

Design of Light Control Sub-system Based on Pulse Width Modulation to Perfect The First Generation of UIN Sunan Kalijaga's High Power UV-LED Fluorescence Spectroscopy System

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Abstract. Research on design of a light control sub-system based on pulse width modulation (PWM) to perfect the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system has been done. The purpose of this research was to design a light control sub-system based on PWM to perfect the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system. This research was done in two steps, firstly was designing a light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system and secondly was designing a light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system. Both were designed using CorelDraw software. The result showed that a design of a light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system has been made successfully using CorelDraw. So as a design of a light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system.

Keywords: fluorescence spectroscopy system, high power UV-LED, light intensity control sub-system, pulse width modulation

Running title: Light Control System Based on Pulse Width Modulation

INTRODUCTION

In material analysis, spectroscopy frequently used method. With the spectroscopic method, new compounds are easier to determine. (Sastrojamidjojo, 2013). One popular spectroscopy is fluorescence spectroscopy. Fluorescence is an atomic or molecular phenomenon that absorbs light with certain wavelength and then emits light with a wavelength greater than a wavelength of the generating light. (Gauglitz and Moore, 2014). Researchers in various fields have made extensive use of fluorescence spectroscopy. One of these researchers is Hassoun et al (2019), where they have used fluorescence spectroscopy to monitor the quality and authentication of fish and meat products. The result is a fast and non-destructive method. Other researchers are Ozbekova and Kulmyrzaev (2019). They used fluorescence spectroscopy coupled with multivariate analysis to study of moisture and water activity of rice. The study demonstrated that fluorescence spectroscopy combined with multivariate statistical tools has promising potential for non-destructive and rapid measurement of moisture content and water activity of rice. Rakhmadi and Rifai (2020) have succeeded in making the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system. The test results that have been carried out on samples of lard and beef showed that the system could work properly. The system was cheap. The system made by Rakhmadi and Rifai (2020) has weaknesses. One of them was the absence of a light intensity control sub-system. The absence of this sub-

system will affect tested sample. If received energy by sample is too large, it can damage sample.

Based on the above weaknesses, the system needs to be equipped with a light intensity control sub-system. There are two ways to adjust the intensity of light source: using a dimmer when the voltage was AC and using Pulse Width Modulation (PWM) when the voltage was DC. Because the system made by Rakhmadi and Rifai (2020) used DC voltage, so the light intensity control sub-system must be developed using PWM. PWM was a technique for generating an output signal with repeated periodically between high and low (Peddapelli, 2017). The advantages of PWM were easier setup than others and the loss power energy from the device was very low.

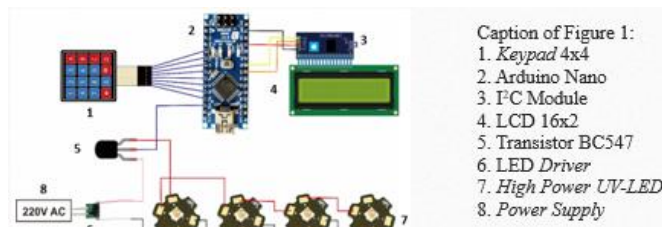
MATERIALS AND METHODS

The research on design of light control sub-system based on pulse width modulation to perfect the first generation of Sunan Kalijaga's *high power* UV-LED fluorescence spectroscopy system was done in two phases. First was designing a light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system. Second was designing a light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system. Second was designing a light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system.

Design of light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system was done using CorelDRAW software. Design of light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system was done using CorelDRAW software.

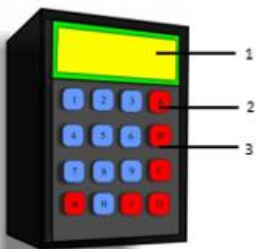
RESULTS AND DISCUSSION

The design result of light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system was shown in Figure 1 and Figure 2. The design result of light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system was shown in Figure 3.



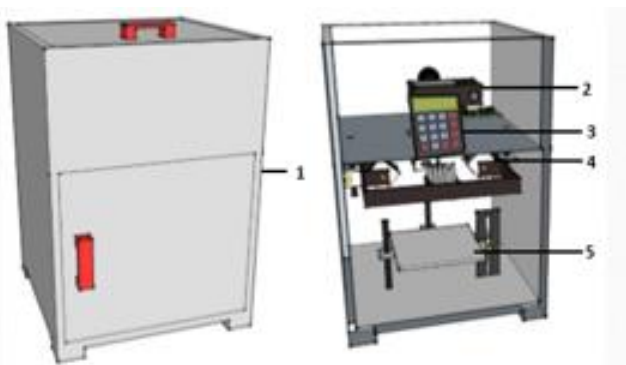
Caption of Figure 1:
 1. Keypad 4x4
 2. Arduino Nano
 3. IC Module
 4. LCD 16x2
 5. Transistor BC547
 6. LED Driver
 7. High Power UV-LED
 8. Power Supply

Figure 1 The design result of light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system



Caption of Figure 2:
 1. LCD 16x2
 2. Keypad 4x4
 3. Black Box

Figure 2 The casing design of light control sub-system separated from the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system



Caption of Figure 3:

1. Container
2. Sub-system of camera
3. Sub-system of light control
4. Sub-system of light source
5. Sub-system of sample place

Figure 3. The design result of light control sub-system integrated into the first generation of Sunan Kalijaga's high power UV-LED fluorescence spectroscopy system

The working mechanism of the light intensity control sub-system begins by connecting the Arduino Nano to the power supply using a USB cable. When the Arduino Nano was connected to the power supply, the LED on the Arduino Nano will flash. This shows that the Arduino Nano was ready to use.

After Arduino Nano was ready, Arduino Nano port will generate a voltage of 5 volt. The voltage from the Arduino Nano will be used to power the LCD 16x2 and keypad 4x4. The I2C LCD was connected to GND, VCC, SDA, and SCL on the Arduino Nano which occupied pins of 29, 27, 23, and 24. The keypad 4x4 was connected to C4, C3, C2, C1, R4, R3, R2, and R1 on Arduino Nano, pins 5, 6, 7, 8, 9, 10, 11, and 12.

The values of duty cycle in this sub-system were between 25-250 with interval of 25. The value of the duty cycle 25 was represented by number 1, duty cycle 50 by number 2, duty cycle 75 by number 3, duty cycle 100 by number 4, duty cycle 125 by number 5, duty cycle 150 by number 6, duty cycle 175 by number 7, duty cycle 200 by number 8, duty cycle 225 by number 9, and duty cycle 250 by number 10.

If we want to input a duty cycle value of 25, we have to press button number 1. If button number 1 was pressed, the number 1 will displayed on the 1st column and on the 2nd row of LCD screen. And so on for number 2 through number 10.

The working mechanism of the whole system begins by connecting the system to the power supply. Connecting the power supply to the system will provide a voltage to the LED driver. The input of the LED driver is an AC voltage, range from 100 to 240 volts. The output of the LED driver was a DC voltage with a voltage of 12 volt. A voltage of 12 volt was used to support four high power UV-LED.

When the sub-system of light source got a power, the four high-power UV-LEDs will emit light illuminating the sample. When high-power UV-LED light illuminates the sample, the atoms in the sample absorb the light energy from the high-power UV-LED. The energy absorption will add the energy of atoms in the sample (Lee et al., 2018).

If amount of energy absorbed by the atoms corresponds to the excitation energy of the atoms, the atoms will be excited at a higher level of $S'1$. This excitation state takes

place in a very short time in the order of nanoseconds. During this time the atoms will experience vibrational relaxation as shown in Figure 4. Under these conditions some energy will be dissipated as heat (Bioscience, 2002).

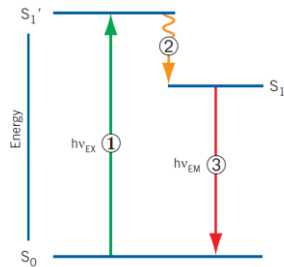


Figure 4 Jablonski Diagram (1) Excitation; (2) Vibrational relaxation; (3) Emission (Bioscience, 2002)

After reaching the S₁' state, the atoms will return to the ground state (S₁). When it returns to the ground state, energy is released in the form of light. The released light has a wavelength greater than the wavelength of the excitatory light (Lee et al, 2002). This phenomenon is known as fluorescence.

Next is entering keypad data to adjust light intensity by pressing buttons. The process of setting light intensity with high power UV-LED, works according to the input of keypad data. When LCD displays a value of 1, the system will represent a duty cycle value of 25, and so on.

Then, the fluorescence phenomenon was detected using a sub-system of camera. The camera will capture fluorescence image and forward it to computer. After the image was displayed on computer, the image was converted to spectrum.

CONCLUSIONS

To design a light control sub-system based on pwm to perfect the first generation of sunan kalijaga's high power uv-led fluorescence spectroscopy system. In this research, the fluorescence phenomenon was detected using a sub-system of camera. The camera will capture fluorescence image and forward it to computer. After the image was displayed on computer, the image was converted to spectrum.

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