

**MULTI-LEVEL DETECTION AND
DETERRENCE OF COUNTERFEITING OF
DOCUMENTS WITH REDUCED FALSE
DETECTION**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to printing and, more particularly, to the prevention of printing of counterfeit currency or other documents.

2. Description of the Related Art

Modern technology has made it easy for most people to quickly and inexpensively make accurate color copies of documents. This copying can be achieved through the use of a color copier or by scanning the document and then printing it using a color printer. There are many legitimate uses for this copying technology, however a small percentage of people use color copying to make counterfeit currency or to counterfeit other documents.

One way to prevent counterfeiting is to use techniques such as are taught by Sato, "Color image input apparatus having color image identifying function", U.S. Pat. No. 5,638,496, issued, Jun. 10, 1997. Sato describes a line sensor and image input section that input a color image in a reading area containing an original, an original extracting section that extracts an area of the original from the input image, a normalization section that normalizes an image of the extracted original area to an image of preset size, an image averaging section that converts the normalized image into an averaged image, and a brightness-hue-chroma converting section that converts the averaged image in Vcd images used as color perception amounts of a human being. A pattern matching section collates the Vcd image with dictionary data in a dictionary data storing section to determine whether or not the original is a specified type of original such as a bill, and an image output controlling section then determines whether or not image data output from the color image input section is to be output to the exterior based on the result of the identification.

Thus typical techniques such as searching for a particular pattern or color distribution can be used to detect and stop the copying of a counterfeit document. However, these techniques can be computationally intense and therefore place an undesirable delay on the copying of every document. This delay is particularly undesirable when one realizes that the majority of documents copied are made, not by counterfeiters, but by law-abiding citizens who are copying documents for legitimate purposes.

Thus, it can be seen that current counterfeiting detection and deterrence techniques impose processing delays upon color copying devices, and hinder the use of these devices in many applications.

Therefore, there is an unresolved need for a counterfeiting detection and deterrence technique that permits one to make color copies without imposing processing delays upon color copying devices.

SUMMARY OF THE INVENTION

A method and apparatus is described for detection and deterrence of counterfeiting that permits one to make legitimate color copies without introducing visual artifacts or experiencing substantial processing delays.

We enable an efficient counterfeit deterrence by the use of an hierarchic detection scheme, in which the majority of

documents are classified as free of suspicion using a simple algorithm that imposes a negligible computational burden. The remainder of documents, which are labeled as suspicious, receive analysis by one or more additional detection algorithms. If the suspicious document is identified as being a secure document, this will lead to printing with selectively deteriorated service or complete denial of service.

For one embodiment, the scheme uses a color look-up table (LUT) to detect a characteristic color (or colors) of frequently counterfeited documents, and alters the characteristic color in the copies if a second test verifies that printing of a counterfeit is being attempted.

Conventional tests for counterfeit documents can be used as a second (or higher) level test. A particularly effective second level detector characterizes a suspicious pattern by the size of the suspected area, and the frequency of the transition between the foreground and background colors.

Our invention has negligible impact on the time to render a page and negligible effect on general images and documents, while denying printing or generating visible artifacts on banknote images. The scheme can be deployed in a printer driver with no hardware changes and the color modulation image degradation function can be fine-tuned such that the area of the LUT that is classified as suspicious can be adjusted to arrive at a compromise that allows reasonable detection, while giving minimal effect on legitimate users. Furthermore, this method can detect the existing currency in circulation with no redesign or reissue of currency required. Moreover, so long as the characteristic color does not change, no alteration is required for a new series of notes.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. 1 is a diagram illustrating a color copying system suitable for use with a counterfeiting detection and deterrence scheme according to the present invention;

FIG. 2 is a diagram illustrating multi-level detection process flow according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating multi-level detection process flow according to a color look-up table embodiment of the present invention;

FIG. 4 is a diagram illustrating line-based color transition frequency testing of currency according to an embodiment of the present invention;

FIG. 5 is a diagram illustrating line-based color transition frequency testing of a natural image according to an embodiment of the present invention;

FIG. 6 is a diagram illustrating a color modulation function according to an embodiment of the present invention;

FIG. 7 is a diagram illustrating a document having a modulated color according to an embodiment of the present invention.

**DETAILED DESCRIPTION OF THE
INVENTION**

Embodiments of the invention are discussed below with reference to FIGS. 1-7. Those skilled in the art will readily appreciate that the detailed description given herein with