and white (L=100). As color space models are known, it is sufficient to limit further comment to pointing out that one skilled in the art will recognize that this system therefore provides for developing relationships between a palette of colors, and is therefore useful to the device **5** described herein.

[**0088**] Preferably, the color scheme selected for use is chosen, at least in part, in consideration of the capabilities of the device **5**. For example, the color space is selected to maximize sensitivity or discrimination of color for a given lens/CCD system **20**. More specifically, and only as an example, in some embodiments, the lens/CCD system is outfitted with an array of red, green and blue color filters **22** (such as in a Bayer Mosaic pattern, discussed further herein). Preferably, a color space is selected that optimizes aspects of operation of the device **5**, in light of the array of filters **22**.

[**0089**] The CMS **15**A coordinates the function of device **5** components, including use of CCA **18**A. In one embodiment, the CCA **18**A may require illumination, whereas another CCA **18**A may make use of ambient or an external source of light. The CMS **15**A operates to provide coordination between the sensor array **20**, the illumination source **30**, the CCA **18**A, and other components as necessary to complete execution of a color measurement.

[**0090**] Referring to **FIG. 8**, the device **5** may execute a given CCA **18**A based upon the stored CCA **18**A either alone, or in cooperation with one or more remote data processors **115**. As shown in **FIG. 8**, a wireless link **95** can exist between device **5** and a wireless local area network (LAN) transceiver **100** that can be coupled directly to a first remote data processor **115**A, and may be coupled indirectly to a second remote data processor **115**B through a wide area network (WAN), such as the Internet **105**. Either one or both of the remote data processors **115** can be a source of CCA **18**A that are transferred into the device **5** using the wireless link **95** and associated components. Data representing one or more CCA **18**A may be inputted to the device **5** using the wireless link **95**, or the data can be loaded using a wired connection, such as through a USB port, or by inserting a preprogrammed memory card or media. That is, in one embodiment the storage **18** may be removable from and installable within the device **5**.

[**0091**] The CCA **18**A can thus be updated as new and/or improved color classification algorithms are developed, or as user needs dictate. The CCA **18**A may be broadcast to a large number of devices **5** for updating them en masse while they are in use in the field.

[**0092**] In another embodiment, one or more of the remote data processors **115** could be associated with a law enforcement agency using color management for authentication of currency or immigration documents. The result of a color measurement operation executed by the CMS **15**A may be transmitted from the apparatus using the wireless link **95**, either alone or in conjunction with raw or processed color data captured from a color target **200**.

[**0093**] In use, an operator of the device **5** holds the device **5** so as to obtain a measurement from the color target **200**, and is enabled to readily change the location of the device **5** relative to the color target **200**. This provides for rapidly making multiple measurements of a single color target **200**, or multiple color targets **200**.

[**0094**] The CMS **15**A may account for various factors, including but not limited to, device **5** characteristics and/or lighting conditions, while evaluating data input from the lens/CCD system **20**.

[**0095**] The device **5** contains, in one non-limiting example, an image sensor **20** that is 1360 pixels wide by 1024 pixels high. In one embodiment, the image sensor **20** is a gray-level sensor overlaid with a Bayer mosaic pattern of color filters **22**, such as those found in inexpensive consumer NTSC color video cameras. An example of a Bayer pattern mosaic **510** is given in **FIG. 9**.

[**0096**] The Bayer mosaic pattern **510** of **FIG. 9** gives color information in a lower bandwidth signal than the gray scale information. In this embodiment there is twice as much green bandwidth as red or blue. This design resulted from the bandwidth allocation of the NTSC color signal, which contains more green than red or blue, owing to the higher sensitivity of the human vision system to green. In **FIG. 9**, each of the "G,""B" and "R" represent one of the green, blue, and red color filters **22**, respectively. Therefore, the bayer mosaic pattern **510** is one type of an arrangement of the color filters **22**.

[**0097**] Decoding and Authentication

[**0098**] Decoding and authentication of the image proceeds through various steps. Each of these steps may be completed in the order described herein, or some of these may be rearranged to produce an alternate order. In other embodiments, certain steps may be omitted or modified to produce a desired outcome. Therefore, it is considered that the following steps are illustrative of the techniques used for authentication of a document and are not limiting of the invention.

[**0099**] A first step to decoding and authentication involves what is referred to as de-mosaic and decimation. This step permits the device **5** to achieve reduced processing time by using lower image resolution. In one embodiment, the application software **15**A reads the raw Bayer image data from the sensor **20** and derives an RGB image by combining groups of sixteen pixels to yield a new image that is decimated by a factor of four in each spatial dimension. This effect is shown in **FIG. 9A**. In **FIG. 9A**, a bayer mosaic pattern **510** is arranged in the array of color filters **22**. Thus, using this approach, an original 1360×1024 mosaic image is decimated to a 340×256 RGB image, or an image that contains 87,040 composite color pixels **1110**. The resulting composite color pixel **1110** generally provides enhanced data for color discrimination. In this example, where green filters **22** are in a 2:1 ratio with red or blue, color levels are set using the following formulas: Red Level=R; Green Level=(G1+G2)/2; and, Blue Level=B.

[**0100**] In some embodiments, only a portion of the image is analyzed using the processes described below, or equivalents thereof. That is, it may be considered that aspects of the security features are robust enough, such that processing speed may be improved by analyzing only a portion of an image, without a coincident loss in the level of security.

[**0101**] As one example, the CMS **15**A divides a decimated RGB image into 80 sections, each 34 composite color pixel blocks wide by 32 composite color pixel blocks high. The CMS **15**A determines the average gray level for each of the 80 sections. These average gray levels are used as back-