METHOD FOR COUNTERFEIT CURRENCY DETECTION USING ORTHOGONAL LINE COMPARISON

FIELD OF THE INVENTION

This invention is generally related to microprocessor based image recognition techniques and, more particularly, to an anti-counterfeit currency detection method using line detection within images.

BACKGROUND OF THE INVENTION

The ability to detect currency patterns in an image can be useful in copier machines or scanners for the purpose of preventing counterfeiting. The challenge of incorporating such a method in current copier or scanning technology is the difficulty with detecting images in a rotation or shift invariant manner. Specifically, the pattern could be of any orientation and at any location of the image. The orientation and the location of the currency or banknote can be relatively simple to estimate in the case of a single note with a plain background; however, it becomes a major obstacle if multiple notes are involved and/or the notes are embedded in some complicated image background.

Examples of skew angle identification and correction are can be found in the following patents:

U.S. Pat. No. 5,528,387 to Kelly et al., issued Jun. 18, 1996, which teaches electronic image registration in a scanner. In particular, the edge data of a document is detected and skew angle calculated. The image is then rotated based upon the skew angle and non-image areas are filled using an image generation feature.

U.S. Pat. No. 4,922,350 to Rombola et al., issued May 1, 1990, discloses a two-pass scanning apparatus for detecting the size and position of an original document on a scanner platen. Image signals captured on a first scan are employed to determine boundaries and a best-fit magnification so that the image may be fir to a recording sheet using image signals generated on a subsequent scanning pass.

U.S. Pat. No. 5,253,765 to Moorehead et al, issued Oct. 19, 1003, teaches a system for sorting randomly sized objects (e.g. mushrooms). Invariant moments are employed, utilizing the complete pixel information for all pixels within the border of a captured image, to extract information about the mushroom size and orientation.

U.S. Pat. No. 5,220,398 to Horn et al. teaches an analog VLSI microchip that uses moments to determine the position and orientation of an object in a scene.

In "Invariant Fitting of Planar Objects by Primitives," published in 1996 IEEE Proceedings of ICPR '96, pp. 508–512 Voss et al, teach a method of pattern recognition using primitives such as triangles, rectangles, circles, ellipses, superquadratics, etc. The author further describe a technique for describing the primitives using moments in a normalized manner; resulting in a decrease in the numerical effort.

In "Managing and Representing Image Workflow in Prepress Applications," Technical Association of the Graphic Arts (TAGA) Vol. 1, 1995 Proceedings, pp. 373–385, Venable et al. teach the use of structured images to manage prepress workflow.

Prior countefeit detection methods rely on point detection during recognition. As disclosed in U.S. Pat. No. 5,533,144 to Fan, entitled "Anti-counterfeit Pattern Detector and Method", an anti-counterfeit detector and method identifies whether a platen image portion to be photocopied contains

one or several banknote patterns. With the '144 method, the detection is performed in a rotation and shift invariant manner. Specifically, the pattern can be of any orientation and at any location of the image, and can be embedded in any complicated image background. The image to be tested is processed block by block. Each block is examined to see if it contains an "anchor point" by applying an edge detection and orientation estimation procedure. For a potential anchor point, a matching procedure is then performed against stored templates to decide whether the preselected monetary note patterns are valid once detected.

Other anti-counterfeiting or pattern detection methods are presented by the following patents:

U.S. Pat. No. 4,153,897

Yasuda, et. al.

Issued May 8, 1979

U.S. Pat. No. 5,216,724

Suzuki, et. al.

Issued Jun. 1, 1993

U.S. Pat. No. 5,291,243

Heckman, et. al.

Issued Mar. 1, 1994

Yasuda et al. discloses a pattern recognition system where similarities between unknown and standard patterns are identified. Similarities are detected at first in respective shifting conditions where the unknown and standard patterns are relatively shifted from each other over the first limited extent, including the condition without shift. The maximum value of these similarities is then detected. The similarities are further detected in respective shifting conditions where the unknown and standard patterns are relatively shifted from each other over the second extent larger than the first limited extent, when the shifting condition which gave the maximum value is that without relative shift.

Suzuki et al. discloses an apparatus for image reading or processing that can precisely identify a particular pattern, such as banknotes or securities. A detecting unit detects positional information of an original image and a discriminating unit extracts pattern data from a certain part of the original image to discriminate whether the original image is the predetermined image based on the similarity between the pattern data and the predetermined pattern.

Heckman et al. discloses a system for printing security documents which have copy detection or tamper resistance in plural colors with a single pass electronic printer. a validating signature has two intermixed color halftone patterns with halftone density gradients varying across the signature in opposite directions, but different from the background.

A fundamental problem in electronic image pattern recognition is with line detection, or more generally, curve detection. In a pre-scan image lines might be detected to decide where the edges of a paper document are. Within a document text lines may be used to estimate the skew angle of the document. Also, line and other simple curve detection often serves as the first step for complex object detection, as the contour of a complex object can always be decomposed into simple curves.