REMOVAL OF DEFECTS FROM IMAGES USING IMAGE RECONSTRUCTION TECHNIQUES

By

Véronique Brenda Leung Kai Yuen

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UNIVERSITY OF MAURITIUS

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One picture is worth ten thousand words.
Anonymous

One picture without defects is worth more than a million words.
V. Leung

ABSTRACT

Images are extensively used in many fields due to their ability to capture valuable scientific, cultural or artistic data. However, these images are often afflicted by different types of degradations which reduce their value. The aim of this project is to show how reconstruction is being used to solve the above-mentioned problem, more particularly in the restoration of images containing defects. Consequently, three techniques have been implemented namely the semi-transparent blotch removal method, the image noise removal method and an extended version of the line scratch correction algorithm. User involvement in the reconstruction processes is required since defect detection is manual, but the actual restoration process is fully automatic or at least semi-automatic depending on the technique. The results obtained show the successful restoration of defects belonging to the following categories: semi-transparent blotches, line scratches and non-transparent defects like spots, blotches or other unwanted objects.

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INTRODUCTION

Images are used to a large extent in almost every field. Their importance is so significant that much effort and money have been invested to be able to produce sophisticated devices that can capture and produce images, may it be for astronomical or medical imaging, or simply as photographic prints. Image reconstruction is a field where the use of images is further expanded. Here, images are extracted from measured data which can be in the form of images themselves or also in the form of complexly encoded data like radio interferometry, ultrasound images or sonar imaging [PUET95b]. This is particularly important since the obtained images can be manipulated without destroying or damaging the original data. The use of image reconstruction includes examples like obtaining the spatial structure of internal organs of the body from measurements of radiation transmission or in image restoration where the aim is to extract a better image from a degraded image.

It is towards image restoration that this project is oriented. Many images obtained are not always of good quality. An old photograph will have acquired visible degradation over time due to aging. But it is not only old photographs that are affected by degradations: astronomical images obtained from space or medical images are often corrupted by degradations even though they are taken with sophisticated equipment. Degradations can arise due to accidental or environmental processes or they can be inherent in the acquisition of the images. Such degradations obviously reduce the quality of the images and make them less reliable in cases where accuracy is primordial like in medical imaging. Also, in certain circumstances, the original degraded images are the only ones available like photographs of ancient relics, thus making it impossible to obtain other similar images or it is simply unfeasible to invest more money to obtain other images since the cost is too prohibitive like obtaining images of stars and planets from outer space. The solution to all these problems resides in the application of image restoration to remove these degradations.

Much research has been done in the field of image restoration ever since the 1950's [BANH97], resulting in the development of several techniques. However, most

techniques have been developed for a particular problem in a specific field and their use in other fields is somewhat limited. For instance, traditional restoration techniques used in astronomical imaging are not adapted to remove degradations that old photographs present. But more recently, a subfield of image restoration has emerged, namely the field of digital image inpainting, which is more appropriate for this type of restoration. In fact, nowadays, advances in technology make it possible to digitize old photographs and store them in numeric form. Hence, the use of digital image restoration and inpainting is ever more appreciated since the digital version of corrupted images can be processed without affecting the original photographic prints, and the restored images can be reprinted as desired. However, it should be noted that image manipulation, including restoration of photographs, has long been performed by photograph retouchers through the use of imaging software, but the point to note here is that the process is largely if not completely manual. Digital image restoration and inpainting aim to overcome this problem and attempt to provide some automation over the restoration procedure.

This report describes how restoration is being done with respect to images affected by common defects like cracks, blotches or scratches, and sometimes even by deliberate human manipulations like superimposed text. This type of restoration is particularly aimed at vintage photographs or old movies, which are often badly affected by these defects. Removal of these degradations is motivated by cultural, artistic or simply personal reasons. If technology can permit it, who would not want a nice and recent looking photograph of their graduation (even if it is dated fifty years back) framed on the wall, instead of an old scratched and badly torn print?

The report is organized in five chapters. Chapter 1 provides the basic background that helps to understand the different concepts related to image reconstruction, including image restoration and image inpainting and also elaborates on the applications of these techniques in different fields. Chapter 2 presents an analysis of the different existing techniques used to remove degradations from images. From the comparisons obtained in the analysis chapter, chapter 3 presents the proposed solution to the problem of removal of defects from images. In this view, three techniques are identified as solutions for the problem and an overview of their workings are explained in this chapter. A coarse-grained design of the system is also

presented. Chapter 4 develops the coarse design into a fine-grained design and provides details on the implementation of the three techniques. Chapter 5 shows how testing has been done on the system and the results obtained are thereafter evaluated. A conclusion is provided whereby we discuss about the benefits achieved, the difficulties encountered and mainly about how this project could be further improved in order to cater for the major problems related in the results evaluation.