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A Half-toning Method based on Error Diffusion

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Abstract. In this paper, a new error diffusion approach is proposed that provides high quality ED results. The proposed error diffusion approach is based on half toning method, which is known as Floyd and Steinberg's filter. The proposed method is faster than conventional methods.

Keywords: Signal, half-toning, residual diffusion.

1 Introduction

The error diffusion (ED) is an approach of half-toning where the discrete values assignment is made and residual is allocated to adjacent pixels [1-5]. Here, non-processed pixels are referred as neighbor pixels [6]. The main goal is to transform a diverse form of images into binary format. The ED is one of half-toning methods, where ED is categorized as region operation (or pixel operation) [7-23]. Therefore, parallel processing is possible and buffer is required for this process.

This paper proposed ED approach, which is modified version of Floyd and Steinberg's filter. To expedite conducting time, the denominator of the proposed method is 2^k. This paper proposes ED method for color images. This paper is organized as follows. Section 2 introduces related works in half-toning methods. The later part of Section 2 provides the proposed method. Section 3 shows objective and visual performances of the proposed method and the benchmarks. Finally, Section 4 provides conclusion remarks.

2 Error Diffusion and Dithering Approach

The ED model is a neighbor method yields sharper images than point methods and creates subjectively pleasant textures. However, this model is very sensitive to dot-overlap printer due to artifacts. Thus, it is requested to merge a printer model in the algorithm. In addition, taking HVS model in ED is helpful.

We assume one dimensional ED case. If images have certain artifact, it can be watched in particular direction. These directions could be horizontal, vertical, or diagonal direction. Our purpose is to design an ED method which needs similar complexity of Floyd-Steinberg ED method. However, as filter size grows, complexity

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increases. Therefore, we adopt 8 coefficients instead of 10 coefficients. Equation (1) shows the proposed method.

$$\frac{1}{10N-12}\begin{bmatrix} X & X & Y & N & N-1 \\ N-2 & N-1 & N & N-1 & N-2 \\ 0 & N-2 & N-1 & N-2 & 0 \end{bmatrix}. \quad \textbf{(1)}$$

Figure 1 shows one of the simplest formats of ED, where parameters w_1 and w_2 are weight, and $w_1+w_2=1$.

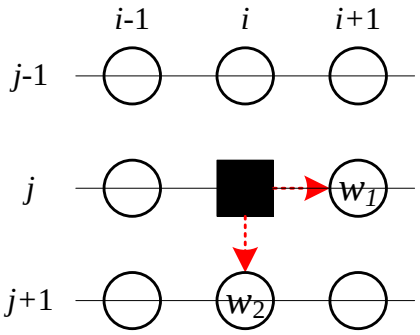

Fig. 1. An example of ED with 3×3 window size. Parameters w_1 and w_2 are weights.

3 Experimental Results

In this section, we provide the result images for the different methods discussed above. Conventional methods are T_{FS} (Floyd and Steinberg), T_{JJN} (Jarvis, Judice, and Ninke), T_{ST} (Stucki), and the proposed methods are T_8, and T_{128}. The LC dataset was adopted for performance comparison, which are 540×720 size images. To assess the performance of the proposed method, we adopted 10 color images from LC dataset.

Figure 2 shows result images for #6 LC image. Figure 2(a) is the original image, and Fig. 2(b) is its T_8 processed image. Figures 2(c,d,e) are red, green, and blue channel decomposed images.

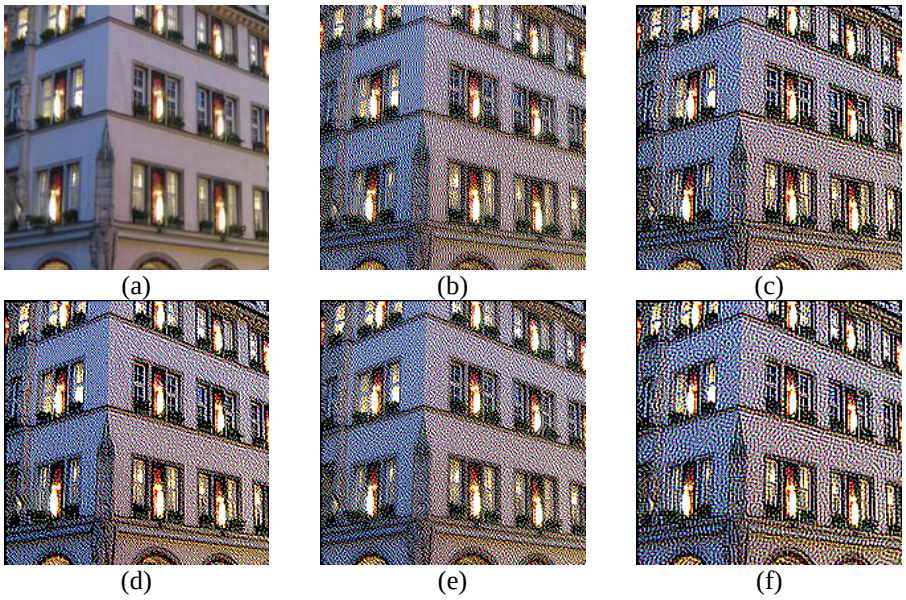

Fig. 2. Performance comparison for different methods on LC image #6: (a) Original image, (b) T_{FS}, (c) T_{JJN}, (d) T_{ST}, (e) T_8, and (f) T_{128}.

4 Conclusion

This paper proposes a new error diffusion approach which is assumed to provide high quality ED. The proposed method quantizes each pixel to 1-bit binary one. To accelerate processing speed, the denominator of the proposed method is selected with the form of 2^k. Thus, the method is faster than the conventional methods, while preserving simplicity property. Simulation results indicate that the provided red, green, blue channels and color images are satisfactory for viewer.

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