one-class classifier, and using the classification data as a reference or template for use in a subsequent validation process.

[0028] According to yet another aspect of the invention, there is provided a method for verifying or validating documents comprising capturing an image of the document, classifying the image using a one-class classifier, comparing the classification data with reference classification data and determining whether the document is valid or invalid based on the results of the step of comparing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Various aspects of the invention will now be described by way of example only and with reference to the accompanying drawings, of which:

[0030] **FIG. 1** is a flow diagram of the steps taken to create a template of a banknote, or other image rich document;

[0031] **FIG. 2** is a block diagram of a system for creating a template of a banknote;

[0032] **FIG. 3** is a representation of a portion of a banknote;

[0033] **FIG. 4** is a representation of the banknote of **FIG. 1** that is segmented into four segments;

[0034] **FIG. 5** is a table showing false negative and false positive rates for two different one-class classifiers;

[0035] **FIG. 6** is a table showing false negative and false positive rates for a two-class classifier;

[0036] **FIG. 7** is a table showing results of an optimized note segmentation and classifier combination;

[0037] **FIG. 8** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 7** for the search space **(3,3)**;

[0038] **FIG. 9** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 7** for the search space **(7,7)**;

[0039] **FIG. 10** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 7** for the search space **(15,15)**;

[0040] **FIG. 11** is a table of results on an optimized note segmentation and classifier combination for another one-class classifier;

[0041] **FIG. 12** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 11** for the search space **(3,3)**;

[0042] **FIG. 13** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 11** for the search space **(7,7)**;

[0043] **FIG. 14** is a diagrammatic representation of an optimized note segmentation and classifier combination for the results of **FIG. 11** for the search space **(15,15)**;

[0044] **FIG. 15** shows data indicating the variability of a genetic algorithm that is used in a process for optimizing the segmentation and classifier combination, and

[0045] **FIG. 16** is a block diagram of an ATM that is adapted to create a template of a banknote and/or automatically validate currency deposited therein.

DETAILED DESCRIPTION

[0046] The present invention provides a system and method for dynamically determining a reference template for a banknote using genuine notes and using that reference template to verify or authenticate banknotes deposited by customers. By providing a mechanism for dynamically generating the reference template, when new currency is issued, a reference template can be readily obtained merely by using examples of genuine notes. This means that banks can be more responsive to changes in currency. This closes a window of opportunity for fraudsters. In addition, if a representative number of counterfeit examples are available, an additional template for these can also be dynamically generated, so that notes deposited by customers can be compared with one or both of the reference template for genuine notes and the counterfeit template.

[0047] **FIG. 1** shows the steps taken to create a template of a banknote in accordance with the invention. As a first step, to characterize banknotes to build up a suitable template for use in a later validation scheme, images of genuine notes are captured **10**. To do this, a plurality of genuine or reference notes **24** is scanned or imaged using a scanner/detector arrangement **20** and the resultant image data is processed using a suitable processor **22**, see **FIG. 2**. The step of imaging can be done in any suitable manner, but preferably by using a set of narrow-band sensors, which provide responses to radiation reflected from across the surface. In a preferred example, four sensors are used. The sensors used are all light emitting diodes (LEDs). Each emits a different type of radiation. Preferably, the sensors comprise a red LED, a green LED, a blue LED and an IR LED. Light from these is directed onto the surface of the banknote and four suitable detectors are provided to detect the reflected signals. In this way, four separate images are captured, one for each of the four LEDs.

[0048] Each of the images captured by the various detectors has a plurality of pixels, which represents the intensity of the radiation received by the detectors at a given point. The image data for each banknote or a selected region of each banknote, is segmented into non-overlapping and equal-sized sub-regions, see step **12** of **FIG. 1**. This is done by over-laying a pre-determined grid on the captured image. Pixels that fall within the same portion of the grid are taken to define a particular segment of the image. As a specific example, **FIG. 3** shows a selected region of a Bank of Scotland £10 note. **FIG. 4** shows a segmentation of the selected region of the bank note of **FIG. 3** into four equal sized square segments. For the purposes of illustration, a one-dimensional distribution for each region is also shown. More generally, each note is segmented into R by C sub-regions, which can be numbered from 1 to L, left-to-right and then top-to-bottom wise, where R and C are respectively the number of segmented rows and columns, and L=RC is the total number of segmented sub-regions.

[0049] Every pixel of each of the four images is compared with the corresponding pixel of each of the other images, and the difference in intensity is stored. In particular, the difference in intensities between the red and green data is