Practical Robotics Projects with Arduino

(CSE 4571)

Lab Assignment No – 07

NeoPixel Ring Programming

Submission Date: _____

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Aim:

NeoPixel Ring Programming – To Program a WS2812B NeoPixel LED Strip with Arduino UNO using the Adafruit library for multicolor and brightness effects.

Objectives:

1) **Gain familiarity with the WS2812B NeoPixel LED strip.**
2) **To write an Arduino code that controls individual pixel colours using setPixelColor().**
3) **Write an Arduino sketch to explore brightness control of a WS2812B NeoPixel 16 LEDs in a strip using the setBrightness() function. This function will control the global brightness based on user input from a push button.**
   - 3.1 **Write an Arduino sketch to control the 5 different global brightness levels based on user input from a push button.**
   - 3.2 **Write an Arduino sketch to control the brightness fades UP and DOWN smoothly each time the button is pressed, instead of jumping in steps. (1st press fade UP, 2nd press fade DOWN, 3rd fade UP again and so on).**
4) **To develop an Arduino sketch that generates static multi-colour patterns on the LED strip.**
5) **To develop Arduino code for multi-colour effects such as rainbow, fading, and chasing animations.**

Pre-Lab Questionnaire:

A. Experiment-Specific

1. What is the WS2812B LED commonly called in Adafruit terminology?
2. Which communication protocol is used by WS2812B LEDs?
3. Why is an external resistor (≈330–470 Ω) recommended on the data line of NeoPixels?
4. Why is a capacitor (≈1000 μF) recommended across the LED power supply?
5. What Arduino library is most commonly used to control WS2812B LEDs?
6. Which Arduino UNO pin is commonly used as the data pin for NeoPixels in example codes?
7. How many bytes are required to represent the color of one WS2812B LED?
8. Why must we call pixels.begin() in the setup function?
9. What power supply voltage is typically needed for WS2812B LEDs?
10. What is the typical maximum current consumption of one WS2812B LED at full brightness white?

Components/Equipment Required:

Sl. No.	Name of the Component / Equipment	Specification	Quantity
1)	Arduino UNO R3	16MHz	1
2)	Arduino UNO cable	USB Type A to Micro-B	1
3)	WS2812B NeoPixel 16 LED strip	Any colour of your choice	1
4)	Breadboard	840 Tie points	1
5)	Jumper Wire	----------	As per requirement

Objective 2

To write an Arduino code that controls individual pixel colours using setPixelColor().

Circuit / Schematic Diagram

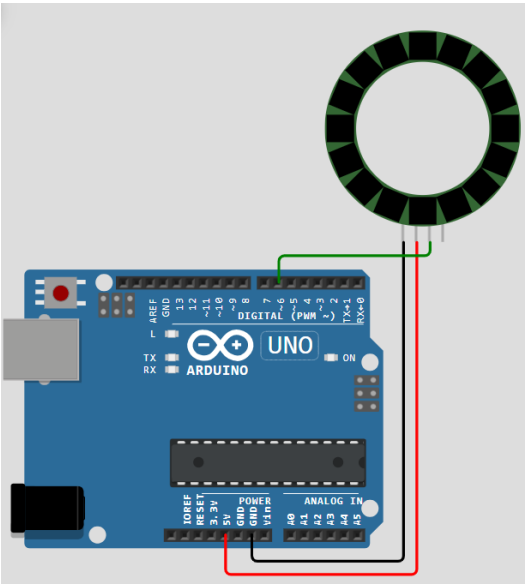

Figure 1: Controls of individual WS2812B NeoPixel colours

Code

Write an Arduino code that controls individual pixel colours using setPixelColor().

```
#include <Adafruit_NeoPixel.h>

#define LED_PIN 6
#define NUM_LEDS 16

Adafruit_NeoPixel strip(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

void setup() {
  strip.begin();
  strip.show();
}

void loop() {
  for (int i = 0; i < NUM_LEDS; i++) {
    strip.setPixelColor(i, strip.Color(255, 0, 0));
    strip.show();
    delay(100);
  }

  strip.clear();
  strip.show();
  delay(500);
}
```

Observation

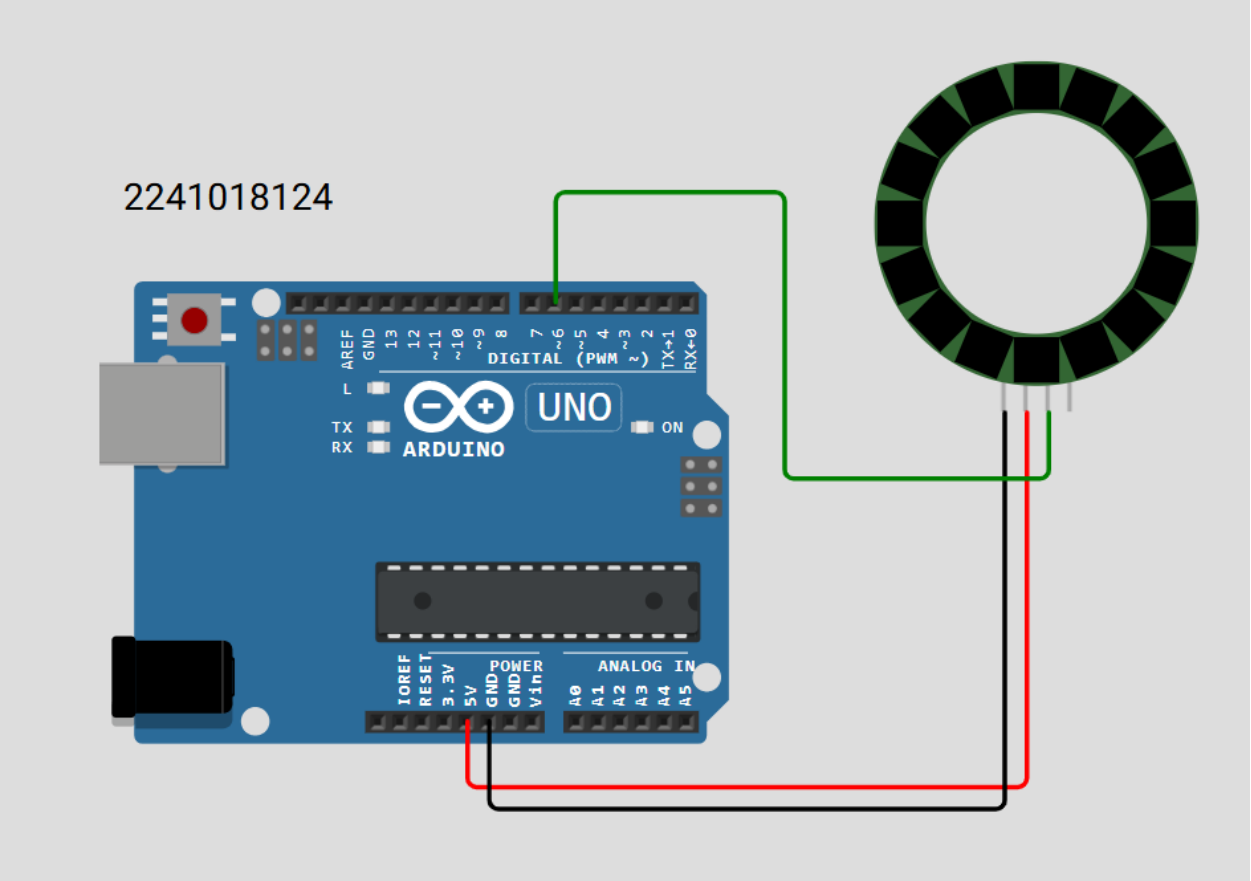

Figure 2: (Simulation-based controls of individual WS2812B NeoPixel colours)

Objective 3

Write an Arduino sketch to explore brightness control of a WS2812B NeoPixel 16 LEDs in a strip using the setBrightness() function. This function will control the global brightness based on user input from a push button.

Circuit / Schematic Diagram

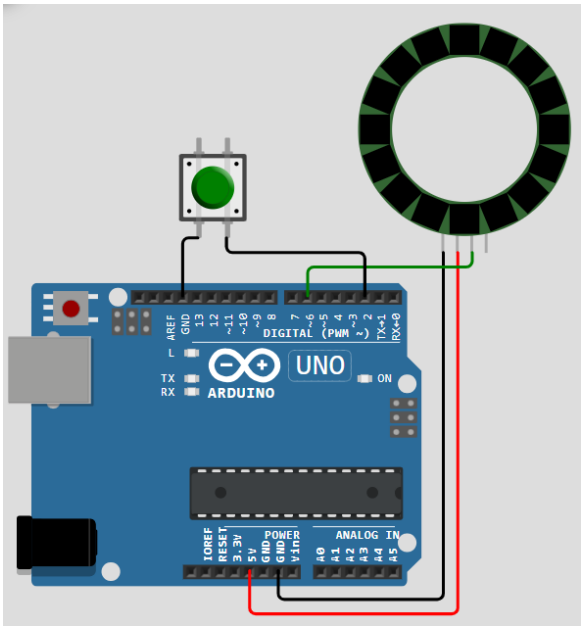

Figure 3: Brightness control of a WS2812B NeoPixel 16 LEDs in a strip

Code

3.1 Write an Arduino sketch to control the 5 different global brightness levels based on user input from a push button.

```
#define LED_PIN 6
#define NUM_LEDS 16
#define BUTTON 2

#include <Adafruit_NeoPixel.h>

Adafruit_NeoPixel strip(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

int level = 0;
int lastState = HIGH;

void setup() {
  strip.begin();
  strip.show();
  pinMode(BUTTON, INPUT_PULLUP);
}

void loop() {
  int state = digitalRead(BUTTON);

  if (state == LOW && lastState == HIGH) {
    level = (level + 1) % 5;
    int brightness = map(level, 0, 4, 0, 255);
    strip.setBrightness(brightness);
    strip.fill(strip.Color(255, 255, 255));
    strip.show();
    delay(250);
  }

  lastState = state;
}
```

3.2 Write an Arduino sketch to control the brightness fades UP and DOWN smoothly each time the button is pressed, instead of jumping in steps. (1st press fade UP, 2nd press fade DOWN, 3rd fade UP again and so on).

```
#define LED_PIN 6
#define NUM_LEDS 16
#define BUTTON 2

#include <Adafruit_NeoPixel.h>

Adafruit_NeoPixel strip(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

int lastState = HIGH;
bool fadeUp = true;

void setup() {
 strip.begin();
 strip.show();
 pinMode(BUTTON, INPUT_PULLUP);
}

void loop() {
 int state = digitalRead(BUTTON);

 if (state == LOW && lastState == HIGH) {
  if (fadeUp) {
   for (int b = 0; b <= 255; b++) {
    strip.setBrightness(b);
    strip.fill(strip.Color(255, 255, 255));
    strip.show();
    delay(5);
   }
   fadeUp = false;
  } else {
   for (int b = 255; b >= 0; b--) {
    strip.setBrightness(b);
    strip.fill(strip.Color(255, 255, 255));
    strip.show();
    delay(5);
   }
   fadeUp = true;
  }
  delay(250);
 }

 lastState = state;
}
```

Observation

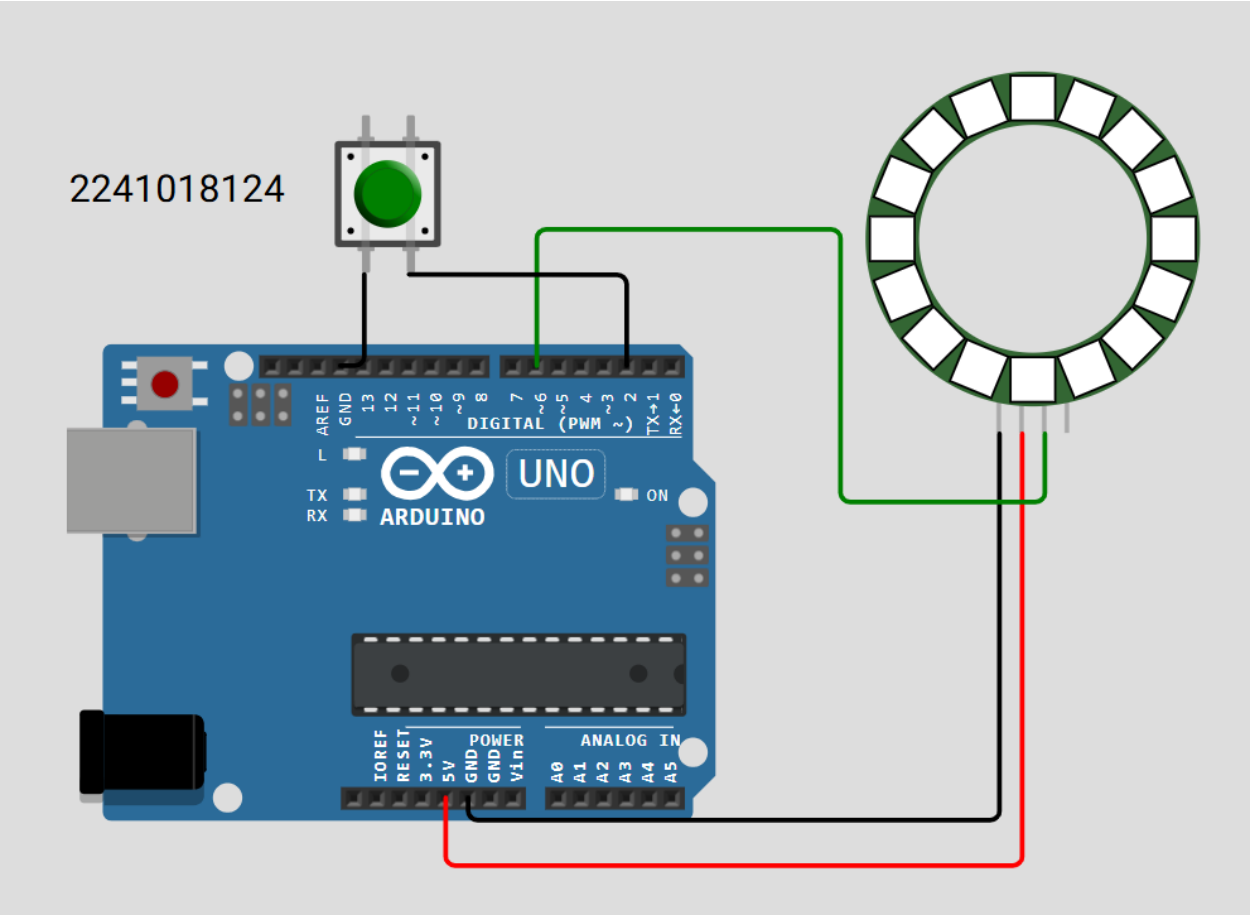

Figure 4: (Simulation-based brightness control of a WS2812B NeoPixel 16 LEDs in a strip)

Objective 4

To develop an Arduino sketch that generates static multi-colour patterns on the LED strip.

Circuit / Schematic Diagram

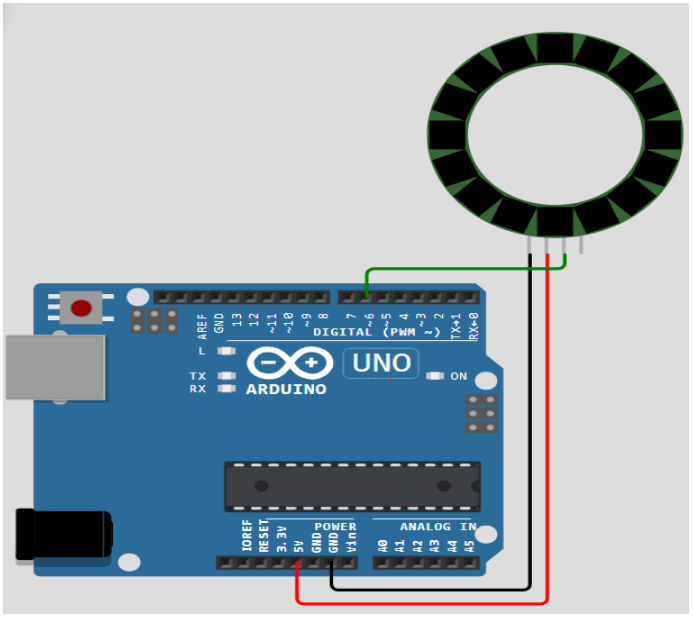

Figure 5: Static multi-colour patterns on the LED strip

Code

Write an Arduino sketch that generates static multi-colour patterns on the LED strip

```
#include <Adafruit_NeoPixel.h>

#define LED_PIN 6
#define NUM_LEDS 16

Adafruit_NeoPixel strip(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

void setup() {
  strip.begin();
  strip.show();
}

void loop() {
  strip.setPixelColor(0, strip.Color(255, 0, 0));
  strip.setPixelColor(1, strip.Color(0, 255, 0));
  strip.setPixelColor(2, strip.Color(0, 0, 255));
  strip.setPixelColor(3, strip.Color(255, 255, 0));
  strip.setPixelColor(4, strip.Color(255, 0, 255));
```

```
  strip.setPixelColor(5, strip.Color(0, 255, 255));
  strip.setPixelColor(6, strip.Color(255, 100, 0));
  strip.setPixelColor(7, strip.Color(150, 0, 200));
  strip.setPixelColor(8, strip.Color(0, 150, 100));
  strip.setPixelColor(9, strip.Color(200, 50, 50));
  strip.setPixelColor(10, strip.Color(50, 200, 50));
  strip.setPixelColor(11, strip.Color(50, 50, 200));
  strip.setPixelColor(12, strip.Color(255, 50, 150));
  strip.setPixelColor(13, strip.Color(150, 255, 50));
  strip.setPixelColor(14, strip.Color(50, 150, 255));
  strip.setPixelColor(15, strip.Color(255, 255, 255));

  strip.show();

  while (1);
}
```

Observation

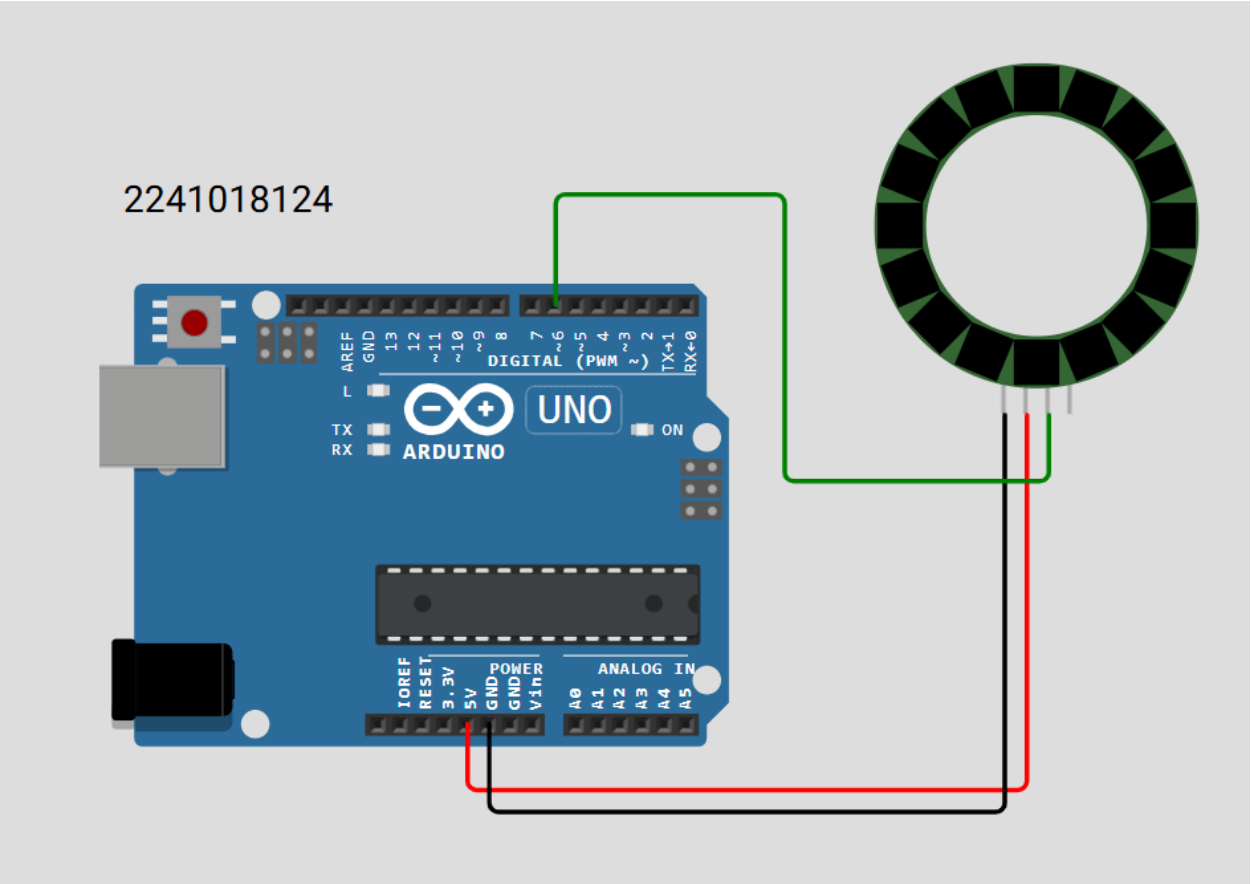

Figure 6: (Simulation-based Static multi-colour patterns on the LED strip)

Objective 5

To develop Arduino code for multi-colour effects, such as rainbow, fading, and chasing animations.

Circuit / Schematic Diagram

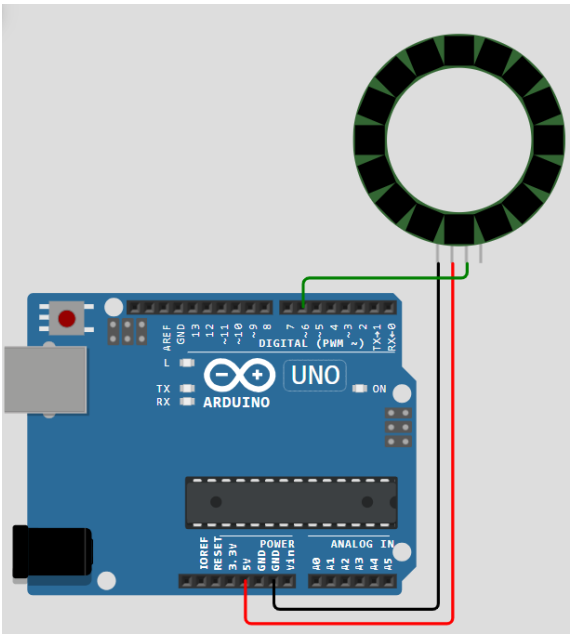

Figure 7: Multi-colour effects on the LED strip animation

Code

Write an Arduino code for multi-colour effects, such as rainbow, fading, and chasing animations

```
#include <Adafruit_NeoPixel.h>

#define LED_PIN 6
#define NUM_LEDS 16

Adafruit_NeoPixel strip(NUM_LEDS, LED_PIN, NEO_GRB + NEO_KHZ800);

void setup() {
  strip.begin();
  strip.show();
}
```

```
void rainbow() {
  for(int j = 0; j < 256; j++) {
    for(int i = 0; i < NUM_LEDS; i++) {
      strip.setPixelColor(i, strip.Color((i*10 + j) & 255, (255 - i*8 + j) & 255, (i*5 + j*2) & 255));
    }
    strip.show();
    delay(20);
  }
}

void fade() {
  for(int b = 0; b <= 255; b++) {
    strip.setBrightness(b);
    strip.fill(strip.Color(255, 0, 150));
    strip.show();
    delay(5);
  }
  for(int b = 255; b >= 0; b--) {
    strip.setBrightness(b);
    strip.fill(strip.Color(0, 200, 255));
    strip.show();
    delay(5);
  }
}

void chase() {
  for(int i = 0; i < NUM_LEDS; i++) {
    strip.clear();
    strip.setPixelColor(i, strip.Color(255, 255, 0));
    strip.setPixelColor((i+1) % NUM_LEDS, strip.Color(0, 255, 255));
    strip.setPixelColor((i+2) % NUM_LEDS, strip.Color(255, 0, 255));
    strip.show();
    delay(80);
  }
}

void loop() {
  rainbow();
  fade();
  chase();
}
```

Observation

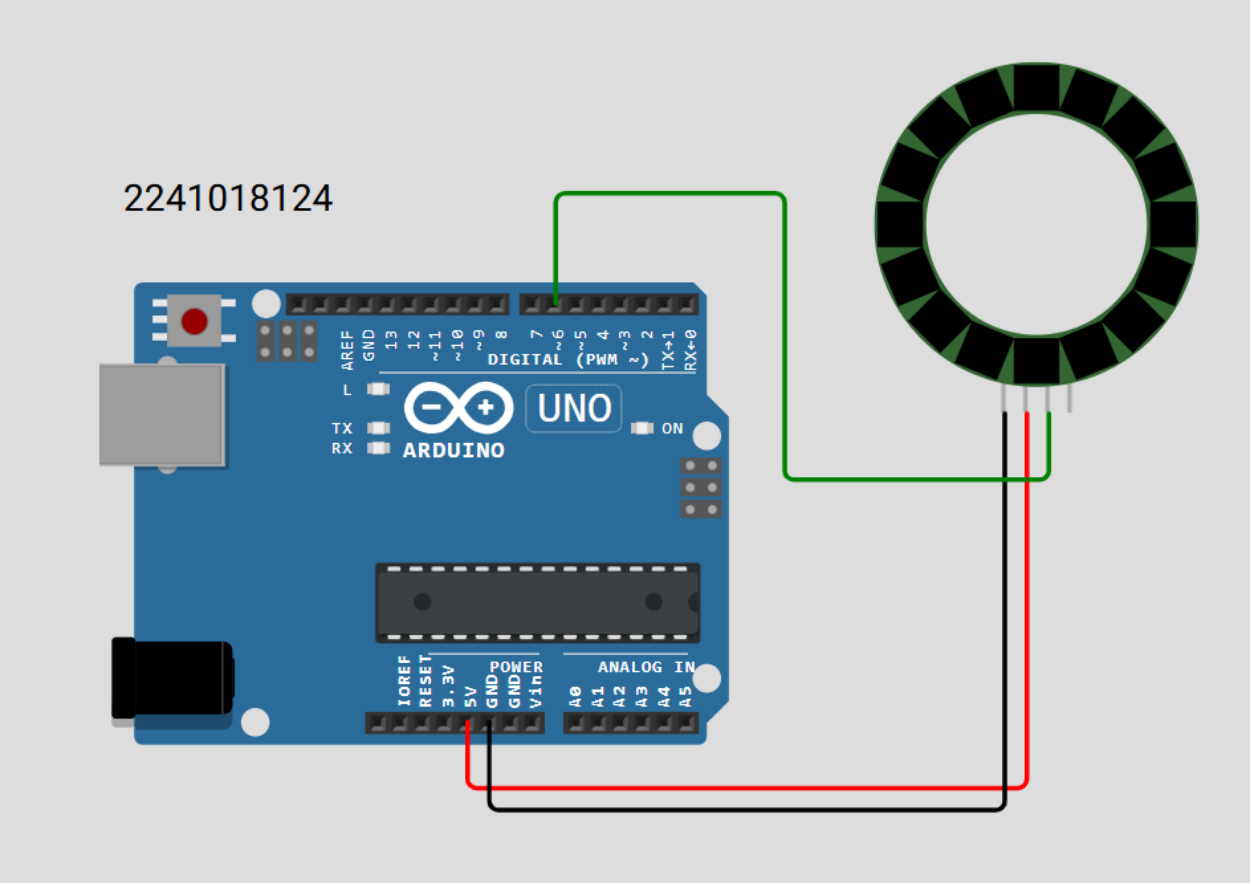

Figure 8: (Simulation-based multi-colour effects on the LED strip animation)

Figure 9: (Hardware Implementation based multi-colour effects on the LED strip animation)

Conclusion:

Precautions:

Post Experiment Questionnaire:

1. What function is used to actually display the updated color values on the NeoPixel LEDs?
2. How do you set the brightness of all NeoPixels in the strip?
3. Which function is used to assign an RGB color value to a particular pixel?
4. What happens if you set pixel colors but forget to call pixels.show();?
5. What was observed when brightness was set to maximum for multiple LEDs?
6. How can you create a color-changing rainbow animation on NeoPixels?
7. What color order (RGB/GRB) did your NeoPixel strip use in the experiment?
8. What practical limitation did you observe when using Arduino UNO for NeoPixel control?

Answers to Post-Lab Questions

(Signature of the Faculty)	**(Signature of the Student)**
	Name:
Date:	**Registration No.:**
	Branch:
	Section