functionally equivalent hardware components, or a combination of software and hardware.

Other objects and attainments together with a fuller understanding of the invention will become apparent and appreciated by referring to the following description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like reference symbols refer to like parts:

FIG. **1** is a block diagram illustrating components in an exemplary image processing/reproduction system that may be used to implement aspects of the present invention.

FIG. **2** is a block and flow diagram showing the overall processing according to embodiments of the invention.

FIG. **3** is a schematic representation of color points RGB_{anchor} and RGB_{ref} in RGB color space and the line segment ("reference axis") extending between them.

FIG. **4** is a schematic representation of the reference axis quantized into K bins for use in the segmenting operation.

FIG. **5** is a schematic representation of a co-occurrence matrix for use in the segmenting operation.

FIG. **6** is a schematic representation of the co-occurrence matrix showing the two regions A and B created by threshold t.

FIGS. **7**(*a*) and **7**(*b*) show the relationship between the RBF function ϕ and the absolute difference between its two variables $\|x_1-x_2\|$ which may be linear as shown in FIG. **7**(*a*) or gaussian as shown in FIG. **7**(*b*).

FIG. **8** is a schematic representation of a distance layer map used in the CRBF filtering operation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates components in a typical image processing system **10** in which the techniques of the present invention can be employed. As illustrated in FIG. **1**, the system includes a central processing unit (CPU) **11** that provides computing resources and controls the computer. CPU **11** may be implemented with a microprocessor or the like, and may also include a graphics processor and/or a floating point coprocessor for mathematical computations. System **10** further includes system memory **12** which may be in the form of random-access memory (RAM) and read-only memory (ROM).

A number of controllers and peripheral devices are also provided, as shown in FIG. **1**. Input controller **13** represents an interface to one or more input devices **14**, such as a keyboard, mouse or stylus. There is also a controller **15** which communicates with a scanner **16** or equivalent device for digitizing documents including photographic images. A storage controller **17** interfaces with one or more storage devices **18** each of which includes a storage medium such as magnetic tape or disk, or an optical medium that may be used to record programs of instructions for operating systems, utilities and applications which may include embodiments of programs that implement various aspects of the present invention. Storage device(s) **18** may also be used to store data to be processed in accordance with the invention. A display controller **19** provides an interface to a display device **21** which may be a cathode ray tube (CRT) or thin film transistor (TFT) display. A printer controller **22** is also provided for communicating with a printer **23** for printing documents including photographic images processed in accordance with the invention. A communications controller **24** interfaces with a communication device **25** which enables system **10** to connect to remote devices through any of a variety of networks including the Internet, a local area network (LAN), a wide area network (WAN), or through any suitable electromagnetic carrier signals including infrared signals.

In the illustrated embodiment, all major system components connect to bus **26** which may represent more than one physical bus. For example, some personal computers incorporate only a so-called Industry Standard Architecture (ISA) bus. Other computers incorporate an ISA bus as well as a higher bandwidth bus.

While all system components may be located in physical proximity to one another, such is not a requirement of the invention. For example, scanner **16** may be located remotely of processor **11**. Also, programs that implement various aspects of this invention may be accessed from a remote location (e.g., a server) over a network. Thus, scanned data or software embodying a program that implements various aspects of the invention may be conveyed to processor **11** through any of a variety of machine-readable medium including magnetic tape or disk or optical disc, any of which may be used to implement system memory **12** or storage device(s) **18**, network signals or other suitable electromagnetic carrier signals including infrared signals.

Overview

The techniques of the present invention segment missing data regions (which may include characters in a date field). Of all the missing data regions segmented, only those having an area/perimeter ratio less than a certain threshold are kept for further processing. Those regions are filtered using a "closest to radial basis function" (CRBF) approach. Missing data regions may be lighter or darker than the neighboring pixels. For example, scratched film negatives show "dark" scratches, while lint on a scanner bed shows "light" scratches on the scanned representation. Light scratches typically show on photos, but old photographs may exhibit "dark" spots. The segmenting and filtering employed in this invention is designed to handle all such blemishes.

The overall processing pipeline is shown in FIG. **2**. A photograph or negative film having one or more regions of missing data is scanned in block **31**. A suitable median filter having a relatively small kernel (e.g., 3×3) is applied to the pixels of the resulting digital representation in block **32**. Then, in block **33**, the representation is segmented to identify blemishes or missing data regions. Those regions are then subjected to two types of filtering: component filtering (block **34**) and CRBF filtering (block **35**). The representation is then reconstructed with missing data regions identified in the segmenting operation filled in. The segmenting, component filtering and CRBF filtering are described in more detail below.

Segmenting

(i) A reference color (RGB_{ref}) is established for a particular sub-portion of the representation that generally coincides with a missing data region. A reference color can be established for more than one sub-portion of the representation, in which case the processing described below will be repeated for each such portion. RGB_{ref} may be one of a number of pre-stored colors or supplied by the user by clicking on the color of interest on a preview scan of the particular image being processed. For example, if a date on a photograph is to be removed, RGB_{ref} is typically the color that was used to overlay the date on the film. A second color, RGB_{anchor}, which is the farthest color from RGB_{ref} in the