuring Elements:

The structuring element is the basic neighborhood structure associated with morphological image operation. It is usually represented as a small matrix, whose shape and size impact the result of applying a certain morphological operator to an image. An essential part of the dilation and erosion operations is the structuring element used to probe the input image. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood. Two-dimensional, or flat, structuring elements are typically much smaller than the image being processed. The center pixel of the structuring element, called the origin, identifies the pixel of interest -- the pixel being processed. The pixels in the structuring element containing 1's define the neighborhood of the structuring element. These pixels are also considered in dilation or erosion processing. Three-dimensional, or non-flat, structuring elements use 0's and 1's to define the extent of the structuring element in the x- and y-planes and add height values to define the third dimension.

Origin of a Structuring Element:

The morphological functions use this code to get the coordinates of the origin of structuring elements of any size and dimension. If $\mu=3$ then structuring element is considered as $strel=2\mu + 1$.

IV. FLOW CHART



V. CONCLUSION

In this paper, Various methodologies is used to detect background image with poor lighting condition and to enhance the contrast in grey level images with bad lighting based on Weber's law notion. Initially, Image enhancement is carried out by simply block analysis later on , we give introduction about basic concepts used in this Mathematical methodology like Morphological operators (Dilation, Erosion, Opening, and Closing), contrast enhancement operators. Then we provide various steps to perform the methodology. Finally Opening by reconstruction is used to analyze multi background definition of images.

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