Suppression of Noise in Historical Photographs Using a Fuzzy Truncated-Median Filter

Michael Wirth and Bruce Bobier

Dept. Computing & Information Science, University of Guelph
{mwirth, bbobier}@uoguelph.ca

Abstract. To a large extent noise suppression algorithms have been designed to deal with the two most classically defined types of noise: impulsive and Gaussian noise. However digitized images such as those acquired from historical photographs such as albumen prints contain a form of quasi-noise we shall term *chaotic* noise. This paper describes the concept of chaotic noise and proposes two fuzzy filters to suppress various types of noise in historical photographs based on the truncated median, an approximation of the mode filter.

Keywords: noise suppression, chaotic noise, fuzzy filter, image quality.

1 Introduction

Photographs represent one of the oldest visual forms of media used to convey information. Historical images constitute an important part of our cultural and documentary heritage (see Figure 1). In many cases the views that these images represent have either changed significantly, or no longer exist, and as such they provide an invaluable insight into the state of structures and monuments of the past 150 years. The purpose of image enhancement is to improve the quality of an image. This usually means improving acuity, augmenting contrast, or suppressing noise. Noise can be described as any unwanted distortion in an image. The two most commonly portrayed types of noise in images are impulse noise and random noise. Impulse noise is characterized by spurious corrupted pixels, which may not effect the content of the image too greatly, and may be due to information loss. Random, or Gaussian noise can be triggered during the process of generating an image, and is analogous to film "grain". In photography, the "grainy" effect of a photograph is caused by developed silver halide crystals that cluster together on the processed negative. When a photograph is printed these grain clusters are enlarged, becoming a perceptible pattern over the whole image. The presence of such film grain has a noticeable effect on the ability to discern small features in an image. Figure 1 shows an example of film grain noise. However there is also a form of quasi-noise we will categorize as *chaotic noise*. Chaotic noise may occur as the result of a deteriorative process, resulting in changes to the physical structure of a piece of art or photograph. When digitized, physical characteristics such as cracks in paintings and albumen prints manifest themselves as noise in the image, contributing to a decrease in image

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