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Utilization of Android-base Smartphone to Support Handmade Spectrophotometer : A Preliminary Study

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Abstract. Visible spectrophotometer is a powerful instrument in chemistry. We can identify the chemical species base on their specific color and then we can also determine the amount of the species using the spectrophotometer. However, the availability of visible spectrophotometer still limited, particularly for education. This affect the skill of student to have experience on handling the instrumentation. On the other hand, the communication technology creates an opportunity for student to explore their smart feature, mainly the camera. The objective of this research is to make an application that utilize the camera feature as a detector for handmade visible spectrophotometer. The software have been made based on android program, and we name it as Spectrophone®. The spectrophotometer consists of an acrylic body, sample compartment, and light sources (USB-LED lamp powered by 6600 mAh battery). Before reach the sample, the light source was filtered using colored-mica plastic. The spectrophone® apps utilize the camera to detect the color based on its RGB composition. A different colored solution will show a different RGB composition based on the concentration and specific absorbance wavelength. We then can choose one type of color composition, R or G or B only to be converted as an absorbance using -Log (Cs/Co), where Cs and Co are color composition of sample and blank, respectively. The calibration curve of metilen blue measured. In a red (R) composition, the regression is not linear (R^2=0.78) compare to the result of UV-Vis spectrophotomer model Spectroquant Pharo 300 (R^2=0.8053). This measurement result shows that The Spectrophone® still need to be evaluated and corrected. One problem than can we identify that the diameter of pick point of RGB composition is too wide and this will affect the reading color composition. Next, we will fix the problem and in advance we will apply this Spectrophone® in a wide scale.

1. Introduction

Regulation of the Minister of national education of the Republic of Indonesia Number 40 of the year 2008 contains about components on-site laboratories which include (1) building/space laboratory, (2) furniture, (3) equipment education, (4) tools and materials experiments, (5) educational media, (6) consumables, (7) other amenities [2]. Facilities and infrastructure is needed to facilitate in an activity. One of the facilities of the laboratory that can help researchers in conducting laboratory research is a instrument. Through these instruments, researchers be facilitated in analyzing the results of the experiments have been performed. One of the instruments of the chemical is laboratory is visible spectrophotometer.

Visible spectrophotometer is a powerful instrument in chemistry. We can identify the chemical species base on their specific color and then we can also determine the amount of the species using the spectrophotometer. In qualitative analysis, organic compounds can be identified by use of spectrophotometer, if any recorded data is available, and quantitative spectrophotometric analysis is used to ascertain the quantity of molecular species absorbing the radiation. Spectrophotometric technique is simple, rapid, moderately specific and applicable to small quantities of compounds. The fundamental law that governs the quantitative spectrophotometric analysis is the Beer -Lambert law [1].

Beer-Lambert law: When beam of light is passed through a transparent cell containing a solution of anabsorbing substance, reduction of the intensity of light may occur. Mathematically, Beer- Lambert law is expressed as:

A = a b c, where

A = absorbance or optical density

a = absorptivity or extinction coefficient

b = path length of radiation through sample (cm)

c = concentration of solute in solution.

Both b and a are constant so a is directly proportional to the concentration c [1].

In absorpsion spectrometry, light is directed through a sample and the fraction of light that passes throught the sample is measured. The amount of light absorbed, or the absorbance A, is define as

$A = -\log\left(\frac{I}{I0}\right)$

where I is the intensity of light transmitted through the sample and I0 is the intensity of light transmitted through a blank. It is useful to use a color wheel (Figure 1) to estimate the color of light that is absorbed by a particular chemical species in solution.This approximation is done by noting the color on the wheel opposite the observed color of the compound. For example, if a particular species appears red in solution, it probably absorbs green light very well. The predictions made using the color wheel are not absolute. Its use is complicated by the fact that our eyes are not equally sensitive to all colors of light, in addition to other factors [3].

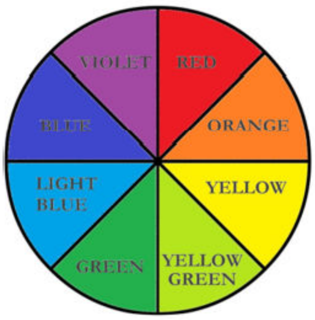

Figure 1. A color wheel used to estimate the color of light absorbed by a solution of a certain color.

However, the availability of visible spectrophotometer still limited, particularly for education. This affect the skill of student to have experience on handling the instrumentation. On the other hand, the communication technology creates an opportunity for student to explore their smart feature, mainly the camera. The objective of this research is to make an application that utilize the camera feature as a detector for handmade visible spectrophotometer. The software have been made based on android program, and we name it as Spectrophone®.

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2. Method

2.1. Materials

The tools and materials needed for the manufacture of SpecPhone are: Smartphone, mirror, test tube, LED lamp, power bank, colored mica, black sticker and acrylic board.

2.2. Experimental

2.2.1 Spectrophotometer design

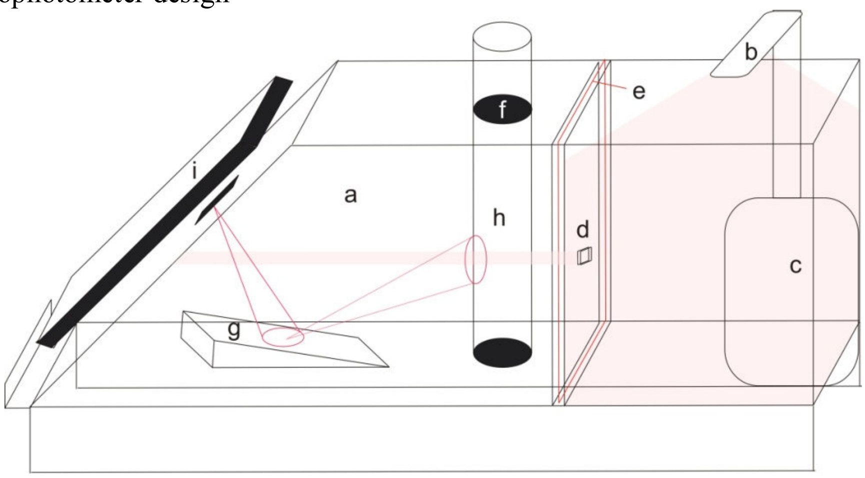

Figure 2. Spectrophotometer design

The Spectrophotometer design is as follows

a. The inside of the coated black stickers no color is reflected.
b. Light source coming from USB LED lamp is 5 watts.
c. Power bank is used as a source of electrical energy for lighting LED lamps with a capacity of 6600 mAh.
d. Regulate the width of the gap / slit which is a maximal hole 1 cm x 1 cm. Slit is made with two types that can and can be shifted so that the width of the hole can be varied.
e. Monochromator, this section is made of colored mica plastic that serves to select wavelengths that convert light coming from polychromatic light sources into monochromatic light. Xmax uses Spectroquant Pharo 300 spectrophotometer model.
f. The sample holder, as the sample venue is measured.
g. Mirror, serves to give the color shadow can be accepted by the camera lens.
h. Test tube size 15 cm to place the test solutions.
i. Smartphone as a catcher of sample color intensity.

2.2.2 Spectrophone interface

The spectrophotometer was completed with the software which can be easily installed. The user-software interface is shown in Figure 3.

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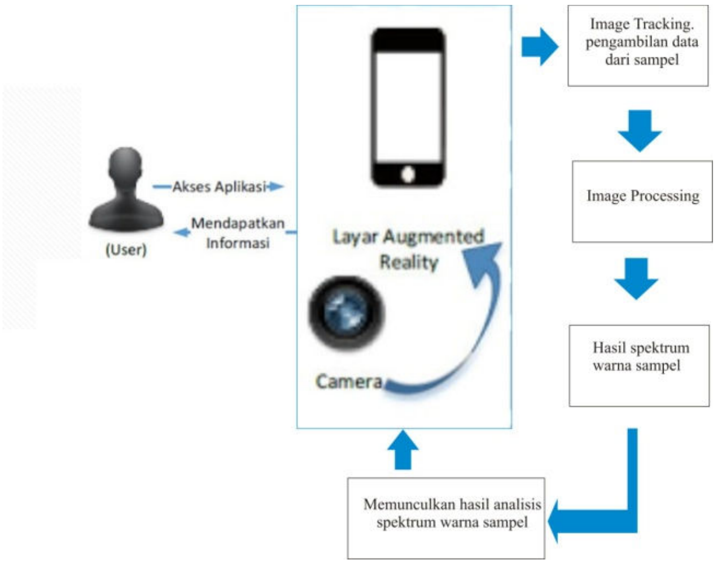

Figure 3. User-Software interface

3. Results and discussion

The spectrophotometer is show below in Figure 4. The Spectrophotometer consist of an acrylic body, sample compartment, and light sources (USB-LED lamp powered by 6600 mAh battery). Before reach the sample, the light source was filtered using colored-mica plastic. Colored-mica plastic used to revamp polikromatik rays of light into monochromatic. Acrylic body is coated with a black sticker so that the light from the outside can't get into there doesn't affect the camera RGB in reading.

Figure 5 show the appearance of Spectrophone® apps. This apps utilize the camera to detect the color based on its RGB composition. A different colored solution will show a different RGB composition based on the concentration and specific absorbance wavelength. We then can choose one type of color composition, R or G or B only to be converted as an absorbance using -Log (Cs/Co), where Cs and Co are color composition of sample and blank, respectively.

Figure 4. The Spectrophotometer

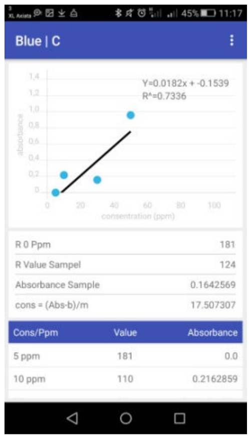

Figure 5. The Spectrophone® apps

4. Evaluation result

Once the application was developed, preliminary testing commenced. Testing is done by comparing the results of spectrophone with UV-Vis spectrophotomer Spectroquant Pharo model 300. Testing is done to determine the levels of Fe in water. Testing conducted in the laboratory of inorganic chemistry of engineering unnes. The method used is the method of calibration with variation concentration of metal blue by as much as 0 ppm 5 ppm, 10 ppm, 20 ppm, 30 ppm, and 50 ppm.

With the use of this procedure, the results of measurements of the levels of metilen blue using UV-Vis spectrophotometer show in figure 5 with the results of the calculations of the levels of metilen blue is 37.04 ppm. Meanwhile, the measurement results with the use of spectrophone can be seen in figure 6 with the result of levels metilen blue is 34.41 ppm in a Red composision.

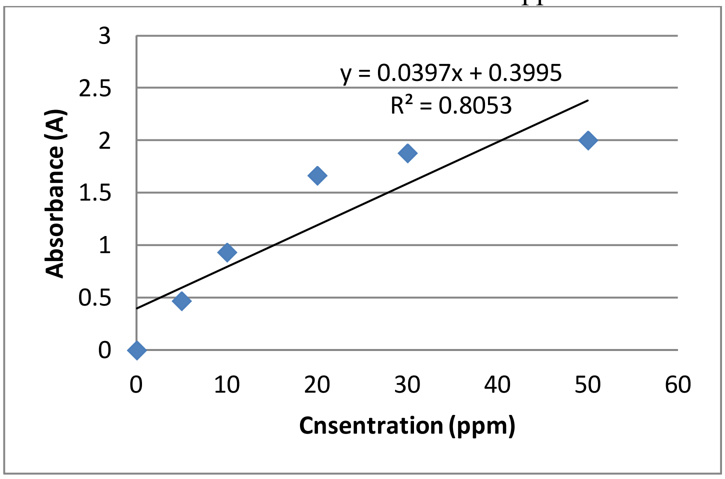

Figure 6. Result of Spectrophotometer UV Visible

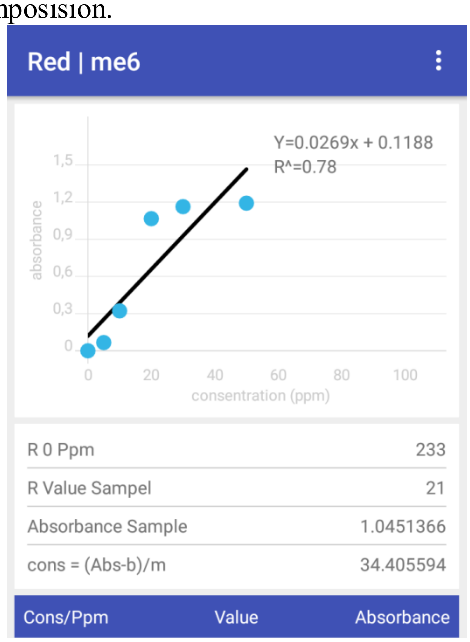

Figure 7. Result of Spectrophone

The calibration curve of metilen blue measured in a red (R) composition, the regression is not linear (R^2=0.78) compare to the result of UV-Vis spectrophotomer model Spectroquant Pharo 300 (R^2=0.8053). This measurement result shows that The Spectrophone® still need to be evaluated and corrected. One problem than can we identify that the diameter of pick point of RGB composition is too wide and this will affect the reading color composition. Next, we will fix the problem and in advance we will apply this Spectrophone® in a wide scale..

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5. Conslusion

The experiment reported here provides a simple way to have explore absorption spectroscopy. Dari hasil pengujian yang telah dilakukan, konsentrasi metilen blue dalam air diukur dengan menggunakan spektrofotometer adalah 36.04 ppm sedangkan dengan spectrophone in a red composition sebanyak 34.51 ppm. This measurement result shows that The Spectrophone® still need to be evaluated and corrected. Next, we will fix the problem and in advance we will apply this Spectrophone® in a wide scale.

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