RGB COLOR SENSING TECHNIQUE

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ABSTRACT

Sensor provides a means for gathering information on manufacturing operations and processes being performed. In a lot of instances sensors are used to transform a physical stimulus into an electrical signal that may be analyzed by the manufacturing system and used for making decisions about the operations being conducted. The purpose of sensors is to inspect work in progress, to observe the work-in-progress edge with the manufacturing utensils, and to permit self monitoring of manufacturing by the manufacturing system's own computer. Color sensors register stuff by contrast, true color, or clear index. True color sensors are based on one of the color models, most commonly the RGB model (red, green, blue). A large percentage of the visible spectrum can be created using these three primary colors. Many color sensors are able to sense more than one color for multiple color sorting applications. Depending on the difficulty of the sensor, it can be programmed to know only one color, or multiple color types or shades for categorization operations. Through this report, the color detection, the basic color theory and the applications of color sensor will be review. In this report will be focusing on the application of color sensor using conveyor system for sorting RGB color.

Keywords: RGB, Hue Circle,

I INTRODUCTION

Color sensors play a significant role in end equipment such as color-observe calibration, color printers and plotters, paints, textiles, cosmetics manufacture and medical applications such as blood diagnostics, urine examination, and dental matching. The complexity of a color sensor system is based largely on the number of wavelength bands, or signal channels, it uses to resolve color. Systems can range from a comparatively simple three-channel colorimeter to a multiband spectrometer. Color Sensors use RGB filters to detect and perform color measurements of objects placed in front of the sensor. Hence when an object is placed in front of the sensor, it will display the same color through a LED. The sensor works on eight colors the primary; green, red and blue, the secondary; magenta, yellow and cyan as well as black and white. The circuit uses optics and digital electronics to detect the color of the object. Color sensors are used to technically match colors accurately. They can be utilized on production lines and allow machines to determine the difference in color for a mass produced product. Thus working as a quality control, to ensure all the products are accurately the same color.

II WHAT IS RGB?

The choice of primary colors is related to the physiology of the human eye good primaries are stimuli that maximize the difference between the responses of the cone cells of the human retina to light of different wavelengths, and that in this manner make a large color triangle. The normal three kinds of light-sensitive photoreceptor cells in the human eye (cone cells) respond most to yellow (long wavelength or L), green (medium or M), and violet (short or S) light (peak wavelengths close to 570 nm, 540 nm and 440 nm, respectively). The variation in the signals received from the three kinds allows the brain to differentiate a wide gamut of different colors, while being most sensitive (overall) to yellowish-green light and to differences between hues in the green-to-orange region. As an example, suppose that light in the orange range of wavelengths (approximately 577 nm to 597 nm) enters the eye and strikes the retina. Light of these wavelengths would trigger both the medium and long wavelength cones of the retina, but not evenly—the long-wavelength cells will respond more. The variation in the response can be detected by the brain and associated with the concept that the light is orange. In this sense, the orange look of objects is simply the result of light from the object entering our eye and stimulating the relevant kinds of cones simultaneously but to different degrees. Use of the three primary colors is not sufficient to reproduce all colors; only colors within the color triangle defined by the chromaticity of the primaries can be reproduced by additive mixing of non-negative amounts of those colors of light.

III COLOR IDENTIFICATION

Color names can be used and conjure reasonably consistent perceptions. There have eleven basic color names have been identified such as white, green, blue, gray, black, red, yellow, orange, purple, brown, and pink. Most or all colors can be described in terms of variations and combinations of these colors. Due to the reality that human color vision is accomplished in part by three different types of cone cells in the retina, it follows that three values are essential and sufficient to define any color. Color Theory was said that there has three values can be thought of as coordinates of a point in three-dimensional space, giving rise to the idea of color space. Hue, saturation, luminance (HSL) is one such color coordinate system, or color space. A more precise method of describing color is by hue, saturation, and lightness. He is the attribute of a color according to its similarity with one of the colors red, yellow, green, or blue, or a combination of adjacent pairs of these colors considered in a closed ring, as shown in this Figure 1.

Color science defines color in a space, with coordinates of hue, saturation and intensity (HSI). He is related to the reflected wavelength of a color when a white light is shined on it. Intensity (lightness) measures the degree of whiteness or gray scale of a given color. Saturation is a measure of the brightness of a given hue. The word chromaticity primarily includes elements of hue and saturation components. Researchers describe color in space using hue as angle of a vector, saturation as the length of it and concentration as a plus or minus height from a center point as shown in figure 2.

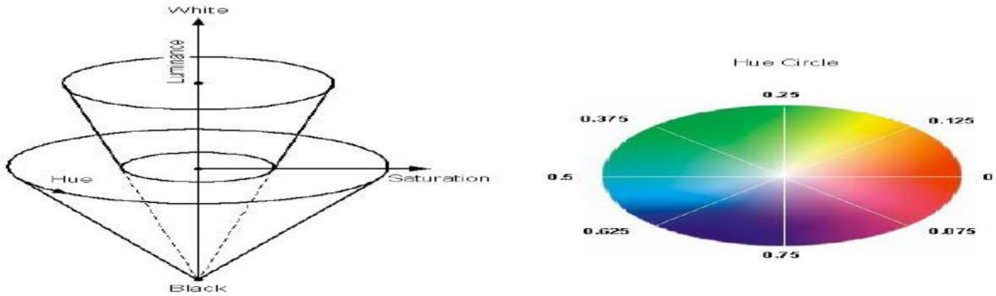


Figure 1: HSL Diagram with Hue Circle

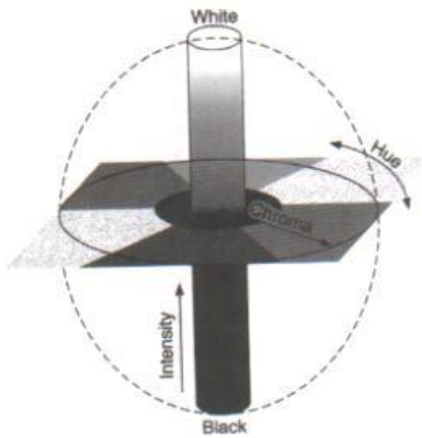


Figure 2: Coordinates Of Hue, Saturation and Intensity of Color in Space

From figure 3, a color is depicted at a molecular level. Color is created when light interacts with color molecules. Color is generate by the way pigment molecules return (bend) incoming light.

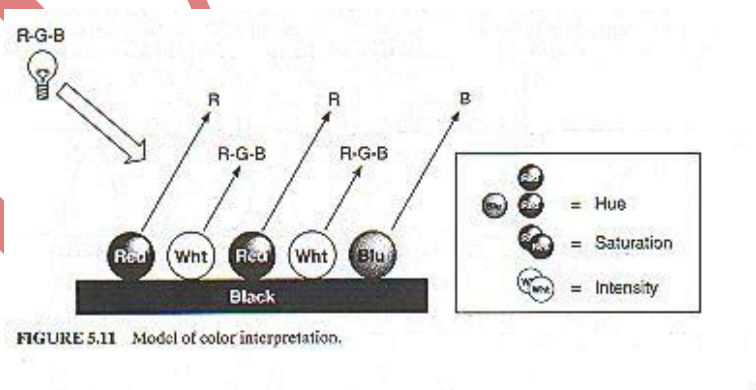


Figure 3: Model of Color Interpretation

3.1 Color and Light

A 'color' is an interaction between a very small range of electromagnetic waves and the eyes and brain of a person. What people call RGB are just ways of categorizing what their brain experiences. An article by Bishop and Lee

(2006) brief that, the spectrum of light where the eye can see is called the visible region as can be seen in figure 4. Light is a type of energy, which makes up a small portion of the electromagnetic spectrum. Visible light could be expressed as a frequency, but the magnitude is so large people generally express the wavelength of light in units of nanometers (10-9 meters) to describe light. The section of visible light consists of light with a wavelength between approximately 380 nm to 780 n m. The visible colors and their related range of wavelengths can be found in Table I

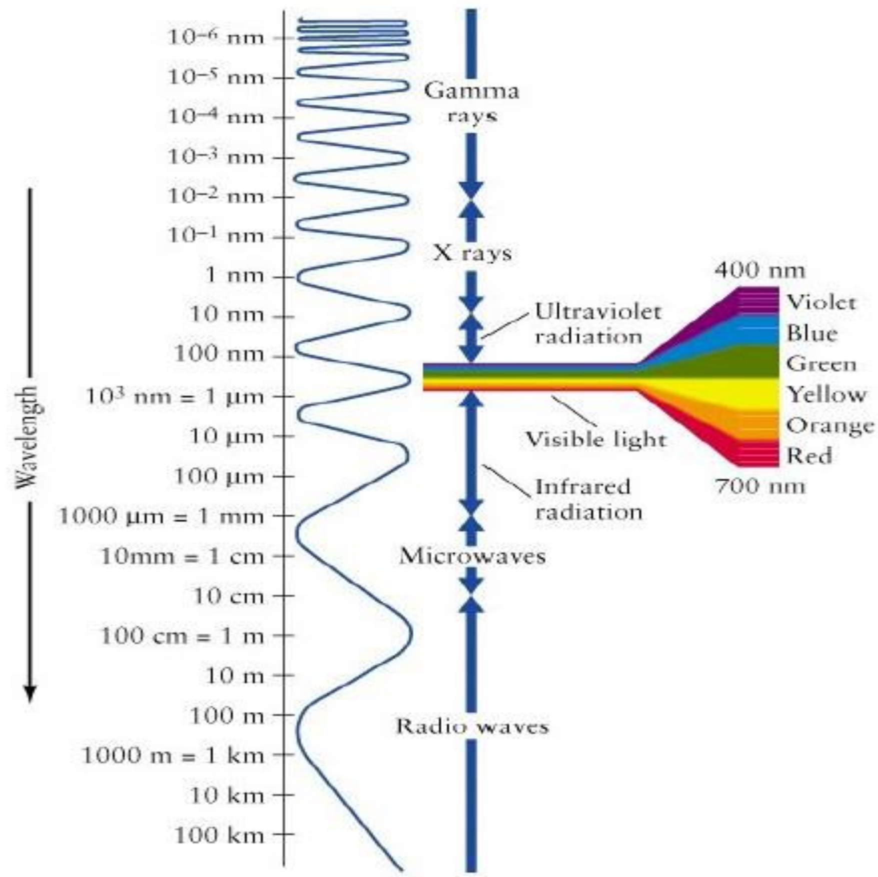


Figure 1. Electromagnetic radiation

TABLE I
Color vs. Wavelength Range

Color	**Wavelength Range (nm)**
Violet	380~480
[illegible]	~450
Blue	450~510
Green	510~560
Yellow	560~600
Orange	600~630
Red	630~780

Figure 4: Electromagnetic Radiation

IV COLOR SENSOR

Color sensors register objects by contrast, true color, or translucent index. True RGB color sensors are based on one of the color models, most commonly the RGB model. A large percentage of the visible spectrum can be created using these three primary colors. Many color sensors are able to sense more than one color for multiple color sorting applications. Depending on the complexity of the sensor, it can be programmed to distinguish only one color, or multiple color shades for categorization operations. Some types of color sensors do not distinguish colors, instead focusing on light wavelengths. Sensor can be configured to locate wavelengths from near infrared (colors in the 750 nm to 2500 nm wavelength range), far infrared (colors in the 6.00 to 15.00 micron wavelength range), and UV (colors in the 50 to 350 and 400 nm wavelength range), in accumulation to the visible range. Sensors that study the visible range are the most common type of color sensors. They calculate color based on an RGB color model. A large percentage of the visible spectrum (380 nm to 750 nm wavelength) can be created using these three colors. Color sensors are usually used for two specific applications:

4.1 True color recognition

Sensors used for true color recognition are required to "see" different colors or to distinguish between shades of a definite color. They can be used in either a sorting or identical mode. In sorting mode, output is activated when the object to be identified is close to the set color. In identical mode, output is activated when the object to be detected is identical (within tolerance) to the color stored in memory.

4.2 Color mark detection

Color mark detection sensors do not detect the color of the mark; rather they "see" differences or changes in the mark in contrast with other marks or backgrounds. They are occasionally referred to as contrast sensors. Color sensors shine light onto the body to be monitored and measure either the direct reflection or the output into color components. Many color sensors have vital light sources to achieve the desired effect. These vital light sources include LEDs, fiber optic, lasers and halogen lamps.

V SORTING

Sorting is any process of arranging items in some sequence and/or in different sets. It has two common distinct meanings such as ordering and categorizing. Ordering is arranging items of the same kind, nature, class etc. in some ordered sequence while categorizing is grouping and labeling items with similar properties together by sorts.

5.1.1 Sorting Information or Data

One important kind of sorting is arranging items of information in alphabetical sequence according to some pre-defined ordering relation (sort key by each group of lists), e.g. when one sorts the books in a library by title, subject or author (all 13 alphabetically sorted normally in ascending order). The consequential order may be either ascending or descending, because essentially all sorting is numerical sorting. The main reason of sorting information is to optimize its usefulness for specific tasks.

5.1.2 Physical Sorting Processes

Various sorting tasks are essential in industrial processes. For example, during the withdrawal of gold from ore, a device called vibrating table uses gravity, shaking, and flows to separate gold from lighter materials in the ore (sorting by size and weight). Sorting is also a naturally happening process that results in the concentration of ore.

VI COLOR SENSOR APPLICATIONS

Historically, components used for color sensing were considered expensive and required precision support circuitry, restraining their application mostly to specialized instrumentation. But, new technologies of color sensors with higher levels of integration are becoming existing, allowing for more cost-effective solutions. As the price of color sensing arrives down, the number of applications using color sensing is increasing. Soloman (2004) explain several example applications using color sensor. The following are five examples of unique situations requiring innovative solution.

6.1 Sorting automotive parts with different colors

A manufacturer of automotive parts needs to differentiate parts whose only visible difference is a slight variation in color. One part is dark grey, the other black. Because efficiency demands that the part be sorted at a high rate of speed, the opportunity for mistakes is tremendously high. By using progress color sensing technology, the manufacturer can sort these parts at an enhanced rate of speed, saving time and virtually eliminating errors.

6.2. Assembly of medical closures with different color components

In this situation, containers of liquid medications consist of an aluminum cap with a plastic cover. A whole closure assembly requires the assurance of proper color combination of two components. Because of this fixed necessity of color accuracy, color sensing technology proves invaluable.

6.3. Lumber sorting by color

Color cording has become a standard method of differentiation in the lumber industry. Not only different types of lumber but the grade, quality and intended purpose of the lumber is indicated by color. Because the environments in which load is sorted can be extremely abusive, it is recommended that protective covers be employed to protect the fiber optics used for this process.

6.4. Color sensing in the food industry

Sensing a white target on a white background is challenging using conventional photoelectric sensors. A manufacturer who needs to assure the presence of the white cap on a jar of mayonnaise improves accuracy with a color sensor that employs the RGB color concept. This technology improves the contrast between two slightly different whites.

6.5. Ammunition final inspection and sorting process

An ammunition manufacturer codes the style and caliber of bullets with various colors on the tips. The need to insure that the proper type and caliber of product are correctly packaged necessitates the automation of the product line with color sensing technology. Because of the critical nature of this application, it is suggested that two color sensing stations be implemented to add an extra safety margin to the operation.

VII THEORY BASED ON COLOR SENSING

7.1 Reflective Sensing Theory

There are three important elements in reflective sensing: detector, goal and illuminant. The detector is a device that captures light reflected from an object. The goal is an object whose color is calculated, like colored paper or paint. Typically non-emissive, it reflects and absorbs different amounts of light at different wavelengths. The illuminant is a light source whose spectrum covers the visible wavelengths, like sunlight. In a reflective sensing system, the detector and illuminant are usually mounted together in a module. When the section is placed close to the goal, light from the illuminant will fall onto the goal surface and reflect to the detector. The color of the light beam reflected off the plane is a function of the color of the plane. For example, white light focused onto a red plane is reflected as red. The reflected red light impinges on the color sensor producing R, G, and B output voltages. By interpreting the three voltages, the color can be resolute. Since the three output voltages increase linearly with the intensity of the reflected light, the sensor also actions the reflectivity of the surface or object. Reflective Sensing System Hardware Design Considerations There are three basic elements in a reflective sensing system: the RGB sensor, an external illuminant such as an Light Emitting Diode, and a non-emissive object.

7.2 Selecting a detector

A suitable detector needs to have good sensitivity and spectral coverage. In reflective sensing, light captured by the detector is reflected from the object beneath measurement. Hence, the intensity of the reflected light is lower than the intensity of the direct lighting source. The spectral response of the individual RGB channels should be overlapping to ensure all wavelength information is capture. Figures 5 and 6 below show the overlapping and non-overlapping spectral responses, respectively. Figure 7 shows an arbitrary spectrum of a signal reflected from a bluish surface. With the use of TCS230 Color Sensor, Basic Stamp programmer and BS2P microcontroller, this project explore the possibility of creating a programming that can sort Red, Green, Blue colors. In this project, the main goal is to create program that can identify RGB colors and fabricate a mechanical system for identify RGB color by using a conveyor. The other objective also includes the indulgent of the application of color sensor in an automated system by related literatures review. In a mathematical context, sensor output is directly proportional to the overlapping area of the reflected signal and sensor spectral profile. Figure 8 shows two non-overlapping areas. Information in those regions will not be captured by the sensor. In Figure 9, we observe that the information of the reflected signal is properly captured by the sensor with an overlapping spectral response.

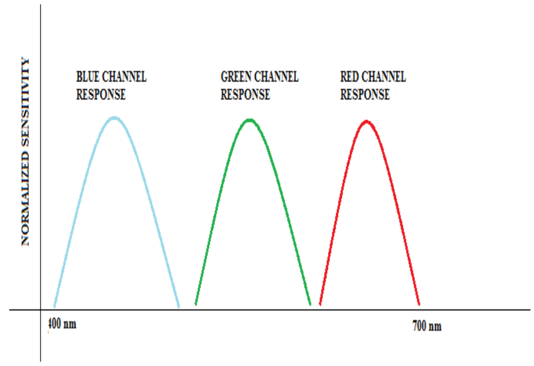


Figure 5: Non-Overlapping Response

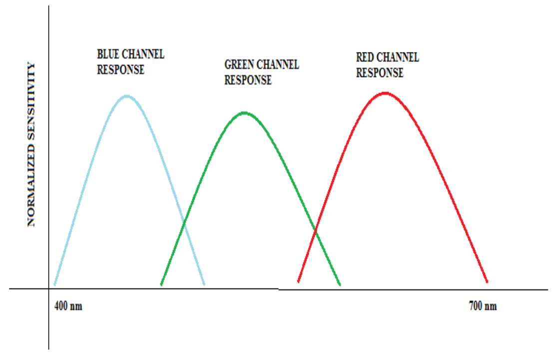


Figure 6: Overlapping Spectral Response

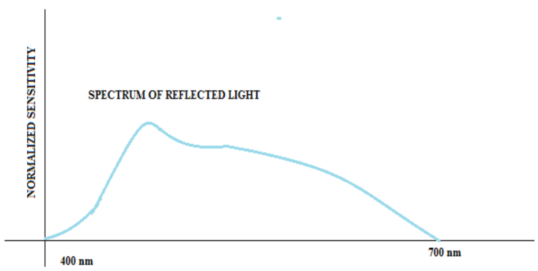


Fig 7: Spectrum of Light Reflected From Bluish Surface

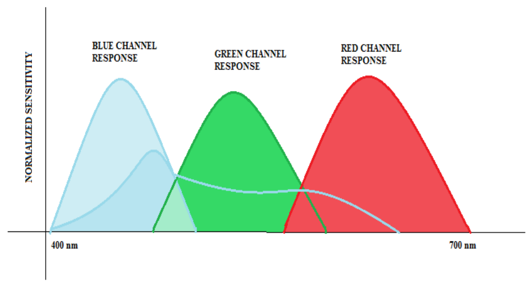


Fig 8: Sensor Spectral Profile Overlaps With Reflected Light

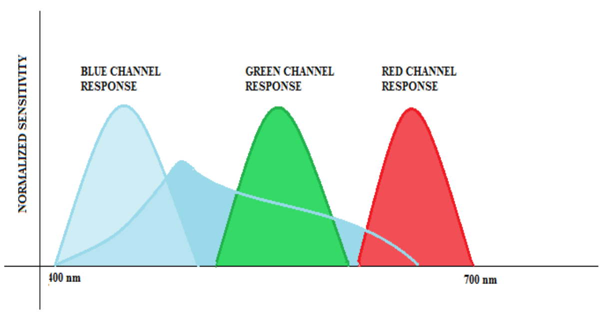


Fig 9: Sensor Spectral Profile Overlaps With Reflected Light

7.3 Selection of Illuminant

The illuminant should have a spectrum that is as broad as possible. Why? A broad-spectrum illuminant ensures that the object surface reflectance or characteristic is fully recovered. Other than having a broad spectrum, the illuminant should be relatively bright and available in various sizes. One option to consider is a white LED. One with high brightness and a narrow angle is preferable. In addition, the selection of packages greatly depends on the end application. If space is a constraint, surface mount white LEDs are the ideal choice; otherwise, use through hole lamps. Several recommendations are the HLMP-CW11 and the HSMWC191.

7.4 Escalating of the Detector and Illuminant

There are two types of reflection: specula and diffuse reflection (see Figure 10). In specula reflection, equal light is bounced off the surface at a 90 degree angle with respect to the incident light. This type of reflection does not carry much color information. Glossy material will have a higher specula reflectance compared to a matte surface. In reflective color sensing, we are more interested in diffuse reflectance. In this type of reflection, incident light is modified by the surface properties. The degree of reflection at each wavelength is dependent on the surface reflectance. The spectrum of the incident light source will be modified by the object/target surface reflectance. Figures 11 and 12 show the geometrical setup of the illuminant and detector. The setup can also include more than one LED if the brightness from one bulb is not sufficient.

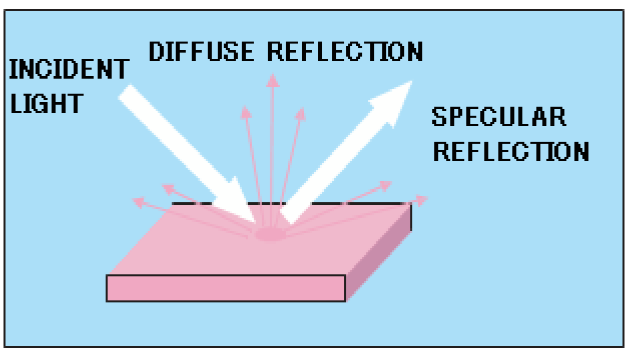


Figure 10: Specular And Diffuse Reflection

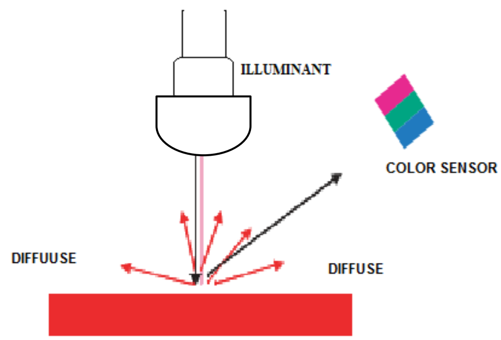
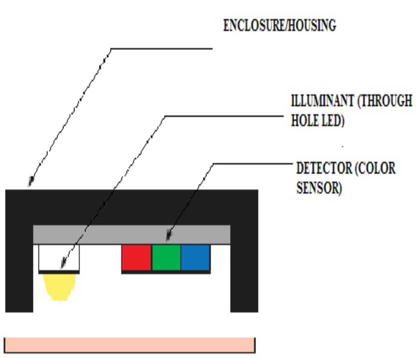


Figure 11: A Typical Setup Is 45°/0° Geometry

7.5 Ambient light rejection/elimination

- The detector and illuminant pair are together with this in a housing to eliminate ambient light.
- The design canon is simple: use an enclosure to minimize ambient light and light traveling directly from the illuminant to the detector.



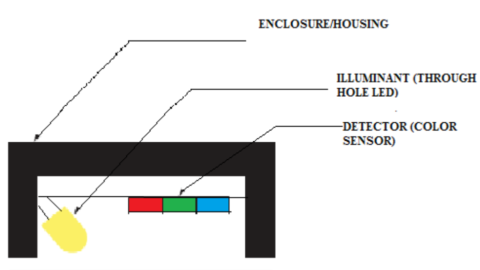


Fig 14: Illustrate Setup For A Through-Hole Led With Color Sensor Fig15: Setup For A Surface Mount Led With Color Sensor

VIII CONCLUSION

Based on the above discussions, we have the following summary points:-

The two basic elements in reflective sensing system hardware design are the detector and illuminant. A detector with good sensitivity and spectral coverage is desirable, while an illuminant with a broad spectrum is suitable for reflective sensing. Sensor output can be processed or interpreted via two methods: the look-up table and the transformation matrix. It offers a wide range of RGB color sensors and LEDs that meet the above mentioned requirements. The hardware design consideration, post sensor signal conditioning, and methods of sensor output interpretation serve as a general guideline for customers who wish to design a reflective sensing system with RGB color sensors.

Based on the above techniques new innovative inventions are:-

1). 'The Color Picker' It is concept pen that can scan colors from anything round and instantly use the color for sketch. After placing the pen against an object, the user just presses the scan button. A color sensor is detecting the color and the RGB cartridge of the pen mixes the required inks to create the target color.

2). 'Royal Chair' These are a set of color responsive chairs and as a person sits in the chair, an RGB color sensor in the back of the seat reads the color of their clothing. The color LEDs on the back of he chair then gradually fade into the color of the sitter. "This gives the being sit on it their own halo of light or personal aura, evoking descriptions of religious icons"

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