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Visual Quality for both Images and Display of Systems by Visual Enhancement under Low-Backlight

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ABSTRACT: *Visual enhancement techniques provide different approaches for improving visual quality of displays under Low backlight conditions for saving the battery. The existing techniques provide the visual quality may be for noise free images only. This method proposes an algorithm that provides the visual quality for both images and display of systems even the images are corrupted with the noise under low backlight.*

This method first proposes a median filter for removing the impulse noise which is the salt and pepper noise. Then using dilation method of morphological operations for providing better growth or thickness of images so that if any breaks in a image it will be repaired. Then designing a linear spatial filter which is the laplacian operator for sharpening of the image used to enhance the details of an image that has been blurred. After that constrained L0 gradient image decomposition is used for separation of base layer and detail layer, and also median-preserving gamma correction is used to alter the output levels of a monitor and a JND-based Boosting for detail enhancement. Experimental results show that this approach performs better than the existing methods.

KEYWORDS: *Median filter, Dilation operation, Laplacian operator, Constrained L0 gradient image decomposition, Median-preserving gamma correction, Low backlight display, Just-Noticeable Difference (JND).*

I. INTRODUCTION

DISPLAYS are known to be among the largest power consuming components on a modern mobile device like Touch screens and pad-like devices. Now a days the needs of displays increases. The battery life of displays on the handheld devices is hard to save.So for saving the battery life, this method proposed the concept of Backlight Scaling and also enhancing the image signals for better visual quality of displays and images. In this using only 40% backlight more battery power will be saved.

Maintaining image quality under various lighting conditions is critical to portable multimedia devices. This paper proposes a technique to maintain the visual quality for both images and also display of systems while the images are corrupted with noise also under low back-light.The first step in the proposed algorithm is for removing the impulse noise which is the salt and pepper noise by using median filter. Then for providing better growth or thickness of images a dilation method of morphological operations is used. So that if any breaks in an image it will be repaired. Then the linear spatial filter which is the laplacian operator is used for sharpening of the image and to enhance the details of an image that has been blurred.Now after using laplacian operator, based on L0 gradient the image is separated into base layer and detail layer. Then this method proposes a median-preserving gamma correction for controlling the brightness of an image. Meanwhile boost the detail layer using our JND profile.

In this method visual enhancement work for all types of backlight-scaled displays with better image quality is proposed.

II. PROPOSED SYSTEM

Based on the Human visual system (HVS) this method proposes the algorithm of image quality enhancement that preserves the perceptual quality of images displayed under extremely low back-light conditions. In this system the brightness of a pixel on the display is the product of transmittance and backlight illumination. The figure:1 shows the system pipeline. First in this method convert the RGB image to HSV image. The image is separated in to H (hue), S (saturation) and V (illumination). The H and S given directly to the output block. The V is having the illumination signal V(x,y) is taken for our system .

A. Median Filter

The V(x,y) which is taken is given to the median filter to remove the noise (salt & pepper) when the illumination signal is corrupted by impulse noise (salt &pepper) which is caused while taking the image itself. This noise can be caused by sharp & sudden disturbances in the image signal. An effective noise reduction method for this type of noise is the usage of a median filter. The median filter is a technique, often used to remove noise. Median filtering is very widely used in digital image processing because it preserves edges while removing noise.It replaces the value of the center pixel with the median of the intensity values in the neighborhood of that pixel. So here the illumination signal V(x,y) is given to the median filter and the filtered output is represented as Vm(x,y).

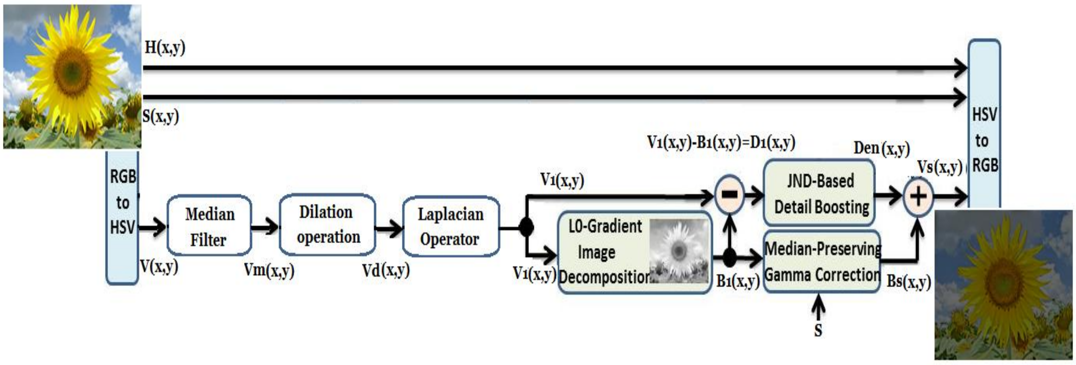

Fig.1: system pipeline

B. Dilation operation

Dilation is the operation that "grows" or "thickness" objects in an image thickening are controlled by a shape referred to structuring element. The structuring element is moved across every pixel in the original image to give a pixel in a new processed image. The value of this new pixel depends on the operation performed.

1. If the origin of the structuring element coincides with a 'white' pixel in the image, there is no change; move to the next pixel.
2. If the origin of the structuring element coincides with a 'black' in the image, make black all pixels from the image covered by the structuring element.

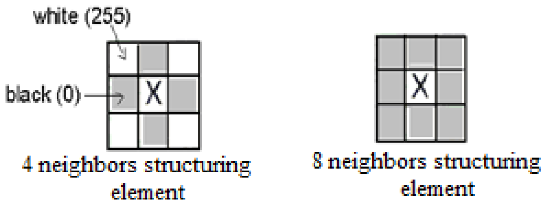

Fig: 2 Structuring element shapes

The structuring element can have any shape. Typical shapes are presented in figure:2.Dilation of image f by structuring element s is given by $f \oplus s$.The structuring element s is positioned with its origin at (x,y).The new pixel value is determined using the rule:

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

Hit: Any on pixel in the structuring element covers an on pixel in the image.So Vd(x,y) is the signal after dilation operation, this signal is given to laplacian operator.

C. Laplacian operation

It can be beneficial to obtain several enhanced images with variety of approaches.Here the approach after dilation operation, image enhancement is done for sharpness of the details using linear spatial filter of laplacian operator. Sharpening in spatial filter is to highlight fine detail in an image and to enhance detail that has been blurred, either in error or as a natural effect of a particular method of image acquisition. In Spatial Filtering Process Simply move the filter mask from point to point in an image. Many spatial filters are implemented with convolution masks. Since the operations performed in the convolution are linear, these types of filters are called linear filters. So here we are using the linear spatial filter of laplacian operator (linear operator) denoted as:

$$\nabla^2 f = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2} \quad (2)$$

We have different laplacian operators in that here this method uses a laplacian operator having the center coefficient 8 for better sharpening. The mask shows in the figure.3.

1	1	1
1	−8	1
1	1	1

Fig.3: Laplacian operator 8

So move the filter mask from point to point in an image. Equation (3) is used depending on the center coefficient.

$$g(x,y)=\begin{cases} f(x,y)-\Delta^2 f(x,y) & \rightarrow \text{If center coefficient is negative} \\ f(x,y)+\Delta^2 f(x,y) & \rightarrow \text{If center coefficient is positive} \end{cases} \quad (3)$$

So finally after applying the laplacian operation to the illumination signal of Vd(x,y) it will get the V1(x,y) which is used for further process.

D. Constrained L0 gradient image decomposition

Now V1(x,y) is the signal after laplacian operation. So first this method Decompose the illumination signal V1(x,y) in to base layer B1(x,y) and detail layer D1(x,y) using the constrained L0 gradient minimization. The original L0 gradient minimization is represented as follows:

$$\min_{B(x,y)} \sum_{(x,y)} |V_1(x,y)-B_1(x,y)|^2 + \lambda.C(x,y) \quad (4)$$

In this L0-gradient minimization C(x,y) represents number of non-zero gradient. Where $C(x,y)=\#\{(x,y)\,|\,|\nabla B_1(x,y)|\neq 0\}$ where # denotes the numbers of pixels while ∇ denotes the difference operator. Since the L0-norm of gradient represents the numbers of non-zero gradient, it is generally counted on the positions containing strong edges. Based on this observation multiplying the Edge (x,y) to the C(x,y) [1]

$$C(x,y)=\#\{(x,y)|Edge\ (x,y).|\nabla B_1(x,y).|\neq 0\} \quad (5)$$

Here Edge (x,y) obtained by adopting the first order Gaussian (FDOG) edge detection on V1(x,y) with a threshold. The thresholds of FDOG and edge map are set to 0.75 and 0.2, respectively. Introducing Edge(x,y) in to minimization can eliminate some inappropriate and speed up the whole process. In this gauss gradient is used. Gradient using first order derivative of Gaussian for edge detection. This function outputs the gradient image using 2-D Gaussian kernel. Determining the size of the kernel and generating 2-D Gaussian kernel along both x and y directions. Applying 2-D filtering by introducing Edge(x,y) process can eliminate in appropriate things. So by taking the absolute values of x and y in a gauss gradient this method can detect the edges or boundaries of a signal. As it is tough to calculate the (4) referring [2] to approximate the L0-norm of gradient by introducing the two auxiliary variables of ax(x,y) and ay(x,y) corresponding to the two variables shown here $(\partial B_1(x,y))/(\partial x)\ and\ (\partial B_1(x,y))/(\partial y)$ Now the L0 gradient minimization is represented as:

$$\min_{B_1,a_x,a_y} \sum_{(x,y)} |V_1(x,y)-B_1(x,y)|^2 + \lambda.C(x,y) + \beta.\left(\left|\frac{\partial\ B_1(x,y)}{\partial x}-a_x(x,y)\right|^2+\left|\frac{\partial\ B_1(x,y)}{\partial y}-a_y(x,y)\right|^2\right) \quad (6)$$

Where C(x,y) is represented in equation (5) and β is an automatic tuning parameter to control the similarity between variables a_x (x,y) and a_y (x,y) and their corresponding gradients. The parameters when doing the L0 smoothing while getting the base layer the smoothing weight λ is set to 0.01, while β is set to 0.02 and is multiplied by 2 during iterations, kappa Parameter that controls the rate, kappa = 2 is suggested for natural images.βmax has the fixed value of 1e5 [2].Equation (6) is solved by alternatively minimizing B1, a_x, a_y. We fix one set of variables while obtain another set of variables.

Finding B1:

Fixing a_x (x,y) and a_y (x,y) to obtain B_1(x,y). This is by solving the quadratic cost function in a linear system:

$$\min_{B_1} \frac{1}{\beta} \sum_{(x,y)} |V(x,y)-B_1(x,y)|^2 + \left|\frac{\partial\ B_1(x,y)}{\partial x}-a_x(x,y)\right|^2+\left|\frac{\partial\ B_1(x,y)}{\partial y}a_y(x,y)\right|^2 \quad (7)$$

Finding a_x and a_y:

In this iteration, fixing B1(x,y) to obtain new ax (x,y) and ay (x,y) by solving the cost function:

$$\min_{a_x,a_y} \frac{\lambda}{\beta} C(x,y) + \left|\frac{\partial B_1(x,y)}{\partial x}-a_x(x,y)\right|^2+\left|\frac{\partial B_1(x,y)}{\partial y}-a_y(x,y)\right|^2 \quad (8)$$

Where the L0-norm of gradient can be modeled as: $C(x,y)=Edge(x,y).H(|a_x(x,y)|+|a_y(x,y)|)$ (9)

Where H (|ax(x,y)|+ |ay(x,y)|) is the binary function.Returning 1 when (|ax(x,y)|+|ay(x,y)|) ≠0 and returning 0 otherwise. By calculating (7) and (8) final Base layer B1(x,y) is obtained from the L0-gradient minimization. The illumination signal is V1(x,y) from the laplacian operator. So the detail layer is obtained by the difference between illumination signal V1(x,y) and the base layer B1(x,y). i.e. D1(x,y) = V1(x,y) – B1(x,y) (10)

The detail layer which is useful for the JND for extracting the details and boosting the low intensity regions of the image.

E. Median-Preserving Gamma Correction

Since this method compress the range of illumination to simulate low backlight that is applying the 40 % scaling. This method uses only 40% backlight. So this method adopt a Gamma Correction - controls the overall brightness of an image. In other words to enhance the contrast of the displayed images. It is a setting that determines how bright the output of the display will be.

Therefore, "gamma correction" is used to alter the output levels of a monitor. The gamma setting affects both the brightness and the contrast of the display. The reason gamma correction is used is because the input signal, or voltage, sent to a monitor is not high enough to create a bright image. Therefore, if the gamma is not altered, the images on the screen would be dark and difficult to see. By applying gamma correction, the brightness and contrast of the display are enhanced, making the images appear brighter and more natural looking. Here in this system it uses the gamma correction to alter the output levels of the signals when applying the scaling to the input signal. The concept of gamma can be applied to any nonlinear relationship. For the power law relationship $V_{out} = V_{in}^{\gamma}$, the curve on a log–log plot is a straight line, with slope everywhere equal to gamma.(slope is represented here by the derivative operator):

$$\gamma = \frac{d \log(v_{out})}{d \log(v_{in})} \quad (11)$$

Based on this the gamma is represented in the median preserving gamma correction is:

$$\gamma = \frac{\log(median(B_1(x,y)))}{\log(median(s.B_1(x,y)))} \quad (12)$$

This method adopt gamma correction and let the median of the scaled brightness approximate to the median of the original brightness this design forces the final scaled base layer to maintain the brightness of the original full backlight. Suppose if the $\gamma < 1$ the image is weighted toward higher (brighter) output values. If $\gamma > 1$ the image is weighted toward lower (darker) output values. If $\gamma = 1$ the transformation has no effect on the image.An underexposed photograph can be corrected using gamma correction with $\gamma < 1$. An overexposed photograph can be corrected using gamma correction with $\gamma > 1$. Using eq (12) the value of γ=0.25 is obtained. By this if the $\gamma < 1$ the image is weighted toward higher (brighter) output values. The final scaled base layer will come out after applying scaling of 40% backlight which is denoted as denoted as Bs(x,y).
The final scaled base layer can be obtained:

$$B_s(x,y) = s.W.\left(\frac{B_1(x,y) - J_{\max}}{W}\right)^{\gamma} \quad (13)$$

Where W is the white value (equal to 255 in 8-bits image or 1 in normalized images) and J max is the maximum value of human JND. Referring to [3] and have J max=μ+σ. W.Here μ and σ are constants.

F. JND-Based Detail Boosting

Just noticeable difference (JND) is the smallest difference in a specified modality of sensory input that is detectable by a human being.Just-noticeable-difference (JND) is the smallest stimulus for human vision to perceive the difference between the operating pixel intensity and its background intensity. Since the flowers are salient as compared to the rest regions, the flowers are enhanced more strongly by using our JND-Based detail boosting.The idea of using this JND is to keep the detail content of the image in the visible luminance range. In addition to the new scaled Bs(x,y).It also enhance the detail layer D1(x,y) to ease human perception. This method proposes a detail boosting method based on JND.

Two-layer image decomposition architecture based on the just noticeable difference (JND) theory is proposed for extracting the details, and a boosting scheme is applied to the details that are in the low intensity regions of the image.
Modifying J max=μ+σ. W for the purpose of obtaining the JND is:

$$JND(x,y) = \mu + \sigma.\ B_s(x,y) \quad (14)$$

The parameters of JND are μ is set to 4 and σ is set to 0.015 and Jmax is 0.02. The enhanced detail layer $D_{EN}(x,y)$ is obtained from the JND-Based detail Boosting by using

$$D_{EN}(x,y) = D_1(x,y)\ .\left(\frac{W + JND(x,y)}{W}\right) \quad (15)$$

The final enhanced V-signal can be obtained by combining the Enhanced detail layer DEN(x,y) from the JND-Based detail boosting and scaled base layer B(x,y) from median-preserving gamma correction.

$$\text{i.e } VS(x,y) = B_s(x,y) + D_{EN}(x,y) \quad (16)$$

Now the final enhanced V-Signal is denoted as Vs(x,y) and the original Hue signal H(x,y) and saturation signal S(x,y) of the input HSV image will combined in the output block in order to get the output in the form of HSV. Now finally the system converts the HSV output in to RGB image.

III. RESULTS

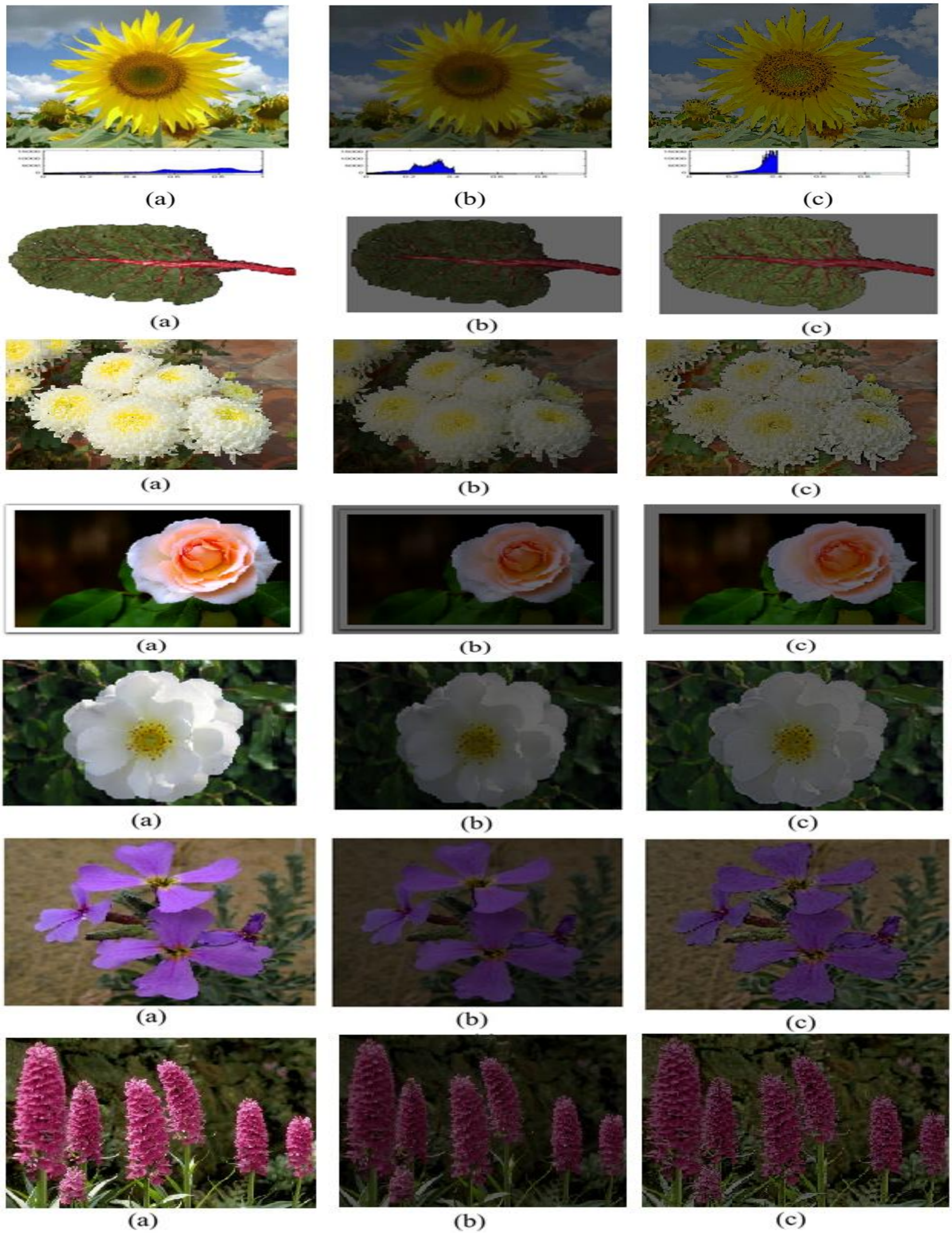

Fig. 4: The results: (a) original image, full 100% backlight: s=1, (b) original image, linear-scaled to 40% backlight: s=0.4, (c) our result using 40% backlight: s=0.4 with improved visual quality of image and also display.

IV. CONCLUSION

This method propose a system which provides the visual quality for both images and display of systems by visual enhancement under low back-light conditions even though the images are corrupted with the noise under low backlight.

So for saving the battery life, this method proposed the concept of Backlight Scaling and also enhancing the image signals for better visual quality of displays and images. If using only 40% backlight then more battery power is saved. This system can not only prolong the battery life but also enhance visual quality. In this work, visual enhancement framework for all kinds of backlight-scaled displays with better image quality is proposed.

The Experimental result shows that the proposed system performs better than the many existing systems.

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