MAPPING DEFECTS OR DIRT DYNAMICALLY AFFECTING AN IMAGE ACQUISITION DEVICE

1 BACKGROUND—FIELD OF INVENTION

This invention relates to image forming devices such as video cameras, scanners, and photocopiers, specifically identifying dust and other defects corrupting such systems.

2 BACKGROUND—DISCUSSION OF PRIOR ART

Photocopiers get dirty. This degrades the quality of the images they produce. In scanners and photocopiers this problem is exacerbated by the fact that the lens, or glass, of such instruments is in direct contact with documents and samples which are somewhat abrasive. Even worse, since the focal plane of such instruments is right at the glass, any dust or scratch obliterates a portion of the scanned image.

One way of detecting defects such as a scratch or dust speck on a photocopier platen is to acquire an image through that platen of a perfect target or reference image, such as a solidly white piece of plastic that has no scratches, dents or dust particles itself. A method for doing this was disclosed in U.S. Pat. No. 5,214,470 to Denber (1993). However, in many typical work environments any such reference image, such as a piece of white plastic attached to the cover or lid of the photocopier or scanner, is likely to receive just as much dust and abrasion as the platen or lens of the photocopier. Maintaining a perfect reference target requires laborious care. A perfect reference target may even be difficult to manufacture. However, any imperfection in the reference target will be interpreted as a defect by Denber's method.

U.S. Pat. No. 5,623,558 to Billawala et al. (1997) discloses a method of correcting a scanned image in pixel locations predetermined to be defective. However, it does not suggest or teach a method for discovering such pixels beyond Denber.

Approaches similar to Denber's but relating to charge-coupled device (CCD) based video cameras are taught in U.S. Pat. No. 5,416,516 to Kameyama et al. (1995) and U.S. Pat. No. 5,625,413 to Katoh et al. (1997). However, in so far as these teach method of identify faulty regions in two-dimensional devices, these patents are similar to Denber's in that they rely on a unique, perfect reference image. In the case of video cameras, the iris is closed creating a perfectly black image against which some kinds of defects can be measured. This, however, necessitates closing the iris, and can only detect "white spot" defects.

U.S. Pat. No. 4,748,507 to Gural (1988) discloses an interesting approach of shifting the imaged object relative to the imaging device so that a given portion of the image is unlikely to be imaged twice by defective pixels, allowing circuitry to correct the defects. However, this is cumbersome for typical operations, requiring at the very least machinery to shift the target or the imaging device.

Finally, a well known technique for dealing with defects in portions of the image is to smooth or filter the image in some general way, exemplified by U.S. Pat. No. 5,442,462 to Guissin (1995). Such techniques may greatly improve the subjective quality of the constructed image to a human viewer. However, they only do so by smearing the image to a greater or lesser degree, and this may be unacceptable for applications wherein a processing system attempts to compute something from the image. Further, such smoothing and filtering techniques will work better when the position of defects is predetermined relative to such filtering. An example of such as system for video cameras tangentially related to the present work in that it uses previous images to suppress noise in stationary regions is U.S. Pat. No. 5,508,751 to Nitta (1996), but it does not teach or suggest the defect detection method.

3 OBJECTS AND ADVANTAGES

Accordingly, the present invention has as its object defect detection without the need for a pristine and perfect reference object. This eliminates a source of error in the defect identification as well as making defect identification more practical and less laborious. A further advantage is that since it does away with the need for separately preparing and scanning or imaging the perfect reference target, it will in some embodiments allow continuous and dynamic identification of dust specks during the normal, day-to-day operation of the instrument. For example, no special action would have to be taken to detect dirt on the glass of a photocopier. The normal procedure of scanning documents would suffice to allow the instrument to alert the user to dirt or scratches on the glass, or for some defect compensation to be automatically and effectively employed, or both.

Methods which rely on keeping a scanner cover perfectly clean and perfectly white are not as practical because any defect in the cover will stymie defect detection. For instance, if the cover is closed forcibly on a point, such as the corner of a book, this is likely to make a dent on the cover. Any such dent will cast a shadow in the scanned image, destroying the ability to automatically detect defects. Such covers are usually fairly soft, because if they are hard they cannot press down nicely on a sample or may abrade the platen.

Additionally, in some photocopiers, the background cannot be a solid cover, because it consists of several friction belts for pulling samples across the platen.

An increasingly important but less common use of these instruments than that of copying documents and photographs is the use of scanning devices as laboratory instruments. One example of such an instrument is the 4R Technology Dirtalyzer™ v. 1.1, sold to the paper industry to measure contaminants in paper. In such usage, even more than in day-to-day photocopying, any dust or scratch on or in the instrument that corrupts the image adds inaccuracy to the measurement. In cases where the paper product to be measured is very clean, the distorting effect of dust on the scanner has been clearly observed to exceed the contaminants within the paper, making the measurement worthless.

However, a major selling point of the 4R Technology Dirtalyzer™ is its use of a specific embodiment of the present invention that alerts the user to presence of dust specks or scratches. This allows corrective action to be taken. Additionally, the offending specks are removed from the measurement, so that no inaccuracy is introduced into the measurement. Since this occurs dynamically without the need to maintain perfectly clean reference targets of any kind or even to take any particular action, this advantage has aroused some enthusiasm among paper quality testing engineers. This advantage was previously impossible in this kind of instrument.

Dynamic defect detection can also be applied to other image devices, such as charge-coupled devices (CCDs) used in telescopes, microscopes and video cameras.

4 REFERENCES NUMERALS IN DRAWING

FIG. 1

100*a–e* are five sheets of paper, containing some dirt.
200 is a scanner or photocopier lid