



# BUT I CAN'T BREATHE

## Proof-of-Concept for a Pulse Oximeter to Reduce Racial Bias in Medicine

AnnaRose Heinly, Shawn Coulesy, and Ashley Spring, Ph.D.  
Eastern Florida State College



### Introduction

Pulse oximeters have a recorded history of racial bias towards patients with a high melanin content have approximately three times the occurrence of hypoxemia undetected by pulse oximetry as patients with lower melanin content (Merrick and Hayes 1976, Sjoding et al. 2020). Measurements from pulse oximeters are also inaccurate on individuals with scar tissue, hyperpigmentation, nail polish, and tattoos (Webster 1997). This study proposed two alterations to pulse oximeters. First, two infrared LEDs— rather than red and infrared LEDs— were used to eliminate the need for calibration of oxygen saturation (Yossef Say et al. 2018, Al-Halawani et al. 2023). Second, adding a time of flight (ToF) value to measure the optical pathlength through skin, yielding a specific number for each person. It is hypothesized adding two infrared LEDs and ToF values to the algorithm will enable the operation of a proof-of-concept for a significantly more accurate pulse oximeter.

### Percent Success - Trial by Fire

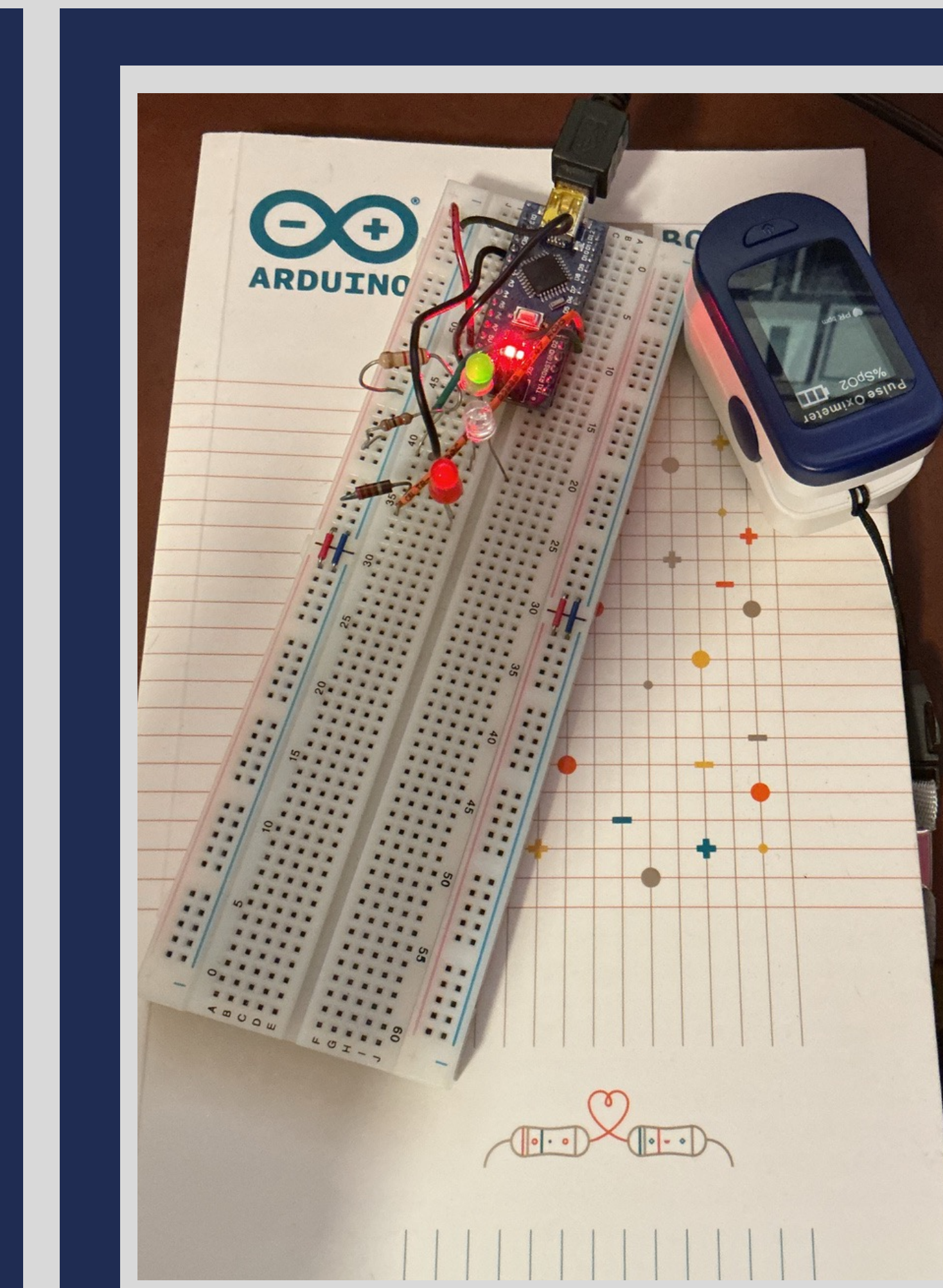
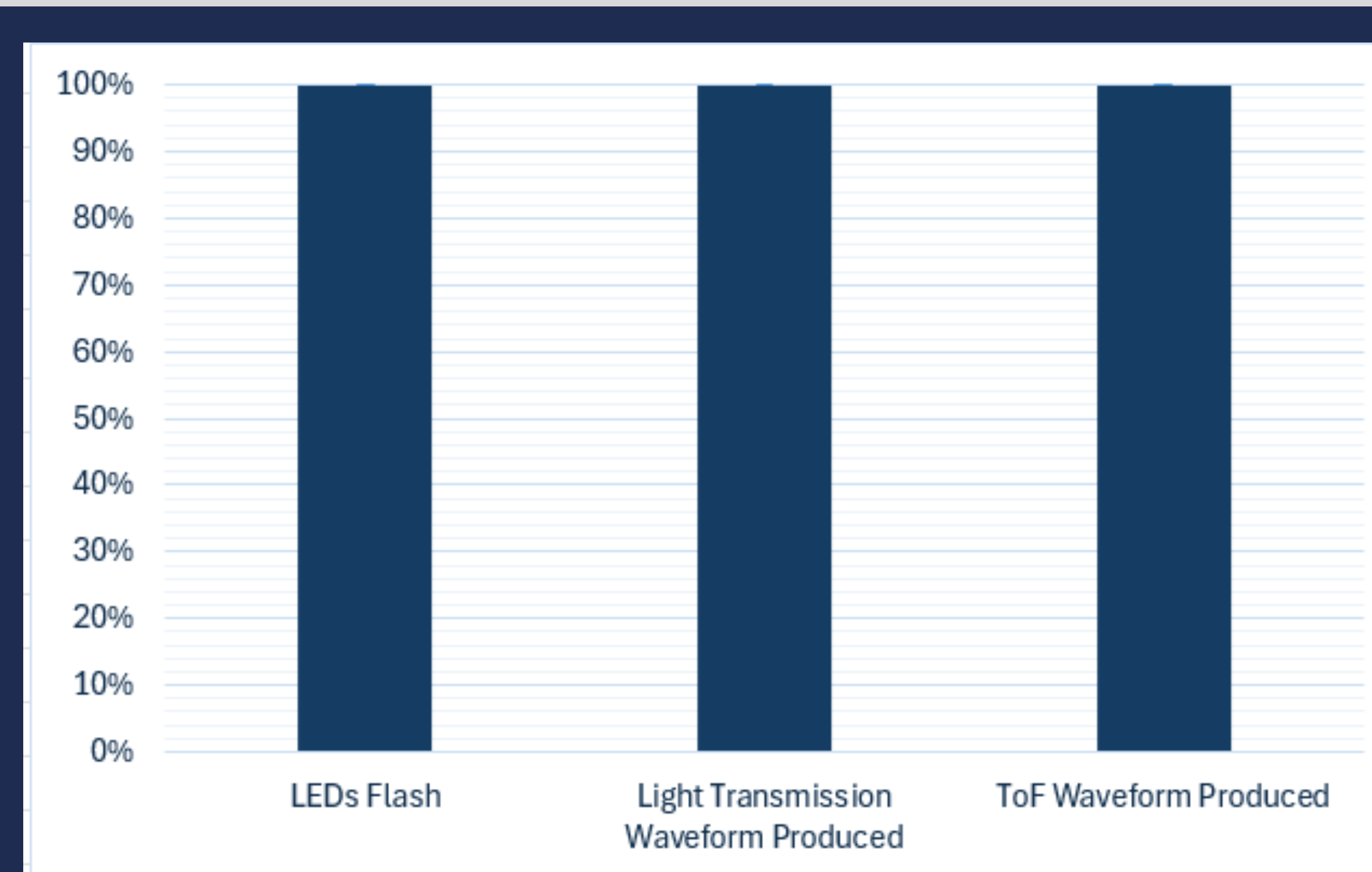


Figure 1. The success rate of LEDs flashing, a graph of light transmission being produced and a waveform of ToF being produced on a pulse oximeter connected to a breadboard (n=5,  $\bar{x} \pm SD$ ).

### Discussion

The results supported the hypothesis that adding two infrared LEDs and a ToF algorithm will enable the operation of a proof-of-concept for a significantly more accurate pulse oximeter. By removing the calibration step and accounting for optical pathlength, the inaccuracies of pulse oximetry will be eliminated (Al-Halawani et al). Following the proof-of-concept phase, the machinery on the breadboard will be decreased in size and crafted into a new pulse oximeter. Then, the pulse oximeter will be tested on a widely diverse group of 150 patients, potentially yielding the most accurate pulse oximeter ever created.



### Materials

- Infrared LED (810 nm)
- Infrared LED (740 nm)
- Light dependent resistor
- Breadboard
- Arduino Uno microcontroller
- Computer

### Methods

- An Arduino Uno microcontroller was connected to a breadboard with two infrared LEDs and a light dependent resistor (LDR) positioned between them.
- An Arduino IDE sketch was created to flash each LED and record values from the LDR, which was then passed to a Python script to plot into graphs and compute oxygen saturation.
- The internal clock of a computer as well as the two LEDs were tested in 5 trials with the production of wavelengths based on light transmission and the time it takes for the Arduino to produce a signal.

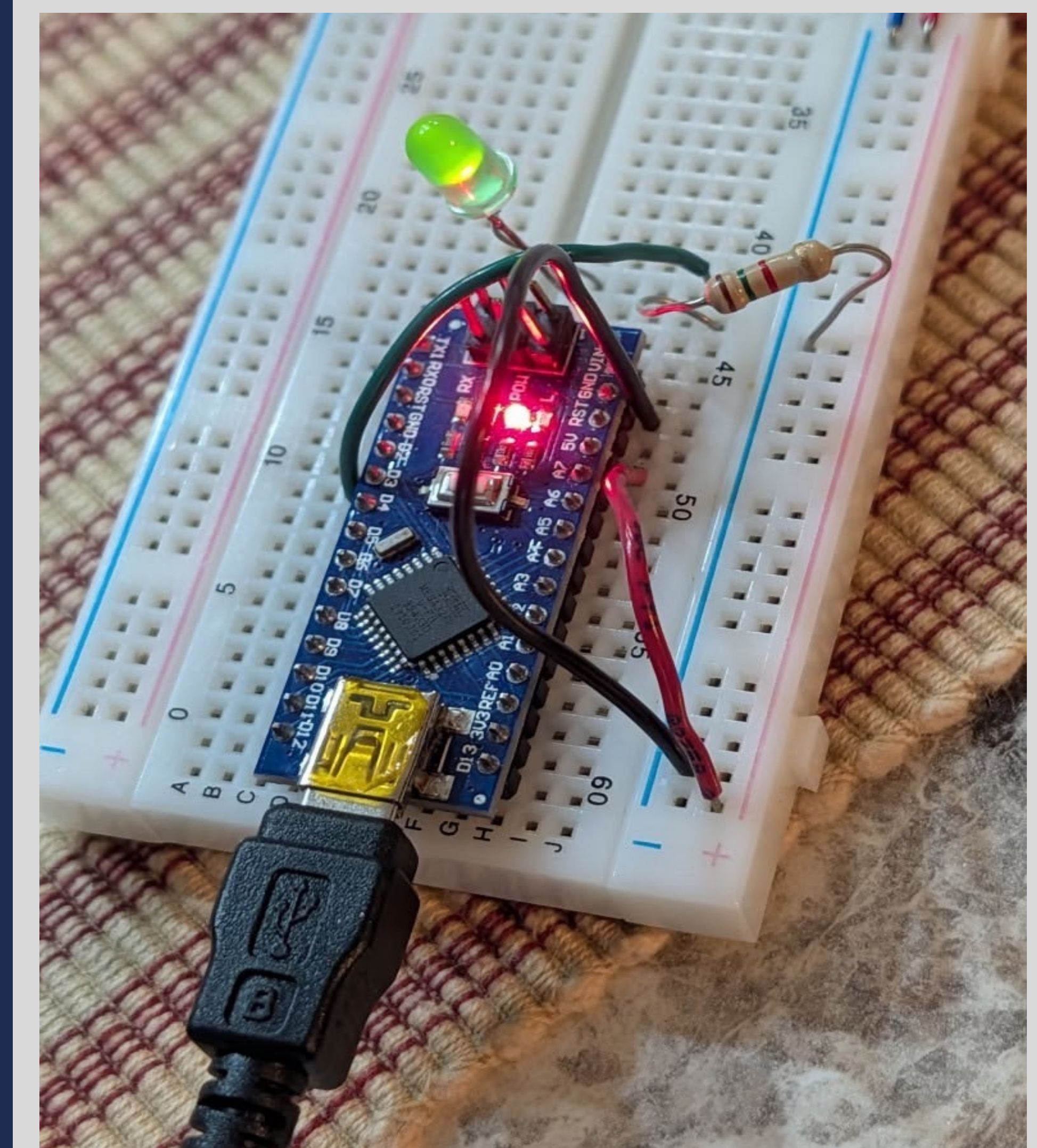
```

9  arduinoData = serial.Serial("COM5", 115200)
10 time.sleep(2)
11
12 # Separate lists for each channel
13 greenList = []
14 redList = []
15 ambientList = []
16
17 fig, ax = plt.subplots()
18
19 def animate(i):
20     # Read all lines currently in the serial buffer
21     while arduinoData.in_waiting > 0:
22         try:
23             raw = arduinoData.readline().decode("ascii").strip()
24
25             if raw.startswith("Green:"):
26                 value = float(raw.split(":")[1].strip())
27                 greenList.append(value)
28             elif raw.startswith("Red:"):
29                 value = float(raw.split(":")[1].strip())
30                 redList.append(value)
31             elif raw.startswith("Ambient Light:"):
32                 value = float(raw.split(":")[1].strip())
33                 ambientList.append(value)
34             except (ValueError, UnicodeDecodeError):
35                 pass
36
37     ax.clear()
38     # Plotting the different colours of light
39     if greenList:
40         ax.plot(greenList, color="green")
41     if redList:
42         ax.plot(redList, color="red")
43     if ambientList:
44         ax.plot(ambientList, color="blue")
45
46     fig.canvas.draw()
47     fig.canvas.flush_events()
48     return fig
49
50 ani = animation.FuncAnimation(fig, animate, interval=1000)
51 plt.show()

```

### Results

There was no significant difference between the categories of LEDs flashing, light transmission waveform produced, and ToF waveform produced (1-way ANOVA,  $F_{2,12} = 65535$ ,  $p > 0.05$ , Figure 1).



### Literature Cited

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