METHOD AND APPARATUS FOR DIFFERENTIAL ILLUMINATION IMAGE-CAPTURING AND DEFECT HANDLING

PRIORITY APPLICATIONS

This application claims priority under 35 U.S.C. §119(e) to provisional application Ser. No. 60/158,672 filed Oct. 8, 1999, entitled "Method and Apparatus for Differential Illumination Image-capturing and Defect Handling" and provisional application Ser. No. 60/158,710 filed Oct. 8, 1999, entitled "Method and System for Defect Detection Using Differential-Illumination."

CROSS REFERENCE OF RELATED APPLICATIONS

This application is related to co-pending application Ser. No. 09/552,473, entitled "Scanner and Method" by Ford et al. and co-pending application Ser. No. 09/679,990, entitled "System and Method for Correcting Defects in Digital Images Through Selective Fill-In From Surrounding Areas" by Edgar et al.

TECHNICAL FIELD OF THE INVENTION

This invention relates to the field of image processing, and more particularly to a method and apparatus for differential illumination image-capturing and defect handling.

BACKGROUND OF THE INVENTION

Image scanners, such as flatbed scanners, are widely used to convert documents, such as papers, images, photographs, negatives and the like, into electronic representations of the document or digital images. This is typically done by placing the document on a glass platen, illuminating the document with visible light and moving an imager relative to the document to record the intensity of light reflected from each minute location of the document and to process that information to form the digital image of the document. The digital image can then be stored, altered electronically, or printed.

A drawback of a conventional scanning system is that defects on the document such as dust, lint, and scratches, as well as defects in the scanning system, such as platen scratches, smudges, dust and fingerprints result in a degraded electronic representation or digital image. Also, when scanning matte finished photographs, many conventional scanners have a tendency to produce lines in the digital image. This is because matte finished photographs have a raised surface texture that causes shadows to be cast in between the raised area.

SUMMARY OF THE INVENTION

Accordingly, it may be appreciated that a need has arisen for a method and system for reducing defects in a digital image. In accordance with the teachings of the present invention, a method and system for differential illumination image-capturing and defect handling is provided which substantially eliminates or reduces the disadvantages and problems associated with conventional imaging systems.

In one embodiment of the present invention, an image processing system is provided. The system includes a first light source operable to illuminate a document in a first direction and a second light source operable to illuminate the document from a second direction. Also included is a sensing device operable to detect light from the first and second light sources after interaction with the document. A processor receives information from the sensing device and produces an image and image defects.

In another implementation of the present invention, a method for determining defects on a document is disclosed. In a first step, a first image record based on light influenced by the document from a first light source is obtained. In a second step, a second image record based on light influenced by the document from a second light source is obtained. Next, a maximum pixel intensity record is obtained by comparing the first and second image records and selecting the highest pixel intensity value for a given pixel location. Then, a minimum pixel intensity record is obtained by comparing the first and second image records and selecting the lowest pixel intensity value for a given pixel location. Next, a difference record is obtained by subtracting the minimum pixel intensity record from the maximum pixel intensity value. Next, the center of a defect region is obtained by locating localized minimums in the difference record. Finally, defect boundaries are determined based on the difference record.

The present invention provides various technical advantages over conventional imaging systems. For example, one technical advantage is that the effects of defects can be substantially removed from a digital image. Another technical advantage is that documents with textured surfaces can be scanned more accurately then with many conventional systems. Another technical advantage is that at least two image datasets, corresponding to illumination from at least two separately illuminated light sources can be acquired. Other technical advantages will be readily apparent to one skilled in the art from the following figures, descriptions and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying figures, in which like reference numbers represent like parts and in which:

FIG. **1** illustrates one embodiment of an image defect correction system in accordance with the teachings of the present invention;

FIG. **2** illustrates the components of a data-processing system in accordance with the teachings of the present invention;

FIG. **3** is a flowchart illustrating the overall operation of the image defect correction system in accordance with the teachings of the present invention;

FIG. **4** is a flowchart illustrating the capturing of a digital image in accordance with the teachings of the present invention;

FIG. **5***a* is a simplified illustration of the image defect correction system, FIG. **5***b* illustrates a document illuminated by a first light source, FIG. **5***c* illustrates a document illustrated by a second light source, FIG. **5***d* illustrates a defect map;

FIG. **6***a* is a density plot illustrating pixel intensity when illuminated from a first light source, FIG. **6***b* is a density plot illustrating pixel intensity when illustrated from a second light source;

FIG. **7** is a flowchart illustrating the processing of forming digital images in accordance with the teachings of the present invention;

FIG. **8***a* is a density plot illustrating a maximum pixel intensity for a pixel location, FIG. **8***b* is a density plot