Task 4:
Part 1:
I decided to use my yellow Winnie the Pooh airpods case for the image detection. Typically, I found the HSV results to be much better as it can be seen from the performance difference between Figure 1 and Figure 2 where Figure 1 used RGB and there was a lot more in the photo detected as yellow compared to the HSV result in Figure 2. However, both methods were able to bound the Winnie the Pooh case well. For RGB, my lower bound was (20, 100, 100) and my upper bound was (80, 255, 255). I was able to get away with a smaller bound for the HSV, using (20, 100, 100) as my lower bound and (30, 255, 255) as my upper bound.

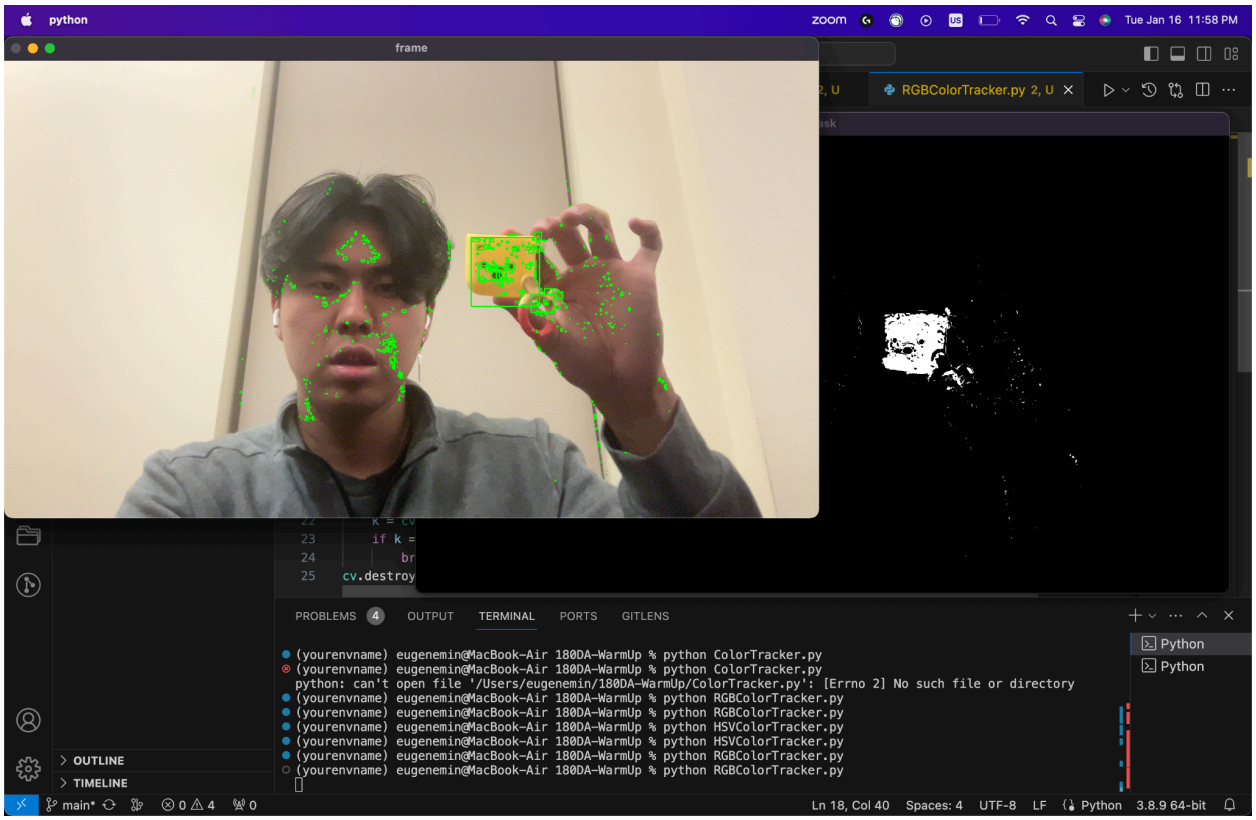

Figure 1: RGB thresholded bounding box

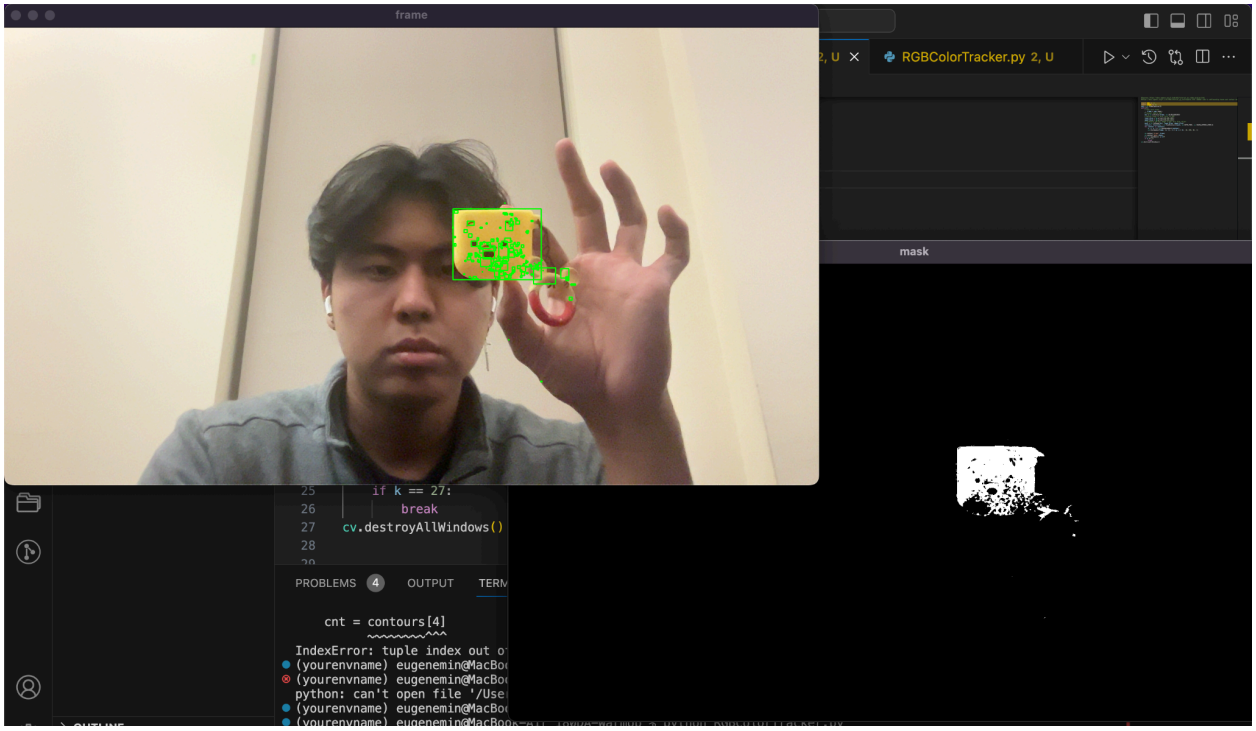

Figure 2: HSV thresholded bounding box

Part 2:
I will now proceed with HSV thresholding because it proves to be more accurate for my yellow object. I increased the light on my object using a phone flashlight as seen in Figure 3 and Figure 4. Depending on how I shined the flashlight on my object, it affected its tracking ability at various degrees, however, overall the tracking ability degraded. Figure 3 has more light exposure, so the performance is worse because the bounding box is seen to be less accurate. This is most likely due to the fact that the added light is causing the object to appear a different color affecting the ability to detect yellow. This demonstrates the lack of robustness in my code design, which I will have to accept with my naive implementation.

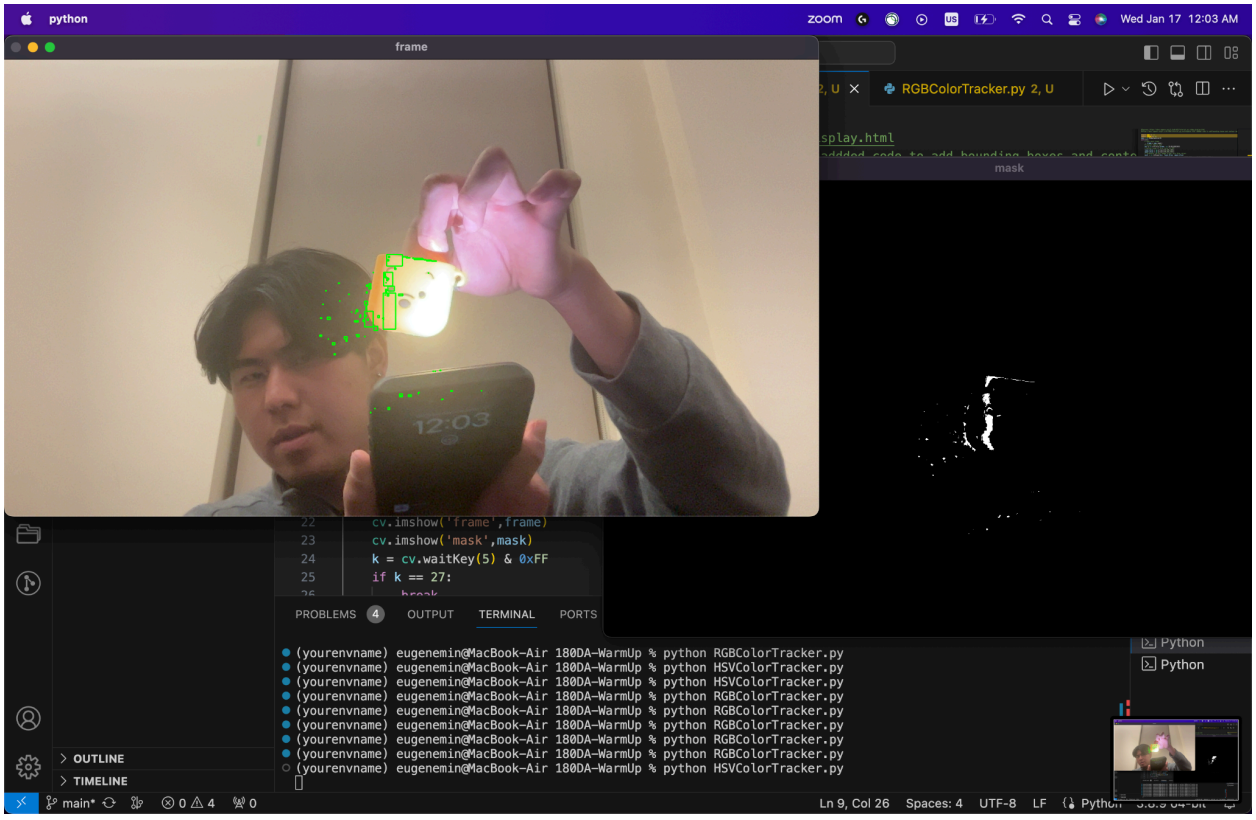

Figure 3: HSV tracking with lots of light

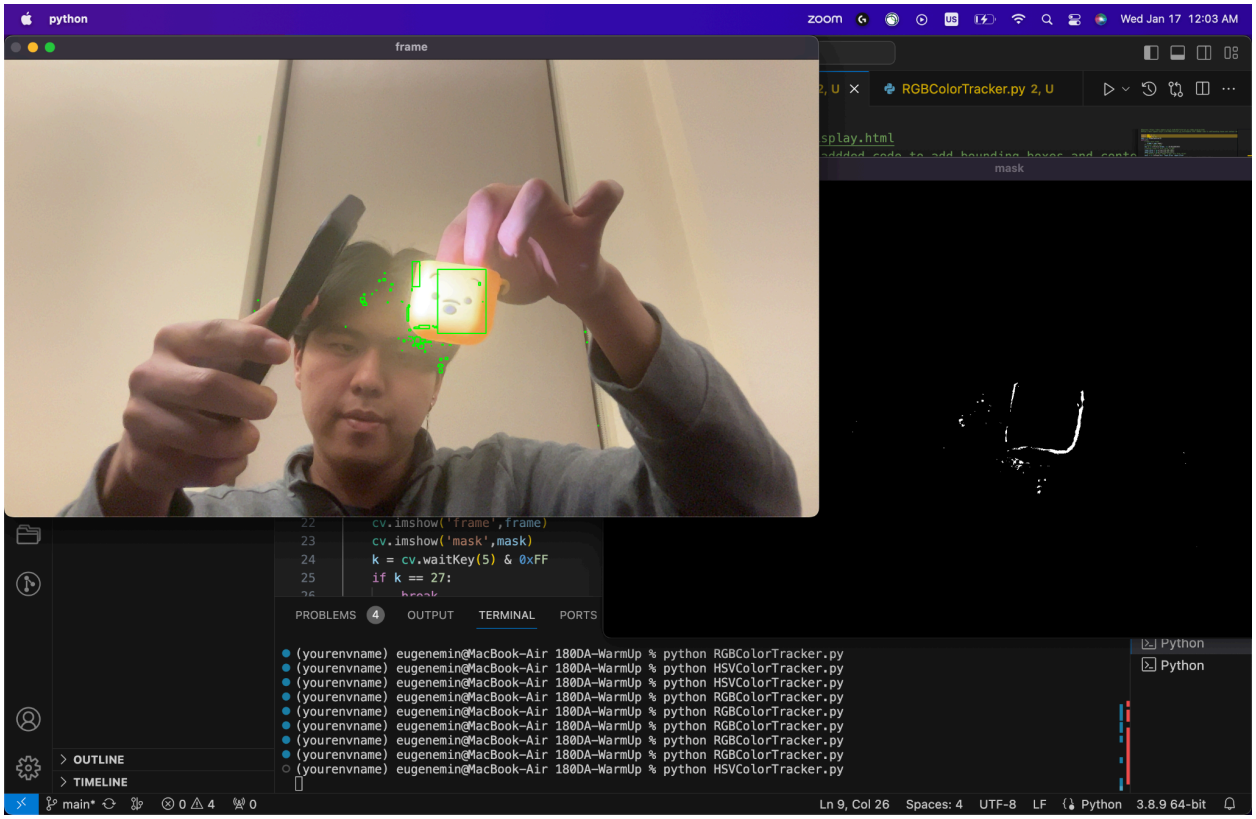

Figure 4: HSV tracking with less light

Part 3:
I was unable to pick up the color with a small range, which I believe has to do with glare issues from my phone into my laptop camera. The range I ended up using was (0,0,220) to (100, 100, 255) which worked really well at detecting the red box on my phone as shown in Figure 5. There was a drastic difference in tracking ability between my phone in full brightness which detected the red box fully shown in Figure 5 and my phone at the lowest brightness setting where nothing was detected shown in Figure 6.

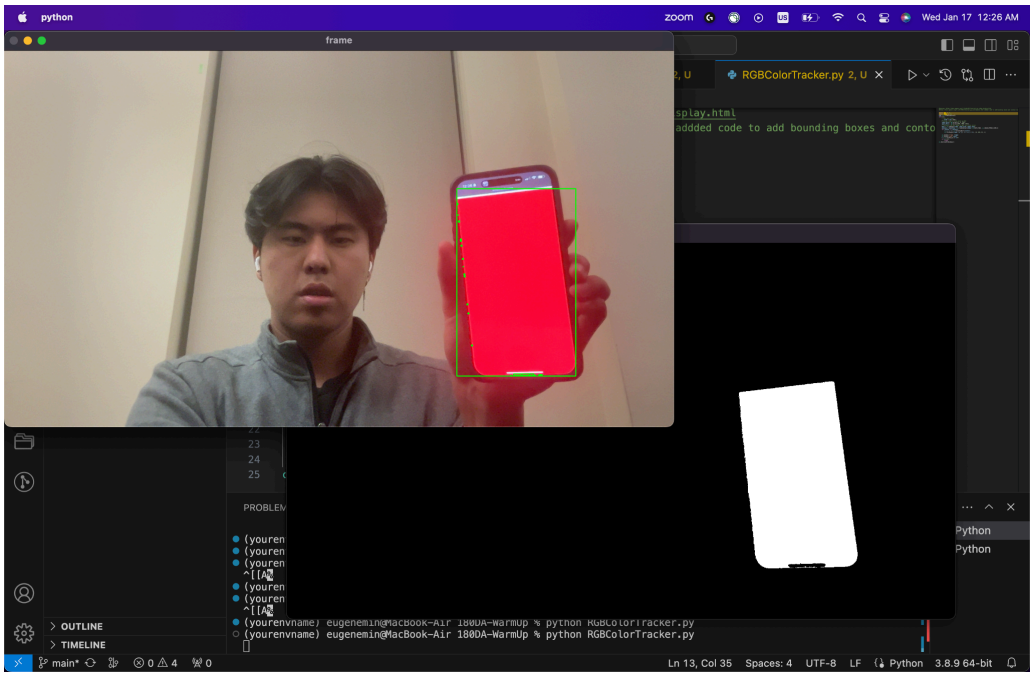

Figure 5: Red detection at full brightness

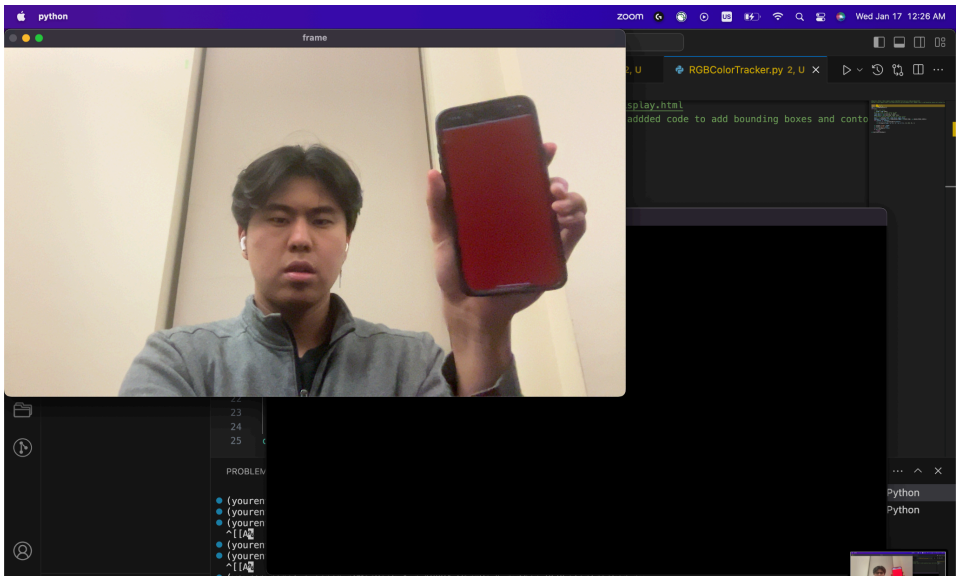

Figure 6: Red detection at lowest brightness setting

Part 4:
For the non-phone object, the detected dominant color changed from (79, 152, 183) from Figure 7 to (145, 195, 220) from Figure 8. Whereas for the the phone, the detected dominant color changed from (51, 23, 233) from Figure 9 to (40, 32, 139) from Figure 10. The non-phone object saw less variation in its RGB value compared to the phone's screen and I believe this is mostly due to the effect of the change in environment not being as severe for the non-phone object because the phone can greatly bring its brightness down. Thus, by experimenting this way, we see that the non-phone object was more robust.

However, I did not feel that this was a fair comparison, so I flashed another phone's flashlight onto my phone to emulate the environment of the non-phone object and the results are depicted in Figure 11 and Figure 12. In this case, the detected dominant color changed from (52, 23, 247) from Figure 11 to (68, 46, 246) from Figure 12. In this experiment, we see much less variation compared to the non-phone object so the phone is more robust to external environmental lighting variations. This makes sense because the phone is generating its own color and light, so it will appear as its color without something like an exerernal's phone's flashlight affecting it that much.

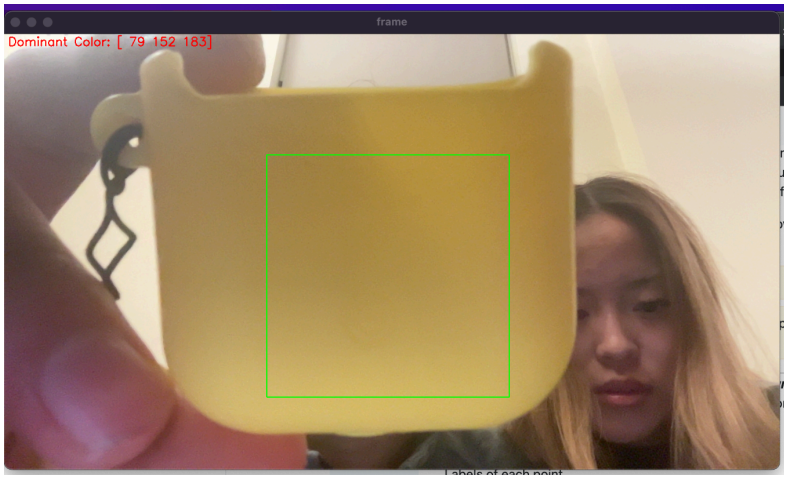

Figure 7: Yellow as the dominant color with no light flashed on it

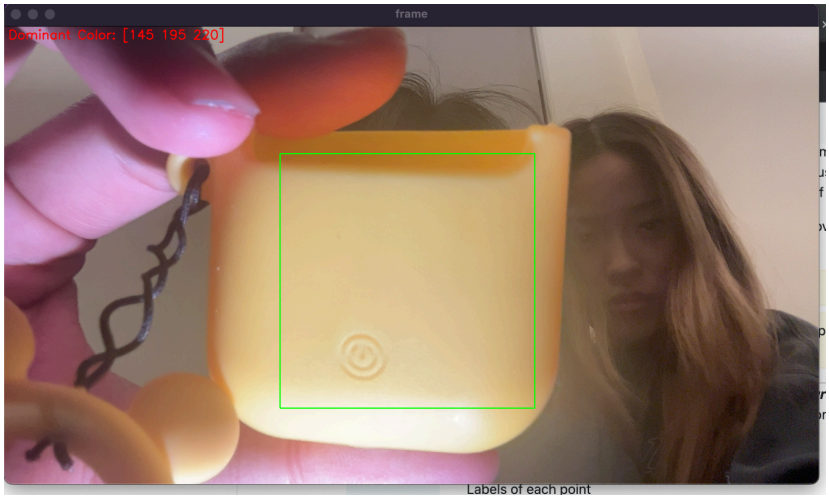

Figure 8: Yellow as the dominant color with light flashed on it

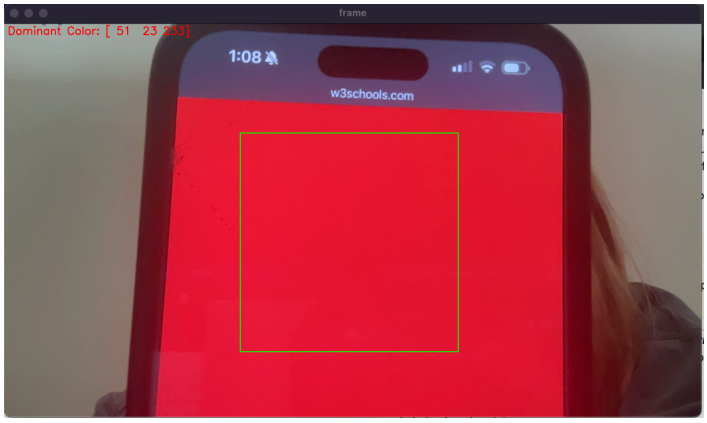

Figure 9: Red as the dominant color with phone at full brightness

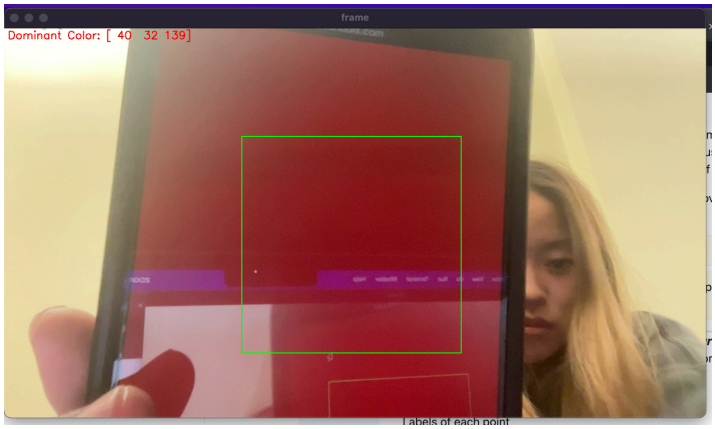

Figure 10: Red as the dominant color with phone at lowest brightness

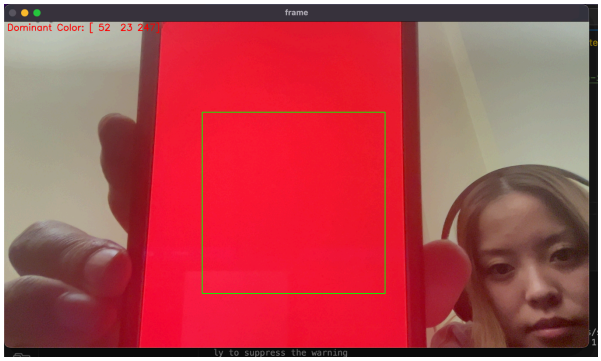

Figure 11: Red as the dominant color with phone at full brightness and no exterior flashlight

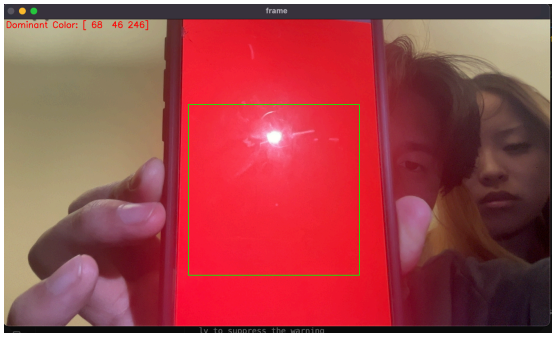

Figure 12: Red as the dominant color with phone at full brightness and flashlight pointed at it