Preface

During the last thirty years, electronic image processing has grown from a dedicated scientific research field limited to a small set of researchers to a technical area that has found use in many scientific and commercial applications. During this time, there has been enormous growth in this field due to the improvements in computer and imaging sensor technologies. In particular, electronic image processing of color images, which had been limited to a dedicated few because of its hardware requirements, is now readily available on typical desktop computers. The manipulation and inclusion of color images is becoming standard practice in business presentations.

Digital film is slowly replacing chemical film technology, making electronic cameras that acquire, capture, and store images digitally available to the general public. Many of these camera systems provide an easy means of transferring these images to a standard desktop computer for processing and storage.

The goal of this text is to provide the fundamentals of image processing to practicing engineers or scientists who needs to understand these fundamentals to perform their technical tasks. In many technical fields, images must be processed to enhance features that are present within the image. For example, the microbiologist is typically interested in enhancing images of cells, while the astronomer is typically interested in enhancing images of remote galaxies. It is hoped that this book will bridge the gap between the existing image processing texts dedicated to researchers in the field, and the practicing engineer or scientist who needs to understand and use the various types of image processing algorithms.

Throughout this text are included a large variety of example images to give the reader a better understanding of how a particular image processing algorithm works. Whenever possible, the text goes into detail, explaining the advantages, disadvantages, and when to use each algorithm.

Chapter 1 discusses the fundamentals of image processing, including the spatial sampling digitization of images. Also discussed in this chapter are the fundamentals of the human visual system, since typically the final result of image manipulation is for viewing by a human. Hence, many types of image processing algorithms take advantage of the peculiarities of the human visual system.

Chapter 2 presents several types of image transforms that are commonly used. This chapter follows the standard classical approach of presenting linear system theory expanded into two dimensions for electronic image processing. Based on Fourier frequency analysis, the effect of spatial filtering of an image is presented. Chapters 3 and 4 build upon Chapter 2, giving several types of image enhancement and restoration techniques in both the spatial and the frequency domains.

Chapter 5 covers a new area of image processing and includes several types of nonlinear and adaptive filters. Compared to linear filters, these do a better job of removing noise from an image while preserving the sharpness of the filtered image. In particular, adaptive filters offer the capability of changing their characteristics depending on the noise or image features present within the filter window.

Chapter 6, which covers color image processing, is the newest area of image processing. Included in this chapter are the many color models that are used to represent a color image and also several color image enhancement methods that are commonly used to enhance color images. Because this is an emerging field, the author has included material from two recent technical papers on the subject.

Chapter 7 covers the important area of geometrical operations and morphological filtering. Geometrical operations include rotating, scaling, and zooming of an image. Since many of these geometrical algorithms require pixel interpolation, a section on image interpolation techniques has been included. Morphological filters, on the other hand, are used to geometrically change the shape of objects within an image and to extract key geometrical features.

Chapter 8 covers image segmentation and representation, in particular, the segmentation of objects and features within an image from its background and the detection of edges within an image. Once an object has been segmented or its edges found, several image representation methods are presented that code these objects or edges using different types of data representations.

Finally, Chapter 9 discusses the area of image compression, giving the reader the background behind the different image compression techniques that are commonly used. A comparison is given between lossless and lossy compression.

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