pH Measurement using Red, Green, and Blue Values

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Abstract - *In this paper, the color change of pH paper according to pH is measured by optical method. A simple method of measuring pH is to use a pH paper or indicator to change the color depending on the pH. Although these methods are simple and quick to measure, they are not results of quantitative values but subjective results of the measurer, so it is difficult to distinguish subtle differences of colors objectively and their accuracy is poor. In this study, we aimed to obtain objective data by indicating the change of pH paper according to pH as Red, Green, and Blue values.*

Keywords: Analysis, Color analysis, Optic sensor, pH, RGB

1 Introduction

pH is a unit that is designed to indicate which solution is more acidic or basic. Definition is the exponent representing the concentration of hydrogen ion, which is the numerical value of how much hydrogen ion (H +) is contained in a certain amount of solution. Depending on how much the substance dissolves in water and releases hydrogen ions, the number of pH changes. In this case, the smaller the pH number, the more hydrogen ions are formed. Therefore, the smaller the pH number, the stronger the acid becomes. The most basic reason for measuring pH is to distinguish between acid and base. All acidic substances are aqueous solutions with a pH value of less than 7 (pH 1 - 6.9), commonly dissolved in water to release hydrogen ions (H +). Because of this nature, there is a characteristic of sour taste. On the other hand, all bases have values greater than pH 7 (pH 7.1 - 13) and dissolve in water to give hydroxide ions (OH-). Therefore, it has a bitter taste or slippery property. pH 7 is neutral [1,2].

The most widely used and most convenient way to use pH paper is to measure the acidity, the basicity and the pH concentration by changing the color. A pH paper is a paper made by infiltrating an indicator into a filter paper. When the pH paper is immersed in the solution, the reagent and the solution on the paper react. At this time, a change in color occurs as a result of the reaction depending on the hydrogen ion concentration of the solution. The pH of the solution can be determined by observing the change in color and compared with the standard discoloration table (a table of standard colors used when measuring the pH of the aqueous solution in paper). This method has the advantages of simple and quick measurement [2,3]. However, the accuracy of the error range is about 0.2 ~ 0.5 pH, which is less accurate. Observe the degree of color change without visualizing the objective value during measurement. And because the color change is not clear, it is difficult to distinguish the color difference and it is affected by the lighting. In order to solve this problem, the pH value obtained from the pH paper was not classified by the naked eye, but the values of Red, Blue and Green were extracted and quantitative and objective values were obtained.

2 Materials and Methods

pH color corresponding to 1-11 of the standard color plate is shown. The pH buffer solution (± 0.25) was used for the experiment.

The TCS3200 color lihgt-to-frequency converter (TAOS), a color analysis module used to quantitatively obtain Red, Green, and Blue values. This module detects and measures almost infinite range of visible colors. And operates on the principle of obtaining RGB values by frequency. The module has a TCS3200 RGB sensor chip in the middle and a collimator lens in front of the sensor. The collimator lens converts the light entering the sensor into a collimated beam, thereby making the beam diameter equal to the distance. White LEDs on both sides act as a standard light source when analyzing color. The TCS3200 chip has a photodiode array of 8x8 and a total of 64 photodiodes of 16 red, green, and blue filters and a photodiode without filters.

Figure 1 shows the setup of the experiment. The TCS3200 module was calibrated to measure the correct value, and the color used for calibration was the 111th color from I.R.I Hue & Tone 120 provided by the Institute of Image Research Institute, IN. This color was based on Munsell color system. A transparent acrylic plate was formed on the TCS3200 chip, and the pH paper was fixed so as not to move. It was also disconnected from other lights to increase the accuracy of the measurements. A black acrylic plate was produced by cutting off external light interference. The pH paper size used in the experiment does not affect the red, green, and blue values of the result data. However, to keep the conditions the same, 1 cm width and 2 cm width are fixed and the amount of pH buffer solution is unified to 0.5 ml. Minimized.

Through the above experiment, RGB values were measured three times through the TCS3200EVM, the color detection software of the sensor, and the results were averaged.

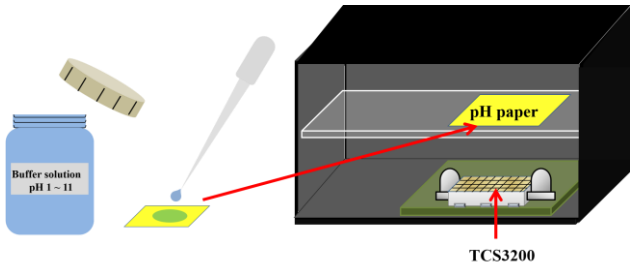

Figure 1. Experimental set up

3 Results and Discussion

In this study, we observed the color change of pH paper according to different pH solution. In order to minimize the interference of external light, the experiment was carried out in consideration of the error although it was treated in the dark room. The average of repeated data was obtained and analyzed.

Figure 2 shows the result of dropping pH 1 ~ 11 in order. The values of Red, Green, and Blue corresponding to each were noted. The images of pH 1-3, 4-6, 7-8, and 9-11 show that it is difficult to distinguish colors from the naked eye. In order to solve this problem, the change of red, green and blue values was confirmed by using pH sensor solution using optical sensor. Compared to the color of the pH standard color, the color corresponding to each result is very similar.

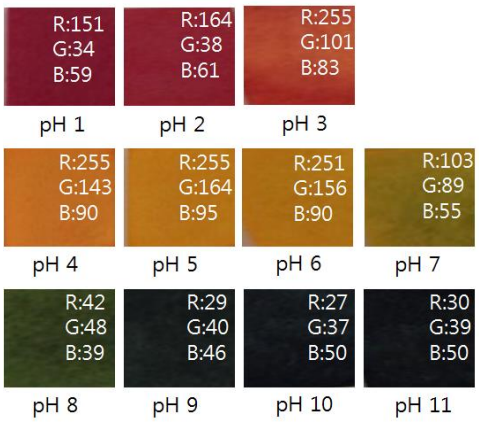

Figure 2. pH paper and RGB value

Figure 3 is a graph showing RGB ratio according to pH change. The X-axis of the graph represents the pH change of the solution, and the Y-axis represents the ratio of the RGB values measured through the experiment. As shown in the graph, the acidity of the pH paper changes to red, the ratio of R is relatively high and the ratio of G is low. In addition, it was confirmed that the ratio of R was decreased and the ratio of G was increased in the case of basicity showing blue color. If the ratio of RGB is used, it can be analyzed to the decimal point which is the point of the pH.

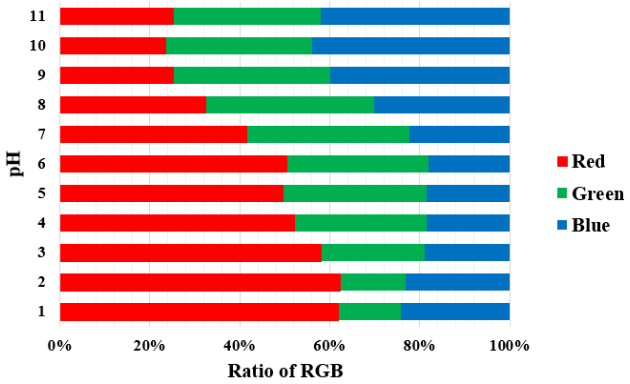

Figure 3. Ratio of RGB according to pH

4 Conclusions

This study suggests a new possibility of estimating the pH through the analysis of the color of the pH paper which is not a subjective method of judging the degree of pH visually but the quantitative data. As a result of the experiments, pH, Red, Green and Blue values were obtained. The sensor used in the experiment has the advantage of obtaining accurate color by using white light as a light source. By using the optical sensor used in this study, it is possible to obtain the value by the small device regardless of the state of the object by measuring the RGB value. The measurement method used in this study can maintain the sample without any damage even after measuring the RGB value, and it is possible to easily measure the value even with the simple operation and analysis. Therefore, it can be widely applied to other fields. Experiments will be conducted to obtain more quantified data by increasing the resolution of the data through a subdivided experiment to be applied to other fields.

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