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(54) **SYSTEMS AND METHODS FOR VALIDATING A SECURITY FEATURE OF AN OBJECT**

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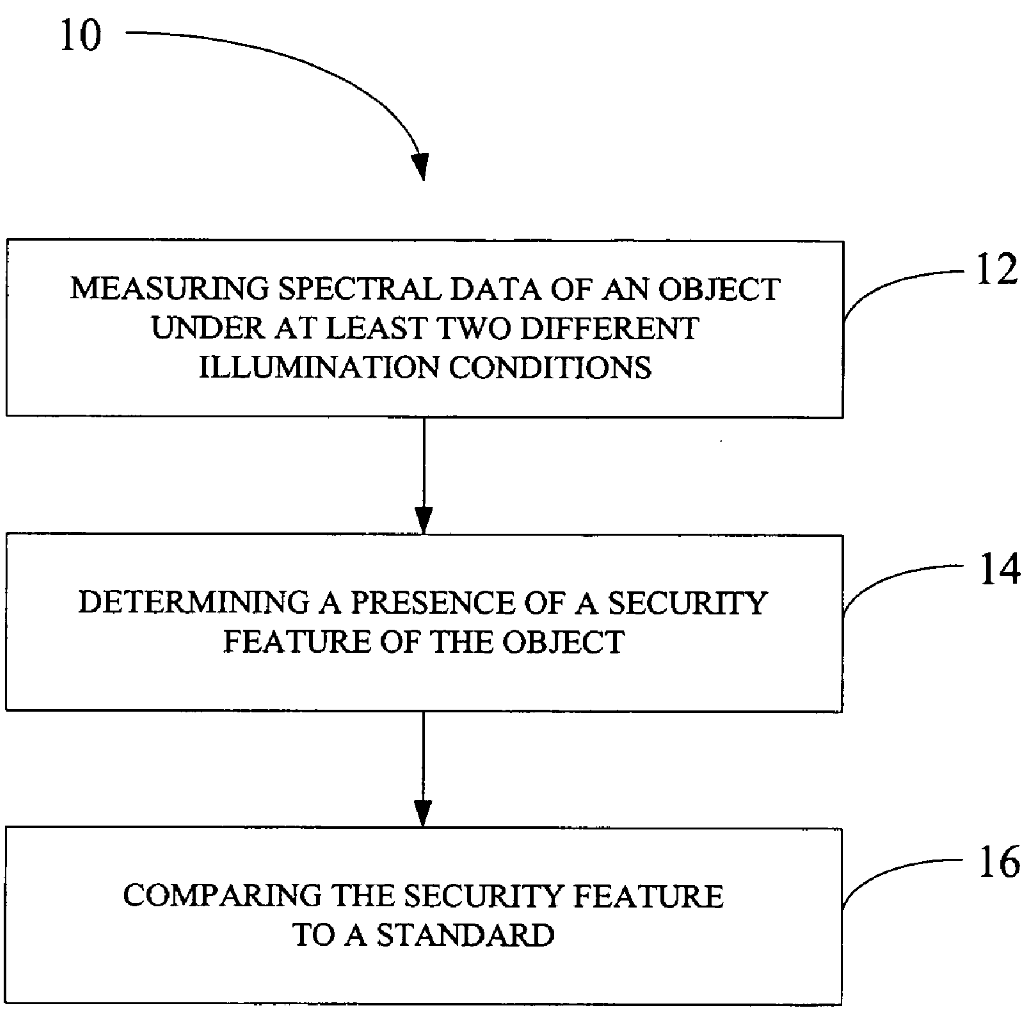
(57) **ABSTRACT**

A method for validating a security feature of an object. The method includes measuring spectral data of the object under a first illumination condition and a second illumination condition. The second illumination condition is different than the first illumination condition. The method also includes determining a presence of the security feature based on the spectral data measured under each illumination condition, and comparing the security feature to a standard.



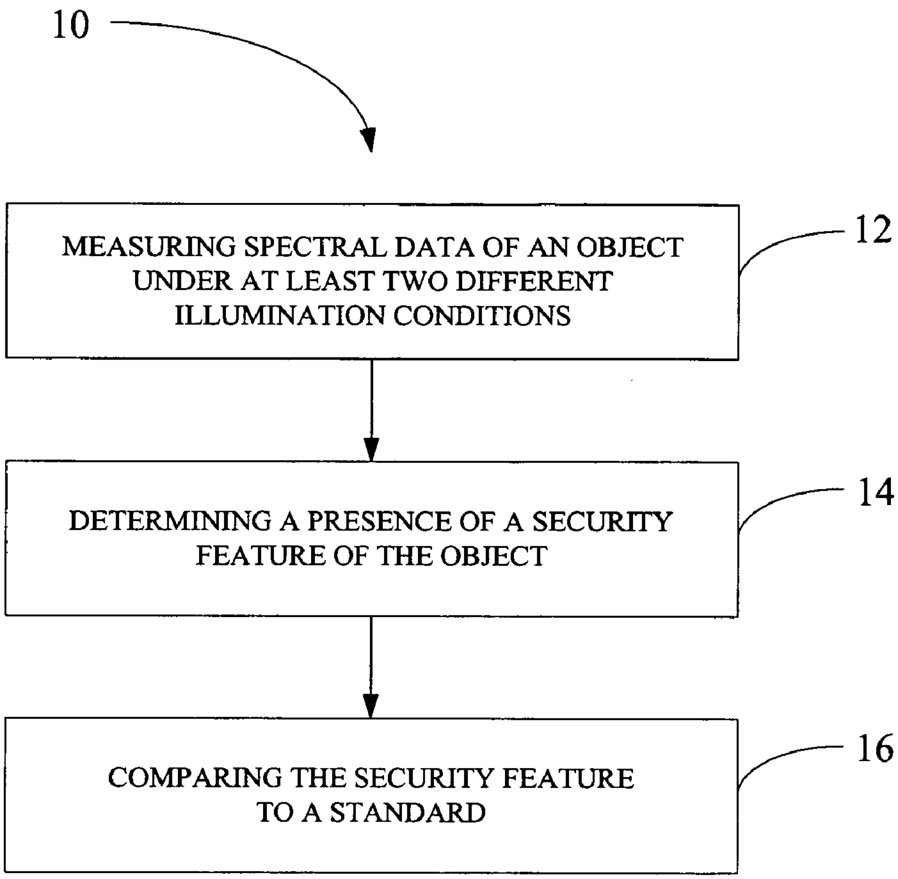

10
MEASURING SPECTRAL DATA OF AN OBJECT UNDER AT LEAST TWO DIFFERENT ILLUMINATION CONDITIONS
12
DETERMINING A PRESENCE OF A SECURITY FEATURE OF THE OBJECT
14
COMPARING THE SECURITY FEATURE TO A STANDARD
16

Figure 1

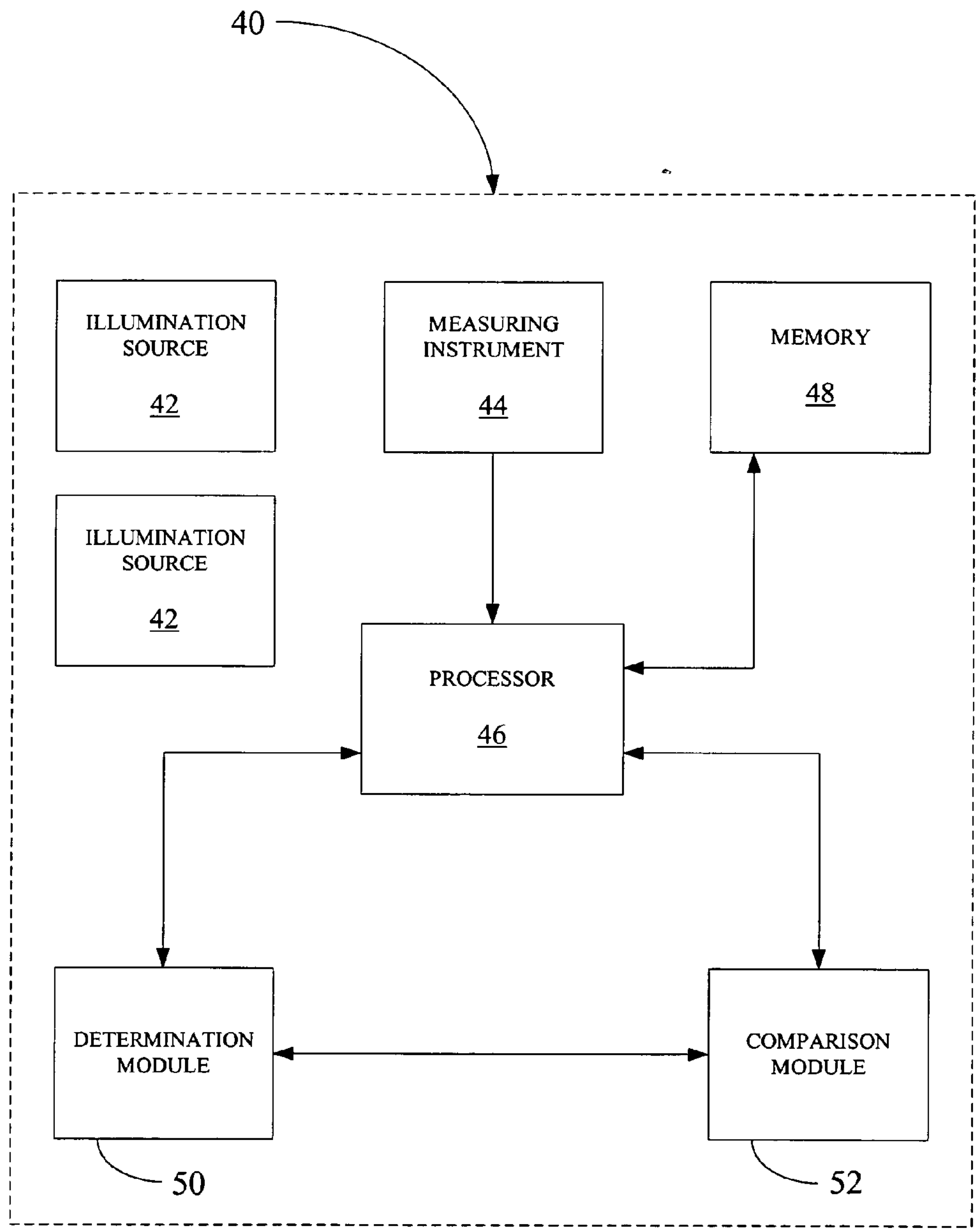

40
ILLUMINATION SOURCE
42
MEASURING INSTRUMENT
44
MEMORY
48
ILLUMINATION SOURCE
42
PROCESSOR
46
DETERMINATION MODULE
COMPARISON MODULE
50
52

Figure 2

# SYSTEMS AND METHODS FOR VALIDATING A SECURITY FEATURE OF AN OBJECT

## CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of U.S. Provisional Patent Application No. 60/670,407, filed on Apr. 12, 2005.

## BACKGROUND

[0002] This application discloses an invention that is related, generally and in various embodiments, to systems and methods for validating a security feature of an object.

[0003] Throughout the world, more and more security features are being added to objects such as currency, documents, product identification labels, etc. to guard against abuses such as counterfeiting, fraud, etc. To be most effective in preventing such abuses, it is important for each security feature to consistently meet a given quality standard. Therefore, for quality control purposes, it is important to be able to measure such security features at the point of production to ensure that the security features are correctly produced and meet or exceed the given quality standard.

[0004] In the printing industry, metallic or pearlescent inks are commonly utilized for providing a security feature of an object. Metallic or pearlescent inks have properties where their color and appearance change with the illumination angle. In general, most print measurement systems are unable to accurately and consistently determine the presence of the metallic or pearlescent inks because the systems only illuminate at a single illumination angle. Although instruments known as goniospectrophotometers are utilized to measure the average value of metallic or pearlescent pigments across a spot of an automotive finish, such spot measuring instruments are unable to effectively measure the complex patterns present in most security features.

[0005] In the printing industry, it is also common to utilize fluorescent materials or markings to provide a security feature of an object. When the fluorescent materials or markings are illuminated with UV light, the materials or markings emit light at a wavelength that is longer than the wavelength of the incident UV light. In general, most print measurement systems are unable to accurately and consistently determine the presence of the fluorescent materials or markings because the systems only illuminate with light in the visible spectrum.

## SUMMARY

[0006] In one general respect, this application discloses a method for validating a security feature of an object. According to various embodiments, the method comprises measuring spectral data of the object under a first illumination condition and a second illumination condition. The second illumination condition is different than the first illumination condition. The method also comprises determining a presence of the security feature based on the spectral data measured under each illumination condition, and comparing the security feature to a standard.

[0007] In another general respect, this application discloses a system for validating a security feature of an object. According to various embodiments, the system comprises at least two illumination sources, a line scanning spectrophotometer, a determination module for determining a presence of a security feature of the object, and a comparator module for comparing the security feature to a standard. Each illumination source is oriented at a different angle.

[0008] Aspects of the disclosed invention may be implemented by a computer system and/or by a computer program stored on a computer readable medium. The computer readable medium may comprise a disk, a device, and/or a propagated signal.

[0009] Other features and advantages will be apparent from the following description, including the drawings, and from the claims.

## DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** illustrates various embodiments of a method for validating a security feature of an object; and

[0011] **FIG. 2** illustrates various embodiments of a system for validating a security feature of an object.

## DETAILED DESCRIPTION

[0012] The figures and descriptions of the disclosed invention have been simplified to illustrate elements that are relevant for a clear understanding of the disclosed invention. It should be understood that the methods, products, and systems described below may include various other processes, components, and elements in actual implementation.

[0013] **FIG. 1** illustrates various embodiments of a method **10** for validating a security feature of an object. The security feature may be located on any portion of the object, may be of any size and shape, may include any number of colors, and may form any number of different patterns. The method may be utilized, for example, to validate printed pearlescent and metallic ink security signatures, and other metallic or pearlescent materials such as sheet films or solid printed areas. The method may also be utilized, for example, to validate fluorescent material in the object or fluorescent markings on the object that serve as security features of an object.

[0014] The method starts at block **12**, where spectral data of the object is measured under at least two different illumination conditions. The measurements may be taken with any suitable measuring instrument. For example, the measurements may be taken with a line scanning spectrophotometer. A first illumination condition may comprise illuminating the object with a first line of collimated light at a first angle relative to an angle of detection. Similarly, a second illumination condition may comprise illuminating the object with a second line of collimated light at a second angle relative to the angle of detection, wherein the second angle is different than the first angle. For example, when light reflected from the object is measured at a detection angle normal to a surface of the object, the first angle may be 15 degrees off the detection angle, and the second angle may be 45 degrees off the detection angle.

[0015] According to various embodiments, a third illumination condition may comprise illuminating the object with a third line of collimated light at a third angle relative to an angle of detection, wherein the third angle is different than the first and second angles. For example, when light reflected from the object is measured at a detection angle 45 degrees off a normal of a surface of the object, the first angle may be 25 degrees off an opposing projection of the detection angle, the second angle may be 45 degrees off the opposing projection of the detection angle, and the third angle may be 75 degrees off the opposing projection of the detection angle.

[0016] According to various embodiments, at least one of the illumination conditions may comprise illuminating the object with a line of UV rich light. Illuminating the object with UV rich light allows for the measurement of any fluorescent content or markings. From the foregoing, one skilled in the art will appreciate that the object may be measured under any number of different illuminations conditions, and that any number of geometries (incident angle combinations relative to the detection angle) may be utilized.

[0017] From block **12**, the method advances to block **14**, where a presence of the security feature of the object is determined. The determination is based on the spectral data measured under each illumination condition. As metallic and pearlescent inks scatter or reorient light in ways that are very different from many materials such as, for example, paper, pigments, standard inks, etc., the pixels showing a color change over angle may be readily identified. Also, as fluorescent material or markings also re-emit incident light in a way that is very different from many materials, the pixels showing fluorescence may be readily identified. Therefore, the presence of the security feature may be determined by utilizing the pixel information of the image of the object to identify the presence of a metallic ink, a pearlescent ink, a fluorescent marking, etc. on the object or a fluorescent material in the object. Once all pixels showing fluorescence and/or color changes over angle are identified, the location, shape, color, pattern, etc. of the security feature may be determined. The presence of the security feature may be determined by a simple determination algorithm that analyzes the spectral data obtained at block **12**.

[0018] From block **14**, the process advances to block **16**, where the security feature is compared to a standard. For example, according to various embodiments, the position and color of the pixels identified as metallic ink pixels may be compared to the desired position and color as defined by a particular quality standard. The placement or patterning of the metallic ink pixels may also be compared to the desired placement or patterning as defined by the particular standard. If the position, color, and placement or patterning of the pixels identified as metallic ink pixels are each within prespecified tolerances as defined by the particular standard, the security feature will be validated. For other security features (e.g., pearlescent ink, fluorescent material, fluorescent marking, etc.), the process described at block **16** will be the same but the standards may vary. The validation of the security feature may be determined by a simple comparison algorithm that compares the location, color, shape, pattern, etc. of the imaged security feature to a given standard. The validation may be communicated in any suitable manner.

[0019] **FIG. 2** illustrates various embodiments of a system **40** for validating a security feature of an object. In general, one or more elements of the system **40** may perform the method **10** as described above.

[0020] The system **40** comprises at least two different illumination sources **42**, a measuring instrument **44**, a processor **46**, a memory **48**, a determination module **50**, and a comparator module **52**. According to various embodiments, one or more of the illumination sources **42**, the processor **46**, the memory **48**, the determination module **50**, and the comparator module **52** may comprise a portion of the measuring instrument **44**. According to other embodiments, one or more of the illumination sources **42**, the processor **46**, the memory **48**, the determination module **50**, and the comparator module **52** may be separate and apart from the measuring instrument **44**. For example, as shown in **FIG. 2**, the processor **46** may be in wired or wireless communication with the measuring instrument **44**, and the memory **48**, the determination module **50**, and the comparator module **52** may be in wired or wireless communication with the processor **46**. According to other embodiments, some system components may communicate with other system components in a different manner.

[0021] The illuminating sources **42** may each project a line of collimated light, and at least one of the illuminating sources may project a line of light that comprises UV rich light. According to various embodiments, each illuminating source **42** may comprise one or more light emitting diodes (LEDs), and a reflector, lens, or combination of both to collimate the light for each LED. Each illuminating source **42** may also comprise a light guide for conveying the collimated light to the object.

[0022] The measuring instrument **44** may be any measuring unit suitable for measuring spectral data of an object. For example, according to various embodiments, the measuring instrument is a line scanning spectrophotometer. The memory **48** may be any type of memory suitable for storing data.

[0023] The determination module **50** may be configured to determine the presence of a security feature of the object. As described above, the determination utilizes the spectral data measured under each illumination condition to determine the presence of the security feature.

[0024] The comparator module **52** may be configured to compare the security feature to a standard. As described above, the comparison utilizes the determined location, color, shape, pattern, etc. of the imaged security feature to compare the security feature to a given standard.

[0025] According to various embodiments, each of the modules **50**, **52** may be implemented as software applications, computer programs, etc. utilizing any suitable computer language (e.g., C, C++, Delphi, Java, JavaScript, Perl, Visual Basic, VBScript, etc.) and may be embodied permanently or temporarily in any type of machine, component, physical or virtual equipment, storage medium, or propagated signal capable of delivering instructions to a device. The software code may be stored as a series of instructions or commands on a computer-readable medium such that when the processor **46** reads the medium, the functions described herein are performed.

[0026] As used herein, the term "computer-readable medium" may include, for example, magnetic and optical memory devices such as diskettes, compact discs of both read-only and writeable varieties, optical disk drives, and hard disk drives. A computer-readable medium may also include memory storage that can be physical, virtual, permanent, temporary, semi-permanent and/or semi-temporary.

A computer-readable medium may further include one or more propagated signals, and such propagated signals may or may not be transmitted on one or more carrier waves.

[0027] Although the modules **50**, **52** are shown in **FIG. 2** as two separate modules, one skilled in the art will appreciate that the functionality of the modules **50**, **52** may be combined into a single module. Also, although the modules **50**, **52** are shown as being part of a common system **40**, the modules **50**, **52** may be installed on separate, distinct systems that are in wired or wireless communication with one another. For example, for embodiments where one or more of the modules **50**, **52** are installed on separate distinct systems, the modules may be in communication with one another via a network (not shown). Such a network may include any type of delivery system including, but not limited to, a local area network (e.g., Ethernet), a wide area network (e.g. the Internet and/or World Wide Web), a telephone network (e.g., analog, digital, wired, wireless, PSTN, ISDN, GSM, GPRS, and/or XDSL), a packet-switched network, a radio network, a television network, a cable network, a satellite network, and/or any other wired or wireless communications network configured to carry data. Such a network may also include elements, such as, for example, intermediate nodes, proxy servers, routers, switches, and adapters configured to direct and/or deliver data.

[0028] While several embodiments of the invention have been described, it should be apparent, however, that various modifications, alterations and adaptations to those embodiments may occur to persons skilled in the art with the attainment of some or all of the advantages of the disclosed invention. Therefore, this application is intended to cover all such modifications, alterations and adaptations without departing from the scope and spirit of the disclosed invention as defined by the appended claims.

What is claimed is:

**1**. A method for validating a security feature of an object, the method comprising:

measuring spectral data of the object under a first illumination condition and a second illumination condition, wherein the second illumination condition is different than the first illumination condition;

determining a presence of the security feature based on the spectral data measured under each illumination condition; and

comparing the security feature to a standard.

**2**. The method of claim 1, wherein:

measuring under the first illumination condition comprises illuminating the object with a first line of light; and

measuring under the second illumination condition comprises illuminating the object with a second line of light.

**3**. The method of claim 2, wherein:

illuminating the object with the first line of light comprises illuminating the object with a first collimated line of light; and

illuminating the object with the second line of light comprises illuminating the object with a second collimated line of light.

**4**. The method of claim 3, wherein at least one of the first and second lines of light comprises a line of UV rich light.

**5**. The method of claim 3, wherein measuring the spectral data comprises measuring light reflected from the object at a detection angle normal to a surface of the object.

**6**. The method of claim 5, wherein:

illuminating the object with the first line of collimated light comprises illuminating the object at an angle 15 degrees off the detection angle; and

illuminating the object with the second collimated line of light comprises illuminating the object at an angle 45 degrees off the detection angle.

**7**. The method of claim 1, further comprising measuring spectral data of the object under a third illumination condition, wherein the third illumination condition is different than the first and second illumination conditions.

**8**. The method of claim 7, wherein:

measuring under the first illumination condition comprises illuminating the object with a first line of light;

measuring under the second illumination condition comprises illuminating the object with a second line of light; and

measuring under the third illumination condition comprises illuminating the object with a third line of light.

**9**. The method of claim 8, wherein:

illuminating the object with the first line of light comprises illuminating the object with a first collimated line of light;

illuminating the object with the second line of light comprises illuminating the object with a second collimated line of light; and

illuminating the object with the third line of light comprises illuminating the object with a third collimated line of light.

**10**. The method of claim 9, wherein at least one of the first, second, and third lines of light comprises a line of UV rich light.

**11**. The method of claim 9, wherein measuring the spectral data comprises measuring light reflected from the object at a detection angle 45 degrees off a normal of a surface of the object.

**12**. The method of claim 11, wherein:

illuminating the object with the first line of collimated light comprises illuminating the object at an angle 25 degrees off an opposing projection of the detection angle;

illuminating the object with the second collimated line of light comprises illuminating the object at an angle 45 degrees off the opposing projection of the detection angle; and

illuminating the object with the third collimated line of light comprises illuminating the object at an angle 75 degrees off the opposing projection of the detection angle.

**13**. The method of claim 1, wherein determining the presence of the security feature comprises determining the presence of a metallic ink.

**14**. The method of claim 1, wherein determining the presence of the security feature comprises determining the presence of a pearlescent ink.

**15**. The method of claim 1, wherein determining the presence of the security feature includes determining the presence of at least one of the following:

a fluorescent material in the object; and

a fluorescent marking on the object.

**16**. The method of claim 1, wherein comparing the security feature to the standard comprises comparing a location of the security feature to the standard.

**17**. The method of claim 1, wherein comparing the security feature to the standard comprises comparing a shape of the security feature to the standard.

**18**. The method of claim 1, wherein comparing the security feature to the standard comprises comparing a color of the security feature to the standard.

**19**. The method of claim 1, wherein comparing the security feature to the standard comprises comparing a pattern of the security feature to the standard.

**20**. A system for validating a security feature of an object, the system comprising:

at least two illumination sources, wherein each illumination source is oriented at a different angle;

a line scanning spectrophotometer;

a determination module for determining a presence of a security feature of the object; and

a comparator module for comparing the security feature to a standard.

**21**. A computer program stored on a computer-readable medium, the program comprising instructions for:

determining a presence of a security feature of an object; and

comparing the security feature to a standard.

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