[0022] FIG. **11** is a flow chart diagram illustrating binary decision map generation **430** of FIG. **4**.

[0023] FIG. **12** is an embodiment for illustrating surrounding sections about a color section.

[0024] FIG. **13** is an exemplary illustration showing results various stages of binary decision map generation.

[0025] FIG. **14** is an exemplary embodiment illustrating color post processing performed on the color binary decision map.

[0026] FIG. **15** is an exemplary embodiment illustrating object separation **1402** performed in color post processing.

[0027] FIG. **16** is an exemplary embodiment illustrating hole filling **1406** performed on enclosed objects.

[0028] FIG. **17** illustrates stages of color processing during generation of the color binary decision map.

[0029] FIG. **18** exemplary diagram of the texture decision map.

[0030] FIG. **19** illustrates a process flow chart for generating the texture decision map according an embodiment of the present invention.

[0031] FIG. **20** is an example illustrating gray level variances for various objects.

[0032] FIG. **21** is an example illustrating an image using halftone mode printing and typical bill printing.

[0033] FIG. **22** illustrates an exemplary embodiment of the binary edge map.

[0034] FIG. **23** illustrates another embodiment of the binary edge map.

[0035] FIG. **24** is an exemplary illustration of traversing feature sections of the binary edge map.

[0036] FIG. **25** is an exemplary embodiment illustrating the object determination step **140** of FIG. **1**.

[0037] FIG. **26** is another exemplary embodiment illustrating the object determination step **140** of FIG. **1**.

[0038] FIG. **27** is an embodiment illustrating object removal according to the present invention.

[0039] FIG. **28** is a process flow chart illustrating an embodiment of the verification method for determining areas within an image corresponding to monetary banknotes.

[0040] FIG. **29** is an exemplary step-by-step visual illustration detailing the verification method of FIG. **28**.

[0041] FIG. **30** is an additional exemplary step-by-step visual illustration detailing the verification method of FIG. **28**.

DETAILED DESCRIPTION

[0042] The present invention contained hereon within provides a verification method for determining areas within an image corresponding to monetary banknotes. The image can be provided from a hardware scanner or a similar device, where the image can contain sample monetary banknotes of a predetermined currency type. Characteristics derived from areas within the sample image are compared with known values and/or ranges corresponding to valid monetary banknotes to verify its location within the sample image. The types of currencies can include United States of America currency and Japanese denomination currencies, but additional embodiments can also include currencies of other nationalities.

[0043] The described method can be applied for use in the detection of counterfeit currency. The scanned image can provide the sample monetary banknotes with an arbitrary rotational shift alignment within the image. This allows a common scanner to be used, instead of a simple banknote reader with fixed input dimensions. Additionally, the scanned image can contain the sample monetary banknotes while superimposed onto an arbitrary background, can contain multiple isolated or independent banknotes, or have overlapping banknotes. The method can be used in conjunction with basic stand-alone scanners, copiers, stand-alone printers, and other related detection and scanning hardware.

[0044] The verification method described in this present invention makes use of new innovations not introduced by the prior art. This not only provides an increased means of security measures when used in application for counterfeit banknote detection, it also provides ease of integration with common hardware devices and a viable low cost approach. The multi-level, large and small-scale approaches of this method help ensure accurate detection rates and low false alarm rates. It is also robust and flexible enough to be applied to a wide variety of image types and conditions.

[0045] Prior to a concise description of the present invention verification method, it is important to understand that certain terms used throughout the following description and claims will refer to particular processes or steps. As one skilled in the art will appreciate, designers may refer to such processes by different names. This document does not intend to distinguish between items that differ in name but not function. In the following discussion and in the claims, the terms "including" and "comprising" are used in an open-ended fashion, and thus should be interpreted to mean "including, but not limited to . . . ". Other examples are equally applicable, and should be understood to those familiar with the proper terminology of the related art.

[0046] An overview of the verification method for determining areas within an image corresponding to monetary banknotes is illustrated with reference to FIG. **1**. The method **100** first comprises of receiving a scanned image, which possibly contains the sample monetary banknotes. Upon receiving the scanned image, image division **110** is performed to separate the image into multiple verification sections. Banknote boundary map generation **120** is subsequently performed to create a banknote boundary map having border sections corresponding to a boundary of valid monetary banknotes within the image. At the same time, texture decision map generation **130** operates to create a texture decision map having texture sections. The texture sections each possess texture values within a valid range according to the texture of a valid monetary banknote. Generation of the texture decision map will be discussed later in greater detail.

[0047] Object determination **140** manages to isolate and count objects in the texture decision map. An object ideally corresponds to a monetary banknote, but may include other identified items in the texture decision map. Each object is separated from each other by removing texture sections in the texture decision map that correspond to the border sections in the banknote boundary map.

[0048] Following object determination **140** are texture property determination **150**, and shape property determination **160**, each performed on identified objects in the prior step. Texture property determination **150** calculates a texture property value for each object according to a texture feature map having a texture feature value for each image section. Different types of texture feature maps are applicable in this step, and will be described more thoroughly to follow. Shape property determination **160** calculates a shape property value for each object.