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Digital Image Enhancement Algorithm

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Abstract

Conventional techniques for solving the noise problem have problems to generate different results, depending on the image size and weight values of the used masks, and they require many operations by using a complex formula. In this paper, we propose an image enhancement algorithm to solve the noise problem in a simple, yet easy-to-use way. For this purpose, we determined the difference between the noise of the two adjacent pixels for the horizontal and vertical, and for the two diagonal directions that each of the noise problem occurred, and then we got the average value of these pixel values. Then, we solve the noise problem by using the optimal average value in accordance with occurrence of the noise in the horizontal and vertical, and two adjacent pixels in a diagonal direction. As a result, we got the result that the noise solution in a simple, yet easy-to-use method to obtain a resultant image.

Keywords: *Digital Image, Image Processing, Pattern Recognition, Image Enhancement, Image Restoration, Noise Elimination, Image Filtering*

1. Introduction

In general, the image that we have mentioned means a picture representing the time information. In particular, the digital image is the one that can be used in the form of a computer and a digital device, and the digital image processing is the task of converting the digital image given by the mathematical analysis and processing into a better form. Digital image processing and pattern recognition are very important to form the two axes at the computer graphics community, and they are closely related to each other. So, in order to obtain a better pattern recognition result, effective process for an input digital image process should be followed. In digital image processing, although there are mainly divided into various research areas, they are mainly divided into two groups; The one is the processing and transformation of images to improve the quality of the input image, and the other is the applications that use image processing.

1.1 Processing and Transformation

Among the techniques that belong to the field of digital image processing and converting, there exist the image enhancement, pattern recognition and image compression and the like. Image enhancement technologies [1] mainly consist of as follows: 1) tasks such as noise modification when readjusting the

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brightness of a given input image , or 2) the sharpness of the picture height lower , or 3) image acquisition due to technical problems of optical device. Through this process, the input image is converted to a better level whereby it is possible to obtain a more effective pattern recognition results. Pattern recognition technique[2] extracts the feature from the input image and compares it with the information stored in the computer. One area of artificial intelligence, pattern recognition technology, which is image enhancement techniques described earlier, can be described as the final step executed after passing a number of pre-treatment. Image compression technology [3] is a way to reduce the size of the video in order to reduce the cost of sending the video. Reducing the size of the video resolution, the image quality itself is lowered. However, there have been researches to minimize the loss or not to recognize it.

1.2 Applications

Representative applications that use the image processing may include the medical field, games, and virtual reality application, and security. In the medical field, mainly doctors use medical diagnostic systems who look into the interior of the patient with a two-dimensional or three-dimensional images obtained by the health of the patient test result. This allows identifying the health condition of the patient, and thereby an accurate diagnosis is possible. In the game and VR areas, installing two cameras at different positions, and creating a three-dimensional image on the screen, it allows a user to enable the spatial reality experience in the virtual space through the senses.

Finally, the security sector has recognized system used to determine the identity of the customer at the bank. There are also such as unmanned automatic monitoring system that automatically runs quality checks on products that is made in the factory.

2. The Related Works

Noise in the digital image (Noise) means, due to the influence of mechanical problems or the surrounding environment of the imaging device, the pixel values cannot be made up from the image in an arbitrary position which is generated in the image acquisition process, so the problem is caused in image quality. This noise typically appears irregularly around the area of the input area. As mentioned in the introduction, the digital image processing has various field research to remove these types of noise, and a lot of research has been performed to produce better image results and they are now advancing.

There are representative imaging methods including low pass / high pass filtering technique, methods of filtering by removing the lower form of the noise to produce the blurring and sharpening effects[4]. There also exists median filter technique using a mask having a specific value, and the max / min filter techniques[5], and Fourier transformation techniques for converting the data format of the input image in a different form, and morphological operation technique to handle the shape created in the input image like etc.

Nevertheless, most of the techniques for solving the noise problem, have the following common problems.

Typical problems include:

1) It uses a complex formula to calculate the new pixel values in order to solve the noise problem. This requires a lot of computation time.
2) The results differ from the technique according to the processing result among the input image.
3) The process results depend on the type of filter used to remove noise.
4) The process results differ depending on the situation by artificially specified the weight value given the size and the initial mask.

5) They apply the filter value and the weight value of the mask which gave the initial common value for all the noise generated on the input image.

Because of these problems, a lot of computing time is required in the process to solve the noise problem. Moreover, original normal pixel values of the input image might have a new undesirable problem, which is damage that occurs as a side effect.

3. The Main Subject

In this paper, we propose an effective technique, which spends the less computation time and improves the picture quality for solving the noise problem that induces a less satisfactory result, comparing it with conventional techniques.

3.1 The Basic Concept

We investigated the problem that the noise generated for each of the pixels constituting the input image. If the noise issue, first, we investigate Two Horizontal Direct Neighbor pixels whether the noise problems come from. If there is no noise problem for the two adjacent pixels in the horizontal direction, we would calculate the difference between two pixel values to obtain an average value thereof. We apply the same way to the vertical direction of two adjacent pixels (Two Vertical Direct Neighbor Pixels). And, we calculate the difference between these two intensity values and average according to whether occurrence of the noise problem.

For the case that no noise problems occur in both the horizontal direction and the adjacent pixels in the vertical direction, we solve the noise problem by using the average value corresponding to the small direction difference of the pixel values from the horizontal and vertical directions. In case that the noise problem occurred both in the horizontal and vertical direction, diagonal-up direction of two adjacent pixels (Two Diagonal-Up Indirect Neighbor Pixels) and diagonal-down direction of two adjacent pixels (Two Diagonal-Down Indirect Pixels for the Neighbor) in the down side, we solve the noise problem in the same way as the process was executed for the horizontal direction and the vertical direction.

If the noise problem solved by using adjacent pixels in the horizontal direction and the vertical direction, we find next pixel with noise problem running the improved algorithm again in the input image. If this did not solve the noise problem by using adjacent pixels in the horizontal direction and the vertical direction, we use the adjacent pixels in the diagonal-up and diagonal–down directions solves the noise problem. The reason is that, when viewed around the structural of the pixel with noise problem, the connection is stronger between the adjacent pixels in the horizontal direction and the vertical direction, than the bonding force between the adjacent pixels of the diagonal-up and diagonal-down directions, it results in the shortening operation time.

3.2 The Image Enhancement Algorithm

Through the following algorithm, we would like to explain in more detail the process by which the image quality improvement

Step 1) Investigate that noise problem occurs for each of the pixels constituting the input image.

Step 1.1) If the noise problem did not occur, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.

Step 1.2) If the noise problem occurred, we investigate whether the noise problems were occurred on of two adjacent pixels in the horizontal direction. Let the two neighboring pixel values be ILP and IRP.

Step 1.2.1) If no noise problems occur in all of the two adjacent pixels in the horizontal direction, we get an average value (HAve) and obtain a difference (HDif) of the two pixel values.

HAve = CInt((ILP+IRP)/2.0) (1)
HDif = Math.Abs(ILP-IRP) (2)

Step 1.2.2) If the noise problem occurs in any one place in the two adjacent pixels in the horizontal direction, we do not calculate the difference and the average value of these pixel values.
Step 1.2.3) By examining two adjacent pixels in the vertical direction, and also we investigate whether these noise problems occur. Let the two neighboring pixel values be IBP and ITP.
Step 1.2.3.1) If no noise problems occur in all of the two adjacent pixels in the vertical direction, we obtain an average value (VAve) and a difference (VDif) of the two pixel values.

VAve = CInt((IBP+ITP)/2.0) (3)
VDif = Math.Abs(IBP-ITP) (4)

Step 1.2.3.2) If noise occurs in one of two neighbor pixels in the vertical direction, do not calculate the average value and the difference of pixels.
Step 1.2.4) If the noise problem did not occur in the two adjacent pixels in horizontal and vertical directions at the same time,
Step 1.2.4.1) If the HDif <= VDif, use the HAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.4.2) If the HDif > VDif, use the VAve solves the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.5) If noise is not a problem in the two adjacent pixels in the horizontal direction and if noise problem occurs the two adjacent pixels in the vertical direction, use the HAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.6) If no noise problem occurs in two adjacent pixels in the horizontal direction but not in the two adjacent pixels in the vertical direction, use VAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.7) If the noise problem occurs in two adjacent pixels in the horizontal direction and If the noise problem occurs in two adjacent pixels in the vertical direction at the same time, we examine two adjacent pixels in ascending diagonal direction to solve noise problem . Let the two neighboring pixel values be ILBP the IRTP.
Step 1.2.7.1) If no noise problems occur in all of the two adjacent pixels in ascending diagonal direction, we get an average value(DUAve) and obtain a difference of the two pixel values(DUDif).

DUAve = CInt((ILBP+IRTP)/2.0) (5)
DUDif = Math.Abs(ILBP-IRTP) (6)

Step 1.2.7.2) If the noise problem occurs in any one of adjacent pixels in ascending diagonal direction, we do not calculate the average value and the difference between these pixel values.
Step 1.2.7.3) We investigate the two adjacent pixels in the downward diagonal direction to investigate whether the noise problems occur. Let the two neighboring pixel values ILTP and IRBP.

Step 1.2.7.3.1) If there is no noise problems in both of two adjacent pixels in the diagonal-down direction, then calculate their average(DDAve) and the difference between two pixel values (DDDif). .

DDAve = CInt((ILTP+IRBP)/2.0) (7)
DDDif = Math.Abs(ILTP-IRBP) (8)

Step 1.2.7.3.2) If the noise problem occurs from anyone of two adjacent pixels in the diagonal downward direction, we do not calculate the difference between the average value of these pixel values.
Step 1.2.7.4) If noise was not a problem in two adjacent pixels in the diagonal-up direction and in two adjacent pixels in the diagonal-down direction at the same time,
Step 1.2.7.4.1) If the DUDif <= DDDif, use DUAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.7.4.2) If the DUDif > DDDif, use DDAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.7.5) If no noise problem occurs in two neighboring pixels in the rising diagonal direction, but if noise occurs in the downward diagonal direction, use DUAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.
Step 1.2.7.6) If noise problem occurs in two neighboring pixels in the rising diagonal direction, but if no noise occurs in the downward diagonal direction, use DDAve to solve the noise problem. Then, go back to Step 1 to investigate the occurrence of a noise problem for the next pixel.

3.3 The Results

The following photos show the results of running the image enhancement algorithms. Figure 1 is a monochrome input image with a resolution of 1370x724.

Figure 2 is an image of 10,000 noise generated on a random position in the input image.

Figure 3 shows the result of applying our proposed algorithm to the image of Figure 2 which has noise. The image quality was enhanced significantly and there is no difference comparing it with the original image in Figure 1.

For the artificial successive noise in the horizontal, vertical, and diagonal directions(Figure 4), the proposed algorithm shows the improved image quality and thus satisfactory result was obtained(Figure 5).

3.4 The pros and cons of the proposed image enhancement algorithm

Like the well known algorithms, the proposed image quality improvement algorithm in this paper has the following pros and cons.

The advantage is,

1) The conventional techniques are complex, and they use a variety of difficult calculation method to obtain a satisfactory result. The proposed method is simple and easy to understand but there is no difference in results comparing with conventional techniques.
2) The proposed method reduces computation time comparing with the conventional techniques because of its simple structure of the enhanced algorithm.
3) While the conventional techniques got the different results depending on the size and weight values of a filter or a mask to resolve the noise problem, the proposed algorithm obtains the same improved results without a filter or mask.
4) The existing techniques using masks cannot solve the noise problem in the case that noise occurs

continuously in the horizontal, vertical, or diagonal direction while our algorithm solve the noise problem effectively in a variety way when there is successive noise.

5) In calculating the new value to replace the pixel value of the noise occurrence, we consider adjacent pixels by a value such that our method minimizes the brightness difference between them. As a result, we can maintain the original image as much as possible.

The disadvantage is, as with the conventional technique, when the noise problem intensively occurs in a specific location forming a predetermined size or more regions form, the proposed algorithm can reduce the size of the area made up of noise at the boundary, however noise problems can not be fully resolved.

4. Conclusion and Future work

Image quality enhancement algorithm is proposed using a simple, yet easy-to-understand algorithm compared with conventional techniques, which generates good results while it takes less computation time. And because the proposed algorithm does not use the mask, while most of the other techniques use it to get a different result, depending on the size and weight of the mask value, it has the advantage that does not cause problems due to the mask used.

For future research directions we are developing an algorithm to effectively eliminate the noise problem occurred in the color image.

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Figure 1. The Original Image

Figure 2. The noisy image with 10000 noise in the original

Figure 3. The restored image solving the noise problem

Figure 4. The image with the continuous noise in the original image

Figure 5. The restored image solving the continuous noise