CONVOLUTION BASED IMAGE ENHANCEMENT IN UNIQUE FINGER IMPRESSION

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Abstract:

Enhancement is used to make an easier view for visual interpretation and understanding of digital imagery. The filtering technique is used for modifying or enhancing an image to emphasize certain features or remove other features. In this paper, we propose a new detail enhancement algorithm which generates the detailed enhanced image directly. The proposed algorithm is combined to sharpen, intensify, smooth and enhance an image for further process.

Keywords: Filtering, Convolution, Kernel, Matrix, Color Values.

I. Introduction

Image enhancement widely used in computer graphics. It is the sub-areas of image processing. The principle objectives of image enhancement techniques are to process an image so that the result is more suitable than the original image for a specific application. The detail enhancement technique is widely used in image editing tool. Filtering is a technique for modifying or enhancing an image. For example, you can filter an image to emphasize certain features or remove other features. Image processing operations implemented with filtering include smoothing, sharpening, and edge enhancement. Filtering is a neighborhood operation, in which the value of any given pixel in the output image is determined by applying some algorithm to the values of the pixels in the neighborhood of the corresponding input pixel. A pixel's neighborhood is some set of pixels, defined by their locations relative to that pixel. Types of filter: Linear and non-Linear filters. Linear filters describe the the output values are linear combinations of the pixels in the original image. Linear methods are far more amenable to mathematical analysis than are nonlinear ones, and are consequently far better understood. There are two complementary ways of studying linear filters, namely - spatial and frequency domains. Each pixel has been replaced by the average of pixel values in a $5 \times 5$ square, or window centered on that pixel. The result is to reduce noise in the image, but also to blur the edges of the fibers. This effect is known as Moving Average Filter.
If the output from the moving average filter is subtracted from the original image, on a pixel-by-pixel basis, then the result is displayed with the largest negative pixel values shown as black and the largest positive pixel values shown as white. This filter (the original image minus its smoothed version) is a Laplacian filter.

The output from the Laplacian filter is added to the original image, again on a pixel-by-pixel basis. This image looks clearer because transitions at edges have been magnified an effect known as unsharp masking.

Nonlinear filters - All filters are not linear, more diverse and difficult to categorize. They are potentially more powerful than linear filters because they are able to reduce noise levels without simultaneously blurring edges. However, their theoretical foundations are far less secure and they can produce features which are entirely spurious.

II. Convolution Based Enhancement

Linear filtering of an image is accomplished through an operation called convolution. Convolution is a neighborhood operation in which each output pixel is the weighted sum of neighboring input pixels. The matrix of weights is called the convolution kernel, also known as the filter. A convolution kernel is a correlation kernel that has been rotated 180 degrees.

Convolution is the treatment of a matrix by another one called kernel. The image is a bi-dimensional collection of pixels in rectangular co-ordinates.

The original image was taken and noise (i.e. motion blur and Gaussian noise) is added to the image and then filtered using regularized filter.

The Gaussian Blur involves the convolution of Gaussian function with the pixels of the image. The equation of Gaussian blur is as follows:

\[
G(xy) = \frac{1}{2\pi\sigma^2} e^{\frac{-x^2 + y^2}{2\sigma^2}} \tag{1}
\]

Where

- value calculated using the Gaussian kernel formula. This value forms part of a kernel, representing a single element.

\(\Pi\) - 22/7

\(\Sigma\) - Threshold or factor value as specified by the user.

\(E\) - Euler’s number equating to 2.718

\(X\) - Horizontal offset or column
Motion blur estimation method has been greatly advanced recently. Besides extensive study on estimation of the space-invariant linear motion blur, current works are mainly focused on two directions, i.e., space-variant motion blur estimation and nonparametric blur kernel estimation.

The Motion Blur effect is a filter that makes the image appear to be moving by adding a blur in a specific direction. The motion can be controlled by angle or direction (0 to 360 degrees or −90 to +90) and/or by distance or intensity in pixels (0 to 999).

\[ \nabla I_b|_{p,b} = I(P + \frac{b}{2}) - I(P - \frac{b}{2}) \]  

The above equation holds for any position p.

We denote the original 2D unblurred continuous signal, the motion blur kernel (point spread function, or PSF), and the blurred signal by I, h, and Ib respectively. In case of space-invariant h, the generation function of the blurred signal is \( Ib = I * h \), where * is the convolution operator. Instead of using its direction θ and length l, we parameterize h by its projection length on x and y axes as a vector \( b = (u, v)^T \), where \( u = l \cos \theta, v = l \sin \theta \).

![High level Design](image)

**Figure-1: High level Design.**

### III. Comparison with the Filter

A Gaussian blur is the result of blurring an image by Gaussian function. The visual effect of this blurring technique is a smooth blur resembling of viewing an image produced by an out-of-focus lens or the shadow of an object under usual illumination.
Gaussian smoothing is also used as a pre-processing stage in computer vision algorithms in order to enhance image structures at different scales.

Motion blurring is associated with photography and video capturing. Rapid movements can be captured in cameras and photography. When recording a single frame, rapid movements could result in the image changing before the frame being captured has completed. Motion Blur filters the size of the kernel specified in convolution influences the perception and appearance of rapidly movement occurred to have blurred the resulting image. Larger kernels produce the appearance of more rapid motion, whereas smaller kernels result in less rapid motion being perceived.

Median filters preserve the edges while removing the noise in the image. The Mean Filter Blur does not result in the same level of smoothing achieved by other image blur methods. The Mean Filter method can also be susceptible to directional artifacts.

The comparative analysis for the filters is explained as follows. We use the following image to illustrate the effect of smoothing with the convolution filters.

**Table-1: The comparative analysis for the filters.**

<table>
<thead>
<tr>
<th>Original image</th>
<th>Enhanced image</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Original Image" /></td>
<td><img src="image2.png" alt="Enhanced Image" /></td>
<td>Gaussian kernel 3x3 weight 5.5 ( \Sigma=4 )</td>
</tr>
<tr>
<td><img src="image3.png" alt="Original Image" /></td>
<td><img src="image4.png" alt="Enhanced Image" /></td>
<td>Corrupted by Gaussian noise, Gaussian kernel 5x5 weight 9.5 Mean=0 ( \Sigma=8 )</td>
</tr>
<tr>
<td><img src="image5.png" alt="Original Image" /></td>
<td><img src="image6.png" alt="Enhanced Image" /></td>
<td>motion blur of 5x5 at 45 degrees</td>
</tr>
</tbody>
</table>
IV. Experimental Results

The comparison of the performance of the filter is one of the important tasks. The performance can be calculated by the help of input image, impulse noise added image and output image. All the filters are simulated with the help of MATLAB10 and Windows 7 operating system.

The performance of all the filtering techniques was evaluated using two different quantitative measures. 1. PSNR 2. MSE

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of a logarithmic decibel scale. The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error. The lower the value of MSE then the error is lower.

\[
MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (I(i,j) - K(i,j))^2
\]

Where

- \(I\) - the original image of size \(m \times n\)
K - the restored images of size m x n.
i,j - the pixels of images.
m, n - row and columns of input images.

\[ PSNR = 10 \log_{10} \left( \frac{\text{MAX}^2}{\text{MSE}} \right) \] (4)

Where MAX = 255, and MSE is calculated using equation (3) mentioned above.

The matrix which are used for performance analysis are Peak Signal to Noise Ratio (PSNR), Mean Absolute Error (MSE).

Table-2: Comparative results of PSNR and MSE of filters.

<table>
<thead>
<tr>
<th>Method</th>
<th>PSNR ratio</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaussian</td>
<td>35.825</td>
<td>27.75</td>
</tr>
<tr>
<td>Median</td>
<td>33.44</td>
<td>29.48</td>
</tr>
<tr>
<td>Motion</td>
<td>21.05</td>
<td>30.34</td>
</tr>
<tr>
<td>Mean</td>
<td>20.21</td>
<td>33.81</td>
</tr>
</tbody>
</table>

Figure-2: Comparative analysis of quantitative measures.

Figure-3: Graph of median filter.
Finally, we test a potential way to address the problem that edge-preserving based detail enhancement algorithms usually boost noises. We use a convolution function to accomplish the filtered image by sigma value and window size.

With this hat function, the pixels in flat areas or at sharp edges are not boosted in the enhanced image. As a result, both the flat areas and the sharp edges are better preserved. The performance analysis is computed based on this function.

**Conclusion**

This paper focus on efficient image enhancement for fingerprint image, the filter will provide the efficient results. Present approach has implemented a contrast Enhancement and convolution technique, and the fingerprint image is given as the input, based on user’s response the images are enhanced on kernels. In order to reduce the processing time the contrast of input image is enhanced and the image is processed by using various filters and the quality and accuracy is measured by PSNR and MSE value and we evaluated the best enhanced image according to these values.

**References**


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