A Two-Step Adaptive Descreening Method for Scanned Halftone Image

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Abstract. Halftoning is a necessary technique for electrophotographic printers to print continuous tone images. Scanned images obtained from such printed hard copies are corrupted by screen like artifacts called halftone patterns. Descreening aims to recover high quality continuous tone image from the scanned image. In this paper, a two-step descreening method is proposed to remove screen like artifacts adaptively. Firstly, an Extreme Learning Machine (ELM) based halftone image classification scheme is introduced to categorize the scanned images into different resolutions. Then in the halftone pattern removal step, patch similarity based smoothing filtering and nonlinear enhancement are combined to remove halftone patterns and preserve the image quality. Experiments demonstrate that the proposed method removes halftone patterns effectively, while preserving more details and recovering cleaner smoothing regions.

Keywords: Scanned image, descreening, halftone, adaptive parameters.

1 Introduction

Currently, most electrophotographic (EP) printers adopt a halftone technique to approximate the original contone image with a binary halftone image. However, annoying halftone patterns often appear in scanned images of such printed hard copies. These patterns decrease the aesthetic quality of scanned images. Moreover, the periodic halftone patterns introduced by clustered dots halftoning[1], the most commonly used halftoning technique in current EP printers, may produce Moiré effect in hard copies if the scanned images are reprinted[2].

Several methods[3]-[6] recover contone images with details and sharp edges from binary halftone images. Nevertheless, these methods can only work on binary halftone images and they are not suitable to descreen the scanned halftone images because scanned images are grayscale. Some other descreening methods are designed for the scanned halftone image. Intuitively, the simplest way of descreening is to perform low-pass filtering on the scanned image. However, these

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filtering approaches have difficulties in striking a balance between detail preservation and halftone patterns removal. Siddiqui *et al.*[2][7] introduced two descreening methods for scanned halftone images. The training based method[2] contains two steps: basic prediction of contone image, and modified SUSAN filtering based on the predicted version. The authors adopt two schemes to predict the basic contone image, one is simply the Gaussian filtering; the other is resolution synthesis based denoising. And the basic image is used to guide the modified SUSAN filtering to obtain the final descreened image. The results of the method have sharp edges. However, it cannot recover high quality smooth regions. And in the resolution synthesis based denoising, different resolution sample image pairs need to be collected and registrated for training. The second method used local gradient information to estimate contone value[7]. Although it has high computational efficiency, this method cannot remove the halftone patterns along edges effectively.

Most of the above methods for scanned images did not pay much attention to the printing and scanning process. In fact, the halftone patterns in the scanned images vary a lot at different scanning resolutions, but most of these methods are not able to select parameters adaptively. This may lead to detail loss and blurred edges in the recovered contone images at some resolutions.

In this paper, a two-step method is proposed to descreen the scanned image adaptively. In the first step, a halftone image classification is proposed to classify the scanned images into different scanning resolutions. The Local Binary Pattern (LBP) feature is extracted and the Extreme Learning Machine (ELM) is used for classification. And in the second step, contone images with high quality are recovered by an adaptive halftone pattern removal algorithm, whose parameters are determined by the classification results. A patch similarity based smoothing filter is used to remove the halftone patterns, and a nonlinear enhancement is followed to improve the details of the recovered contone images.

2 Adaptive Scanned Image Descreening

Fig.1 is an overview of the proposed descreening method. It consists of two steps: scanning resolution classification, and adaptive halftone pattern removal. The classification step focuses on distinguishing different scanning resolutions of scanned halftone images. Scanned images with known resolutions make a training dataset. The LBP features of all the scanned images in the training dataset is extracted to train an ELM classifier. For the input scanned image with arbitrary resolution, the ELM classifier is used to predict its scanning resolution. In the adaptive halftone pattern removal step, a patch similarity based smoothing filtering is used to remove halftone patterns of the scanned image, and a nonlinear enhancement is followed to improve the sharpness and contrast of the recovered contone image. The parameters of the patch similarity based smoothing filter and the nonlinear enhancement are adaptively selected by the predicted resolution of the input image.