

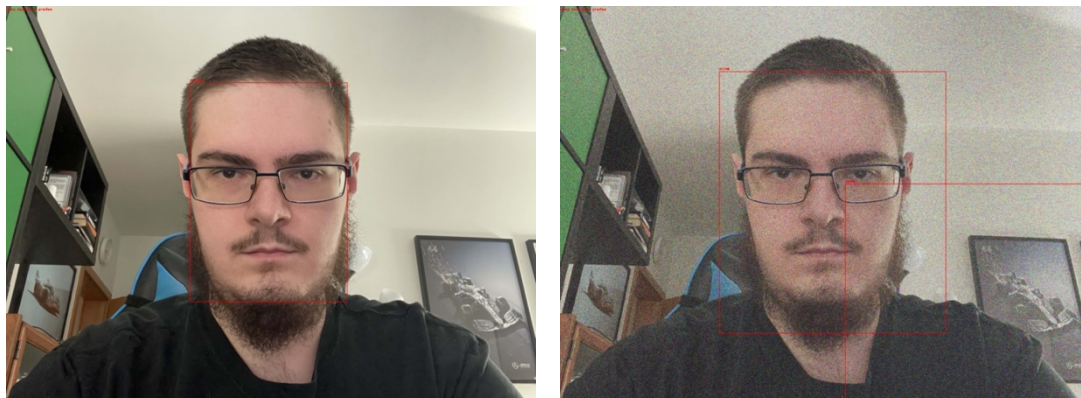
Assignment 4 – face detection

1. Hypothesis – gaussian noise

Hypothesis: Applying 50% gaussian noise lowers face detection confidence rate at least by 50 %.

In first hypotheses I tried to test the effect of gaussian noise on face detection. I started with baseline photo and then I continuously added 5 % to next photos. I used Adobe Photoshop for editing images in first three hypothesis. In table below we can see that face detection certainty gets continuously lower with every 5 % added. At 35 % it rapidly drops, and it starts to detect another face in room. At 45 % (and more) I was unable to detect face at all, however with human eye you can clearly spot a face. This result support my hypothesis and thus I cannot reject it.

Gaussian noise intensity	Face detection confidence
Baseline photo	0.9999995
5 %	0.9999993
10 %	0.9999976
15 %	0.9999918
20 %	0.99985635
25 %	0.99466693
30 %	0.9712634
35 %	0.60844094, 0.2375087
40 %	0.27032733, 0.24382938
45 %	No face detected
50 %	No face detected
55 %	No face detected
60 %	No face detected



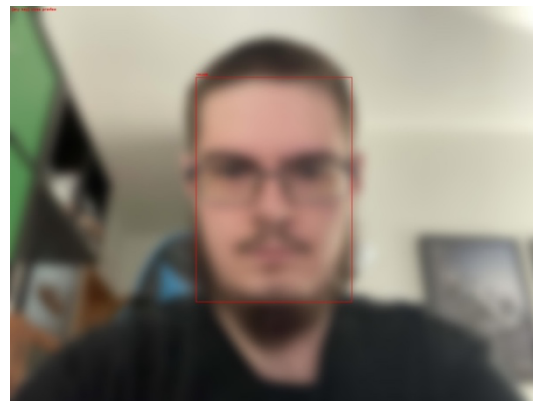
Face detection of image before and after adding 40 % gaussian noise

2. Hypothesis – gaussian blur

Hypothesis: Adding gaussian blur with radius 30 will lower confidence level at least by 50 %.

In second hypothesis I tried an “opposite” to first hypothesis, instead of adding noise, I tried to add gaussian blur. I used same baseline photo and then I continually increased blur up to radius 30. I thought that face detection would not be vulnerable to gaussian blur as it was to noise, but even with radius 30 it was still able to find my face with more than 99% confidence. It basically didn't affect detection at all. Based on this result, I have to reject my hypothesis.

Gaussian blur radius	Face detection confidence
Baseline photo	0.9999995
3	0.9999995
6	0.9999994
9	0.99999917
12	0.9999989
15	0.9999982
18	0.9999968
21	0.99999475
24	0.9999918
27	0.9999869
30	0.9999783



Face detection of image before and after adding gaussian blur with radius 30

3. Hypothesis – exposure

Hypothesis: Increasing exposure by 3 or lowering by 6 will lower face detection confidence level at least by 25 %.

In third hypothesis I tried focus on exposure adjusting and its effect on face detection. As we can see in the table below, exposure has minimal impact. I had to make the photo almost completely black/white for face detection to fail. But I have to reject my hypothesis, because mentioned values didn't effect detection at all.

Exposure	Face detection rate
-7.0	0.49925607
-6.0	0.99513006
-5.0	0.9999281
-4.0	0.9999924
-3.0	0.9999976
-2.0	0.9999988
-1.0	0.9999993
baseline	0.9999995
+1.0	0.9999993
+2.0	0.99999845
+3.0	0.99994826, 0.29353362
+4.0	0.9983045, 0.3189708



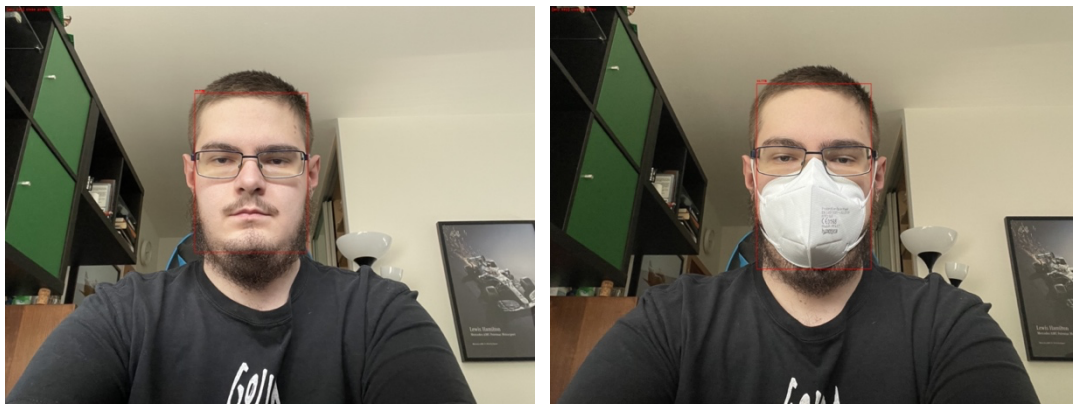
Face detection before and after increasing exposure by 3

4. Hypothesis – respirator

Hypothesis: Face detection software won't find my face while wearing a respirator at least in 25 % of test photos.

Because the covid pandemic is still not over, I got an idea to try wearing a respirator. I took 10 photos without respirator as a baseline and then 10 photos with respirator. I tried do this from same angles and distance, but it is not 100% accurate, because I don't have a tripod. Result is quite surprising to me - as we can see in table below, it was still able to find my face on all photos. On some photos it detected another face in the room, but this happened on photos without respirator as well and it was still able to find my face, so I count it as a success in this hypothesis. Since it successfully found my face on all photos, I have to reject my hypothesis.

Photo	Face detection rate	Photo with respirator	Face detection rate
close	0.99999416	resp_close	0.9915976,0.39403212
close_left	0.99988055	resp_close_left	0.9544062,0.27729174
close_right	0.9991843,0.32237703	resp_close_right	0.87236357
close_up	0.999866	resp_close_up	0.931553
close_down	0.99848276	resp_close_down	0.98325515,0.20802407
far	0.9953412	resp_far	0.99770665
far_left	0.9478564	resp_far_left	0.9490679
far_right	0.96785206,0.318539	resp_far_right	0.89517605
far_up	0.9942842	resp_far_up	0.5028247
far_down	0.9999516	resp_far_down	0.94568545,0.38675725



Face detection on images far.jpeg and resp_far.jpeg

5. Hypothesis – sunglasses

Hypothesis: Face detection software won't find my face while wearing sunglasses in at least 25 % of test photos.

Because covering my mouth and nose didn't fool the program, I got an idea to use sunglasses to cover my eyes instead. Thus, I stated a similar hypothesis, but this time I put on a pair of sunglasses. I used same baseline photoset as in the fourth hypothesis. The results are quite surprising to me, because it was still able to find my face on all photos, thus I have to reject my hypothesis.

Photo	Face detection rate	Photo with sunglasses	Face detection rate
close	0.99999416	glasses_close	0.99999166
close_left	0.99988055	glasses_close_left	0.9999763
close_right	0.9991843,0.32237703	glasses_close_right	0.9990709
close_up	0.999866	glasses_close_up	0.40867317
close_down	0.99848276	glasses_close_down	0.9996362
far	0.9953412	glasses_far	0.9991321
far_left	0.9478564	glasses_far_left	94978935,0.20662367

far_right	0.96785206,0.318539	glasses_far_right	0.9222849
far_up	0.9942842	glasses_far_up	0.2974371
far_down	0.9999516	glasses_far_down	0.9976871



Face detection on close_left.jpeg and glasses_close_left.jpeg

Summary

From my observation I think that face detection is mostly vulnerable to randomness, because it had biggest problem with noise. I think that this could be achieved with some random very unusual make up for example, but I don't have resources to test this. It didn't have almost any problem with exposure and other changes, that effects whole image (unless it got to the extreme like almost black image). It also didn't have any problem with partial face covering, it was still able to detect face with high confidence level. I think that AI behind this program could have been trained with some similar photos with glasses/masks as well. However, face detection software had problems too. It was often detecting "face" in room or in my glasses, I don't really understand why this is happening. Only explanation that came to my mind is that threshold for accepting part of an image as a face is set way too low.