P2-10 An Optical System of a Portable Color Sensor for the Blind

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1. Introduction

Many color sensors have been developed and put in practical use mainly in industry and daily commodities[1], for an example, CCD color camera. The efficiency and sensitivity of these sensors are usually very high, but they are composed of a large scale and are very costly. It is, then, desirable to develop a simple and portable color sensor with low cost for the blind.

In this paper, a principle for a simple color sensor has been proposed by using a white light and some photo receivers with a color filter, and a preliminary experiment has been conducted to provide corroborative evidence of the efficacy of the principle by using an equipment made on an experimental basis.

2. Principle and Method

Figure 1 shows a sensor head. A white light from a halogen lamp was used as a light source and four silicon photodiodes as a light receiver. One is used for white light and the remainders are used for three primary colors, i.e., red R, green G, and blue B. Each of the three light receivers has a color filter with a half-width of about 70 nm for each color, and obtains light intensities for each color. The sensor head has a glass window through which light illuminates an object. It serves two functions; one is to protect the light source and four silicon photodiodes, while the other is to provide close contact of the glass window to the cloth, which makes a cotton cloth surface flat. The close contact is very important for precise measurement of the light intensity since a scattered light intensity will be considerably influenced by surface appearance.

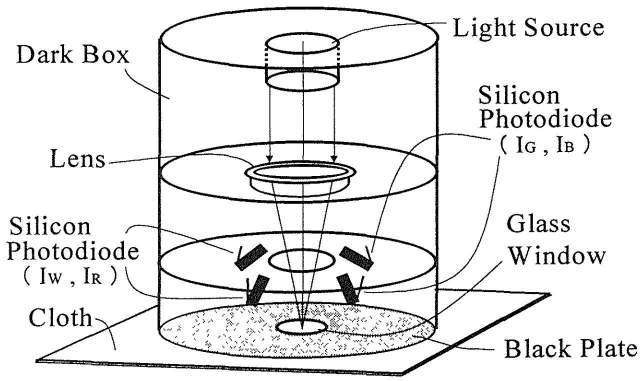

Fig. 1 Sensor Head

An intensity level of the white light, I_W, was used to standardize the light intensities of the three primary colors; I_R, I_G, and I_B. The standardization is indispensable for the stabilization of the light intensity, that is, the standardized light intensities of the three primary colors, I_R/I_W, I_G/I_W and I_R/I_W, will be constant even if the intensity of the white light fluctuates. These standardized intensities can, then, be used for color detection.

Figure 2 shows the color detection system based on the above principle. Each light intensity was amplified to an appropriate power and then digitized by an 8 bits A/D converter into 256 levels. The digitization was done so that the maximum light intensity reflected from a white object corresponds to the maximum level, i.e., level 256, and the minimum light intensity reflected from a dark object to the minimum level, i.e., level 1. The color was then detected by using a computer; we call it "computer color".

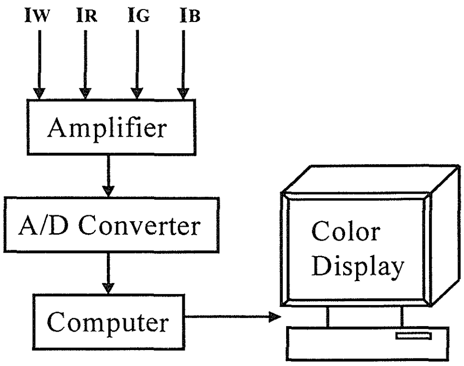

Fig. 2 Color Detection System

3. Experimental Results

Figure 3 shows a photograph of an equipment made on an experimental basis. The size was about 5cm×5cm in base and 8cm in height, which could be of practical use for the blind.

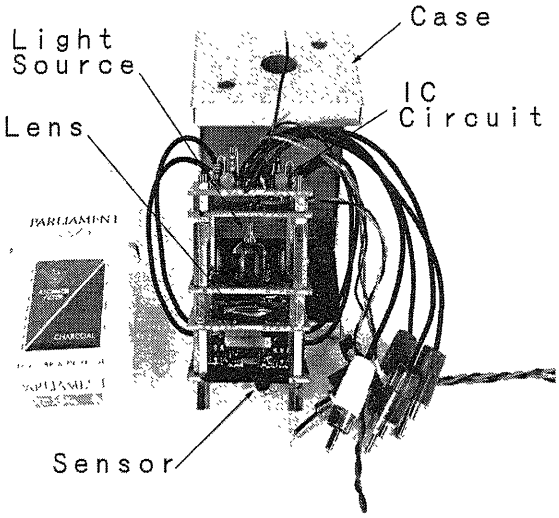

Fig. 3 Equipment of the Sensor

Preliminary experiments were conducted by using this equipment for papers and cloths, each of which corresponded to 16 standard colors. All the "computer color" agreed well with the object colors; the human eye judged the "computer color" and the object colors as the same within the range of the 16 colors. Furthermore, the depth of each color was agreed upon within 3 levels. No remarkable difference were found between paper color and cloth color. An accuracy of the color detection increased with the closeness of the glass window to the object, as expected in section 2. This was seen in particular with the cloth. This will be due to a constant scattering condition on the cloth.

Another experiment was conducted by using a semi-transparent glass bottle and a polyester container. The color detection was impossible in this case. This was due to a mirror-like reflection on the bottle surface. That is, no scattered light was incident on the light receiver. We could, however, detect a bottle color simply by inserting a white paper into the bottle. In this case, the white paper produces the scattered light and it acts as a illuminating light.

4. Conclusion

A method for a simple and portable color sensor has been proposed and verified experimentally with the equipment made on an experimental basis. It was composed of only a white light source, four silicon photodiodes as a light receiver, four amplifiers and A/D converters for each light intensity, and a computer. It was found from a preliminary experiment that all the colors were detected within a level of 16 standard colors, and that the depth of each color was agreed upon within 3 levels.

We are now developing a color-finding software and conversion hardware that is capable of transforming a light signal into an audio signal, which is of practical use for the blind.

Acknowledgement

We express our appreciation to M. Maekawa of Technical Research Center of Ishikawa Prefecture for his technical support and useful discussions.

References

1. H. Kubota ed., Handbook for Optics(2nd ed.), Asakura, p. 931, 1975