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Image Intensification Using Mathematical Morphology

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ABSTRACT
This paper deals with analysis of image Intensification carried out various methodologies used in Mathematical Morphological [MM] theory on dark images. In this paper, Poor lighting images have been processed through Block Analysis, Morphological Operation and Opening by Reconstruction. Basically, Weber's Law Operator is used to analyze poor lighting 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. Such Morphological operations are 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 filtering techniques along 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, This approach is used to enhanced the Poor lighting image along with the concept is to detect the background in images 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]

1.1Morphology

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 neighbors. 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 are block analysis, while the second proposal is morphological operations.

2.1Background 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.

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

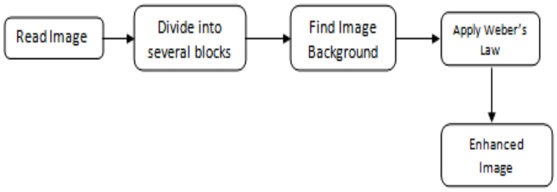


fig. 2.1.1 Block diagram of Background Detection by Block Analysis

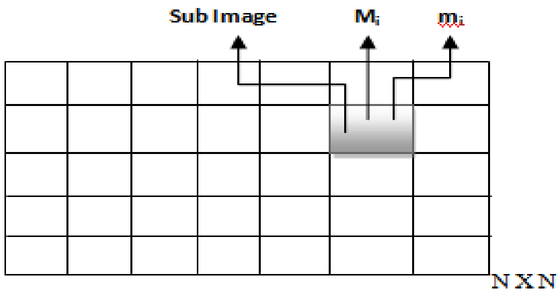


Fig. 2.1.2. Background detection by Block Analysis

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

$$\tau_i = \frac{m_i + M_i}{2} \qquad \forall_i = 1,2,\ldots\ldots n$$

Once τi 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:

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

Note that the background parameter depends on the Ti value. If f<= τi (dark region), the background parameter takes the value of the maximum intensity(Mi) within the analyzed block, and the minimum intensity(mi) 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 Ki in above equation is obtained as follows:

$$K_i = \frac{255 - m_i^*}{Log(256)} \qquad \forall_i = 1,2,\ldots\ldots n$$

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

On the other hand, Mi. and mi values are used as background parameters to improve the contrast depending on the Ti 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 Lmax against its surrounding luminance Lmin is defined as follows[2][4].

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

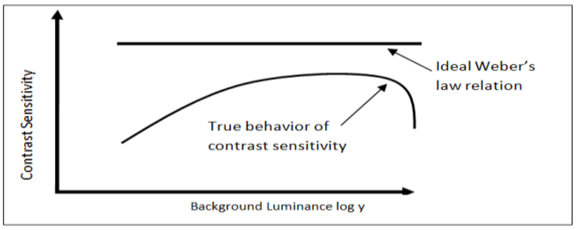


Fig.2.1.3 Weber's law Analysis

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

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

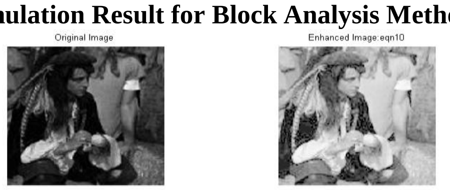
In the above Equation indicates that $\Delta(\log L)$ is proportional to C. Therefore, Weber's law can be expressed as

$$C = klogL + b \qquad L > 0$$

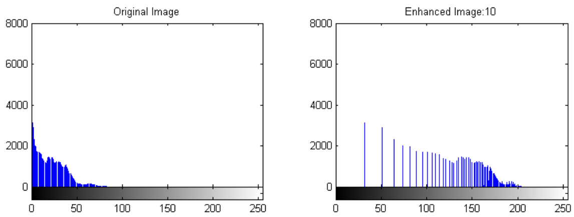
Where k and b are constants, b being the background. In this case, an approximation to Weber's law is considered by taking the luminance L as the grey level intensity of a function (image); in this way, above expression is written as follows

$$C = klogf + b \qquad F > 0$$

Simulation Result for Block Analysis Method



(a) **(b)**



(c) (d)

Fig. 2.1.4 (a) Original Image (B) Enhanced image using Block Analysis. (c),(d) corresponding Histogram of the Images of Fig.(a),(b)

2.2 Background detection using morphological operators:

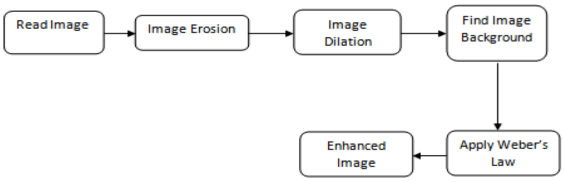


fig. 2.2.1 Block diagram of Background Detection by Erosion & Dilation

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

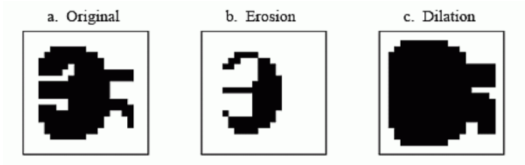
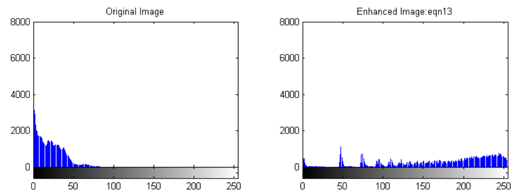


Fig.2.2.2(a) Original Image,
Fig (b) Erosion Operation on Image (a).
Fig(c) Dilation on image (a).

Simulation Result for Morphological Operation Method

(a) (b)



(c) (d)

Fig.2.2.3 (a) Original Image (B) Enhanced image using Block Analysis. (c),(d) corresponding Histogram of the Images of Fig.(a),(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.

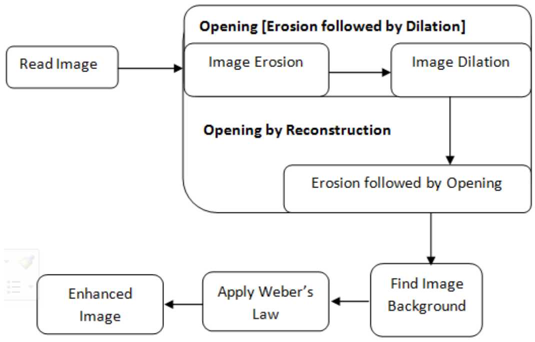


Fig.3.1 Block diagram of Opening by Reconstruction

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 τ(x) i.e.,

$$\tau(x) = \tilde{y}\mu\,(f\,)(X)$$

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 , μ=1i.e.

$$b(x) = \varepsilon_1\left[\tilde{y}_\mu\,(f\,)\right](X)$$

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.

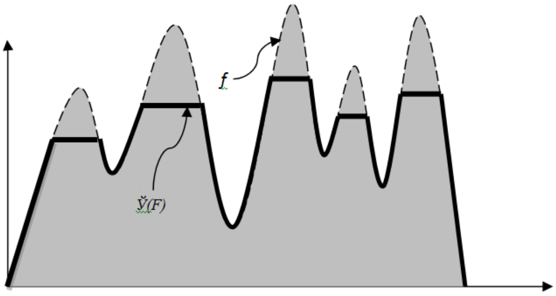


Fig. 3.1 Opening by reconstruction

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.

Simulation Result for Opening By Reconstruction Method

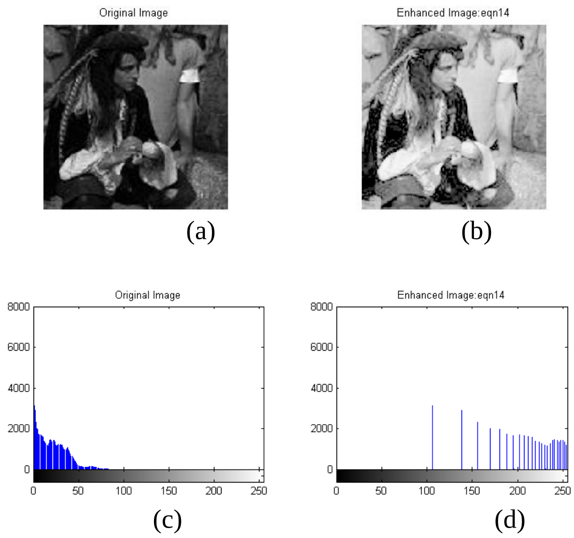


Fig. 3.2 (a) Original Image (B) Enhanced image using Block Analysis. (c),(d) corresponding Histogram of the Images of Fig.(a),(b)

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 μ=3 then structuring element is considered as strel=2μ +1.

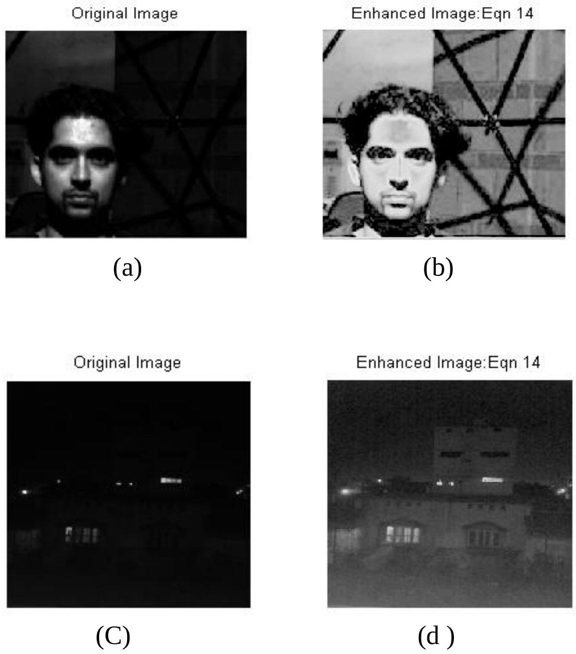
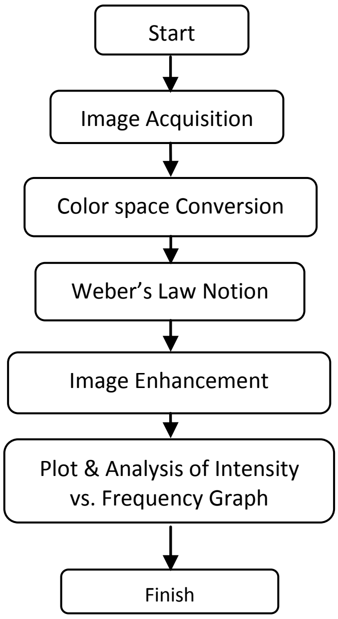


Fig.3.3 Output Images illustrated through Opening by reconstruction as background criteria. (a), (c) Original images ;(b), (d) enhanced images

IV. FLOW CHART



V. PERFORMANCE ANALYSIS

Performance of Enhanced Image is analyzed by Mean Square Error [MSE], Peak Signal to Noise Ratio [PSNR] along with the Processing time .i.e. Elapsed time for Execution

Fig.5.1 Image (I) Image (II) Image (III)

Table: 1 Performance Analysis

Original Image	Erosion-Dilation Method			Opening by Reconstruction		
Image	PSNR (dB)	MSE	Elapsed time (Sec)	PSNR (dB)	MSE	Elapsed time(Sec)
I	48.86	0.85	1.4946	51.12	0.51	0.086622
II	42.84	3.40	1.5130	48.59	0.91	0.085086
III	39.43	7.46	1.4916	39.59	7.19	0.088016

VI. CONCLUSION

In this paper, various poor lighting images have been processed through Block Analysis method, Morphological Operation and Opening by Reconstruction with different background image. Initially, Image enhancement is carried out by simply block analysis later on , we give introduction about basic concepts used in this Mathematical Morphology like Morphological operators (Dilation, Erosion, Opening, and Closing).Then we provide various steps to perform the methodology. Finally Opening by reconstruction is used to analyze multi background definition of images. Statistical Analysis of Enhanced images with various algorithm is carried out by MSE [Mean Square Error], PSNR [Peak Signal to Noise Ratio] and Elapsed Time. These enhanced images are also illustrated through filter.

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