MEMORANDUM

TO: Dr. Christopher Peters
FROM: Yelnur Abilakim
DATE: 14 Oct 2021
SUBJECT: ECE-303 Lab 3: Pulse Width Modulation

Summary

In this experiment, the LED intensity is being varied by sweeping the LED input voltage. While this can be done using the analogWrite() command, the challenge of the experiment is to achieve the desired outcome by implementing PWM using timers. Once the proper circuit is set up, Arduino code is written to change the duty cycle from 5% to 100% in 5% increments. The time between readings is two and a half seconds (at least two seconds as per protocol) to ensure all transients are minimized.

The following information is being displayed on the Serial Monitor on each iteration:

- Duty Cycle (%).
- Voltage across resistor in LED circuit (V).
- Voltage across the resistor in the photocell circuit (V).

Introduction

Photoresistors are very simple yet useful pieces of electronic circuits. They are used in several equipment, such as cameras and slow RPM counters. In this project, a photoresistor is analyzed by controlling the intensity of an LED. As the PWM signal increases the duty cycle, the LED gets brighter, up until a point. Additionally, the photocell decreases in resistance as more light is incident on it.

Methods

Experimental apparatus used in this lab:

- Breadboard.
- Arduino MEGA 2560 connected as follows:
  - To laptop via USB cable.
  - To outlet via power cable.
- One 1kΩ resistor.
- One 10kΩ resistor.
- One photocell.
- Four jump wires.

The LED used in this experiment is a red LED in series with a 1kΩ resistor (either one can be connected to ground). On a different circuit, the photocell will be connected to the 5V pin, and in series with a 10kΩ resistor (resistor to ground).

The circuit used for the lab is shown in Figure 1.

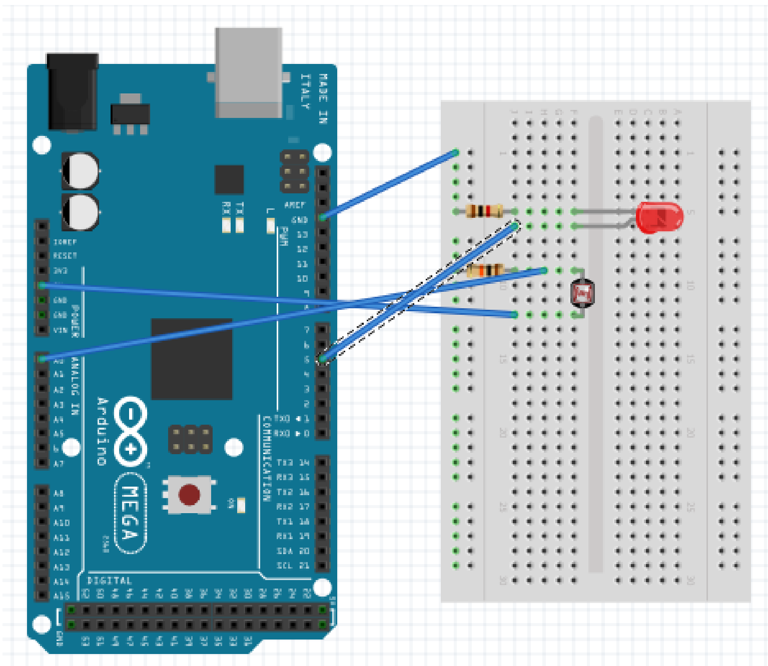

Figure 1. Circuit setup

Note that the LED should be placed near the photocell head, and photocell wiring needs to be bent such that the photocell head is in direct line with the LED. This minimizes energy losses, resulting in a more accurate measurement. In addition, the measurements should be performed in a dark environment so that external light sources do not interfere.

Results

The physical circuit used for the experiment, built according to Figure 1, is displayed in Figure 2.

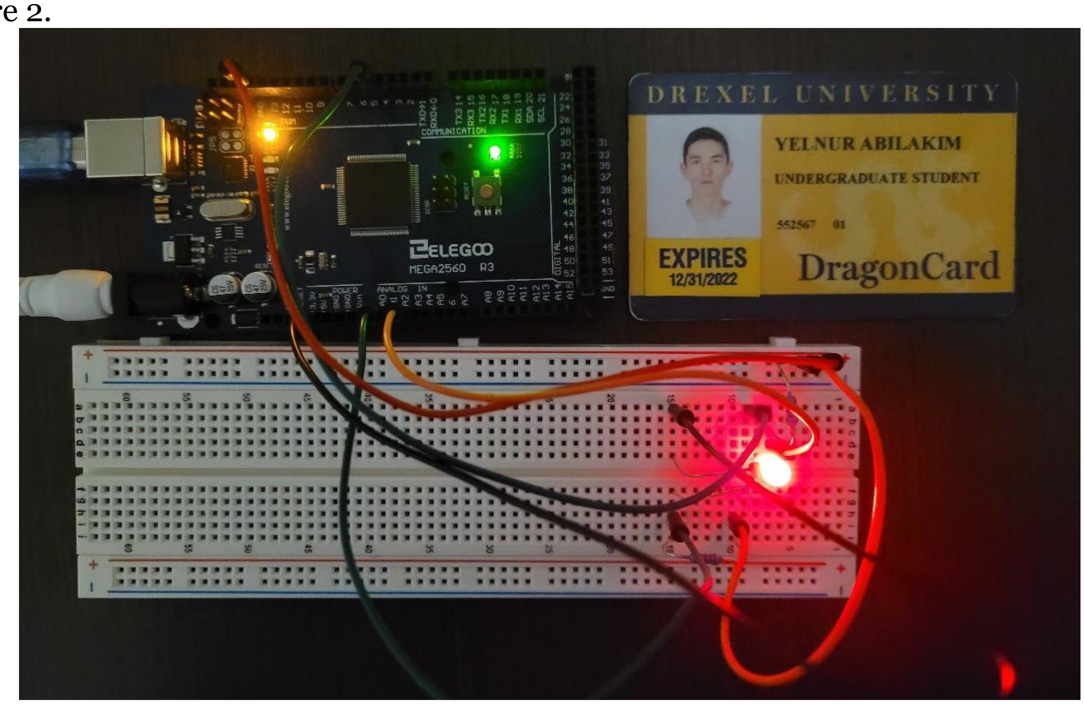

Figure 2. Physical circuit

Outputs from the Serial Monitor are summarized in Table 1.

Table 1. Serial Monitor outputs

Duty cycle, %	Photocell resistor voltage, V	LED resistor voltage, V
5	0.78	0.62
10	0.86	0.62
15	0.88	0.62
20	0.89	0.62
25	0.9	0.62
30	0.9	0.62
35	0.9	0.62
40	0.9	0.62
45	0.9	0.62
50	0.9	0.62
55	0.9	0.62
60	0.9	0.62
65	0.9	0.62
70	0.9	0.62
75	0.9	0.62
80	0.9	0.62
85	0.9	0.62
90	0.9	0.62
95	0.9	0.62
100	0.9	0.62

The code written for this experiment is appended at the end.

Conclusions/Recommendations

The experiment was successful. The goal of changing the LED intensity via the implementation of PWM using timers, rather than analogWrite() command, has been achieved. The Serial Monitor has displayed all required values as expected.

Appendices

```
const int pinLED = 5; // timer 3
const int pinPhoto = A0; // photocell at analog pin 0
const int pinRes = A2;
int valuePhoto; // store photocell resistor voltage
int valueRes; // store LED resistor voltage

void setup(){
  Serial.begin(9600);
  TCCR3A = 0b10000010;
  TCCR3B = 0b00010011;
  ICR3 = 12500;
  OCR3A = 625;
  TCNT3 = 0;
  pinMode(pinLED, OUTPUT);
  pinMode(pinPhoto, INPUT);
  pinMode(pinRes, INPUT);
}

void loop(){
  if (ICR3 >= OCR3A){
    delay(2500);

    Serial.print("Duty cycle: ");
    Serial.print(int(float(OCR3A) / float(ICR3) * 100));
    Serial.println("%");

    valuePhoto = analogRead(pinPhoto);
    Serial.print("Photocell reading: ");
    Serial.println(float(valuePhoto) / 1000);

    valueRes = analogRead(pinRes);
    Serial.print("LED reading: ");
    Serial.println(float(valueRes) / 1000);

    Serial.println();

    OCR3A = float(OCR3A) + 625;
  }
}
```

Figure X. Code