ISIM Final Project Report: Concerning Color Sensing

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For my final project, I aimed to use the two photodiodes I had to sense color. What I came up with Was a circuit that could sense the saturation of red in the color it was exposed to.

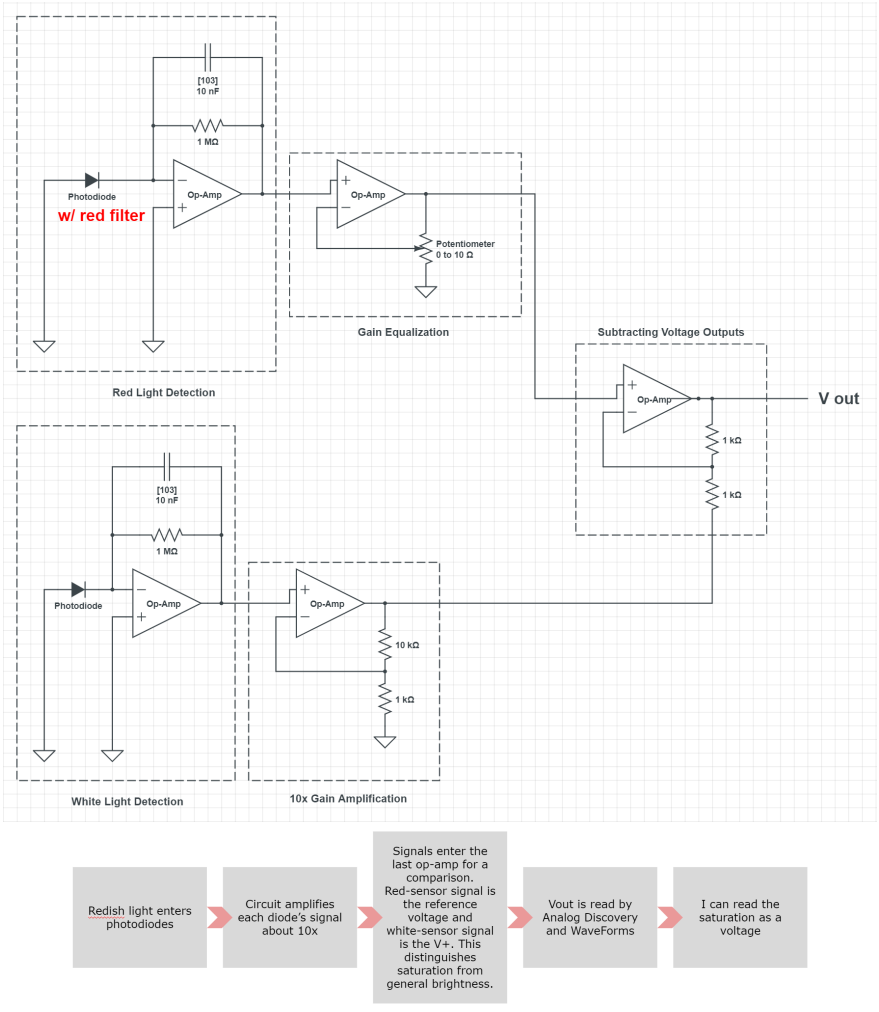

Figure 1: This is the circuit I designed along with the corresponding block diagram. The photodiode inputs are taken from the Oximeter lab, minus the low pass filter in order to see the level of the light, not just the change. I used a potentiometer instead of two resistors for the amplification on the red-filtered side to balance the inputs. The last op-amp before the V_{out} is to subtract the two channels and output one difference.

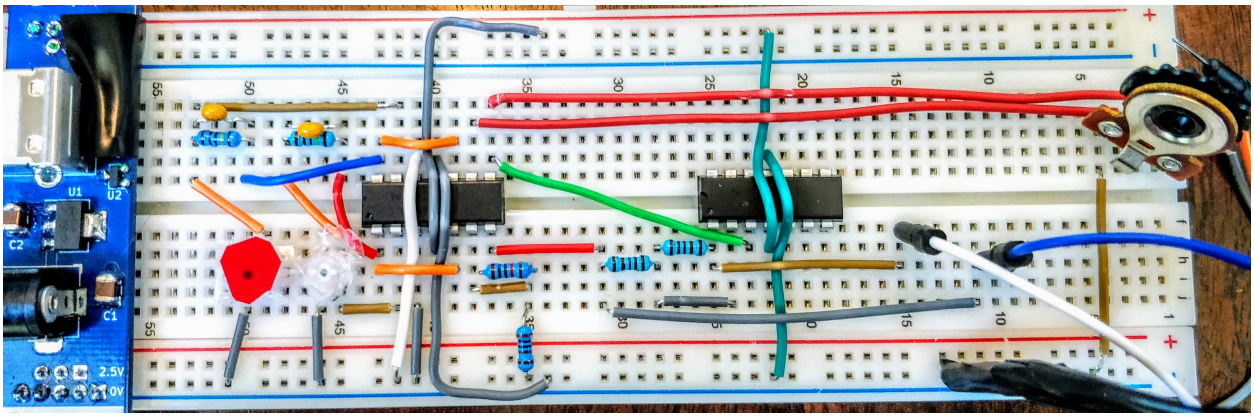

Figure 2: This is my final circuit. The long red wires lead to the wheel-shaped potentiometer in the upper right corner. The two photo-diodes can be seen towards the lower left, with the white light sensor to the direct right (a bit hard to see) of the red sensor (visible by it's red filter top). The blue and white wires extending from the board go to the Analog Discovery's Ch2+ and Ch2- respectively. I recorded data by adjusting a HSV color picker on my phone and lying my phone on top of both of the sensors.

H	S	V	Voltage (V)
0	100	60	-0.026
0	80	60	0.040
0	60	60	0.350
0	40	60	0.660
0	20	60	1.330
0	0	60	2.170

Figure 3: This data table contains the calibration values from the beginning of my experiment. The right three columns specify the settings on the color-picker app on my phone and the Voltage column records the V_{out} value shown in WaveForms at that time. H is for hue (where 0 is red), S is for saturation (where 100 is fully saturated and 0 is fully grey), and V is for value (where 100 is white and 0 is black), in HSV color codes. I held H at red and V at 60 (a midrange grey that didn't fully saturate either sensor at S=100 or S=0) while I varied S. My data trended in the right direction (displaying a larger V when the difference between the two sensors was larger) but the values tended to fluctuate highly based on small things like the exact position of the phone and where my had was when I would record the values.

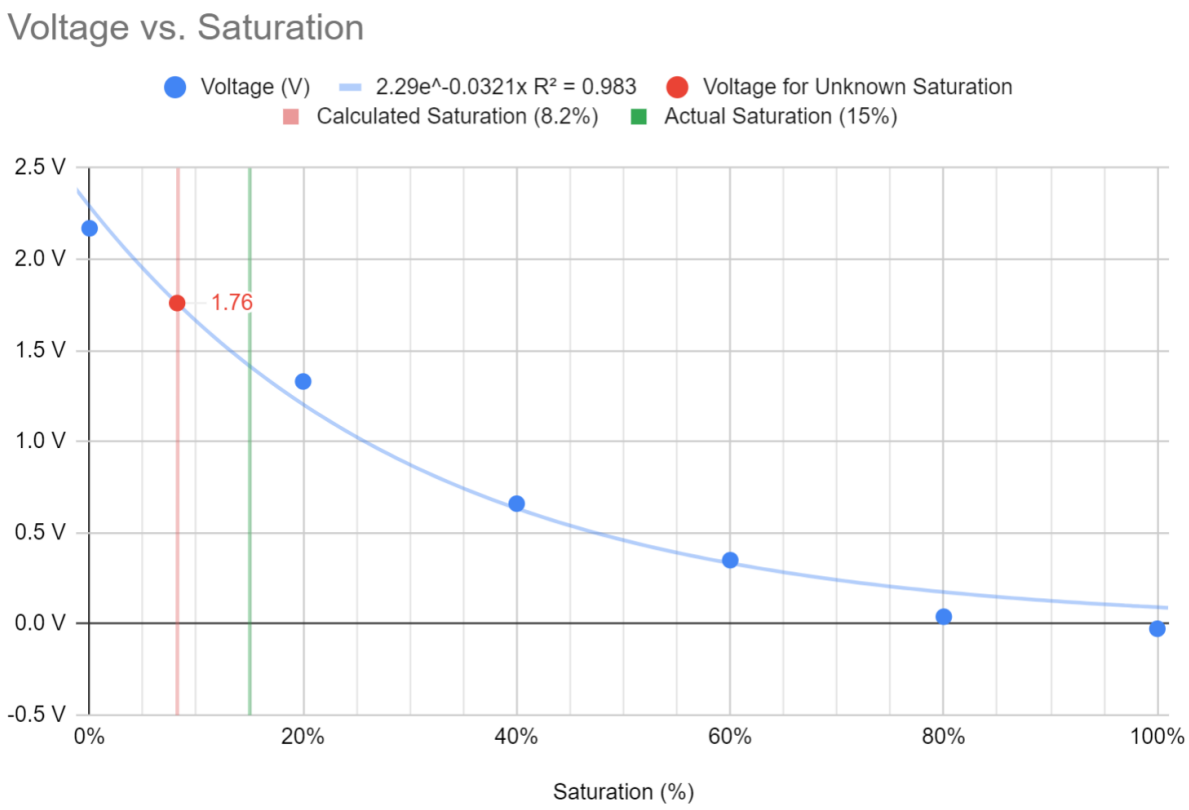

Figure 4: I plotted the voltage values from Figure 3 in blue in the graph. I used an exponential for my calibration curve in hopes of best matching the data for estimating a value within the measured range, but I am unsure if this reflects actual theoretical behavior. I used the equation of the best-fit curve $V = 2.29e^{-0.0321S}$ to determine the "unknown" saturation with my test voltage of 1.76V.

H	S	V	Voltage (V)
0	100	60	-0.026
0	80	60	0.040
0	60	60	0.350
0	40	60	0.660
0	20	60	1.330
0	0	60	2.170

H	Real S	V	Voltage for Unknown S	Calculated S
0	15	60	1.76	8.20

Figure 5: Using the inverse of the equation of the best-fit curve with my test voltage of 1.76V I determined that the the saturation should be about 8.2 percent. In reality, the saturation I held up to the sensor was 15 percent. There is a pretty large gap between the numbers, evidence of the trouble I had getting consistent measurements from my circuit, but the fact that it is between the two data points for 0 and 20 percent saturation says that I have the right idea.