Measurement of Heart Rate from Video Capturing

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Problem setting

- Heart rate is often measured with wearable devices

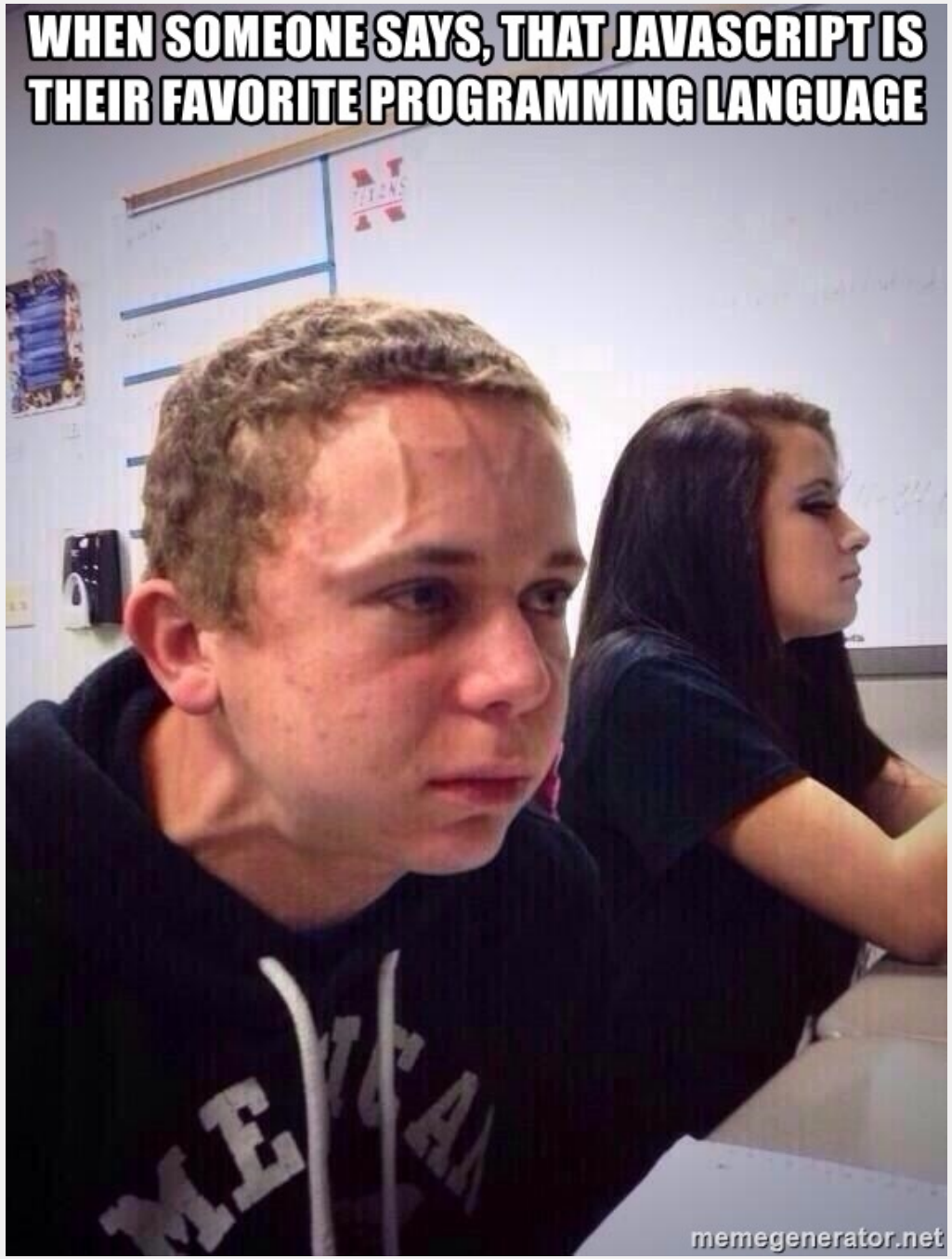
- In practice this is often not applicable for telemedicine

- Aim: Find a contactless method to determine the heart rate

General Idea

- Physical body parameters, like blood volume influence the state of the skin

- We use image analysis methods to detect the change of the skin in order to determine the body parameters.



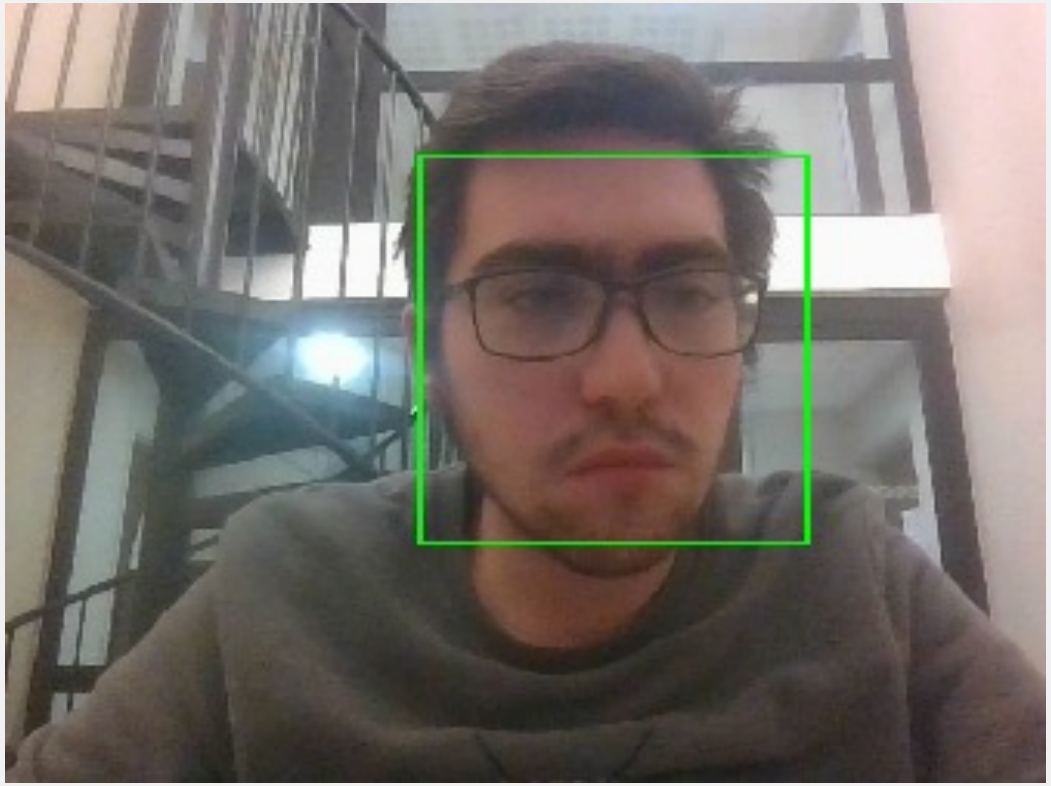
Physical stress can affect the skin.

Method Pipeline

- Step 1: detect the face in an image with a bounding box
- Step 2: choose the Region of Interest (ROI) from the face region
- Step 3: extract heart rate from the time sequence of image colors

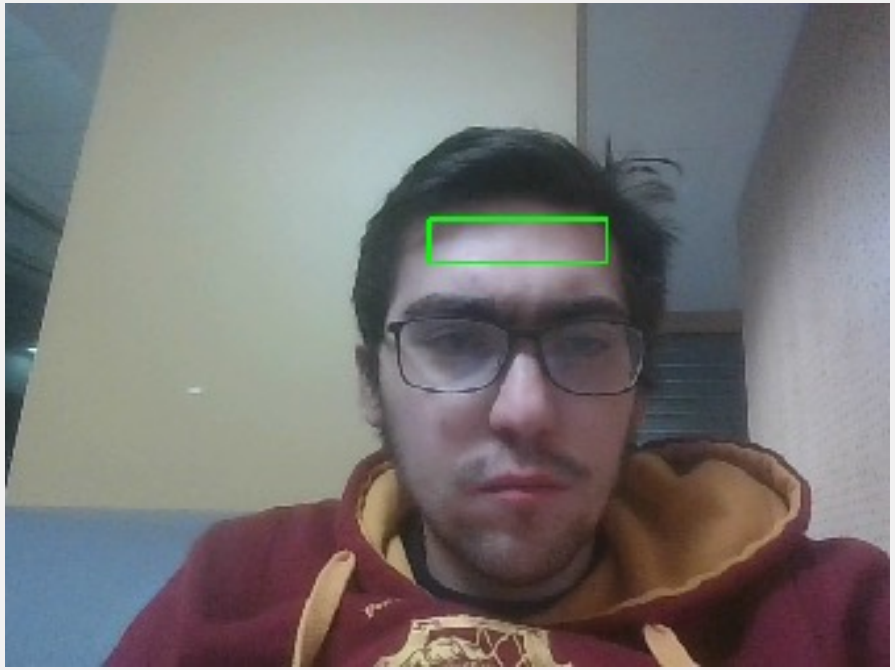
Step1: Face detection

- Face detection is performed with Haar cascade classifiers.



Step2: Choose the Region of Interest (ROI)

- There are 2 choices: forehead and face segmentation (GrabCut)

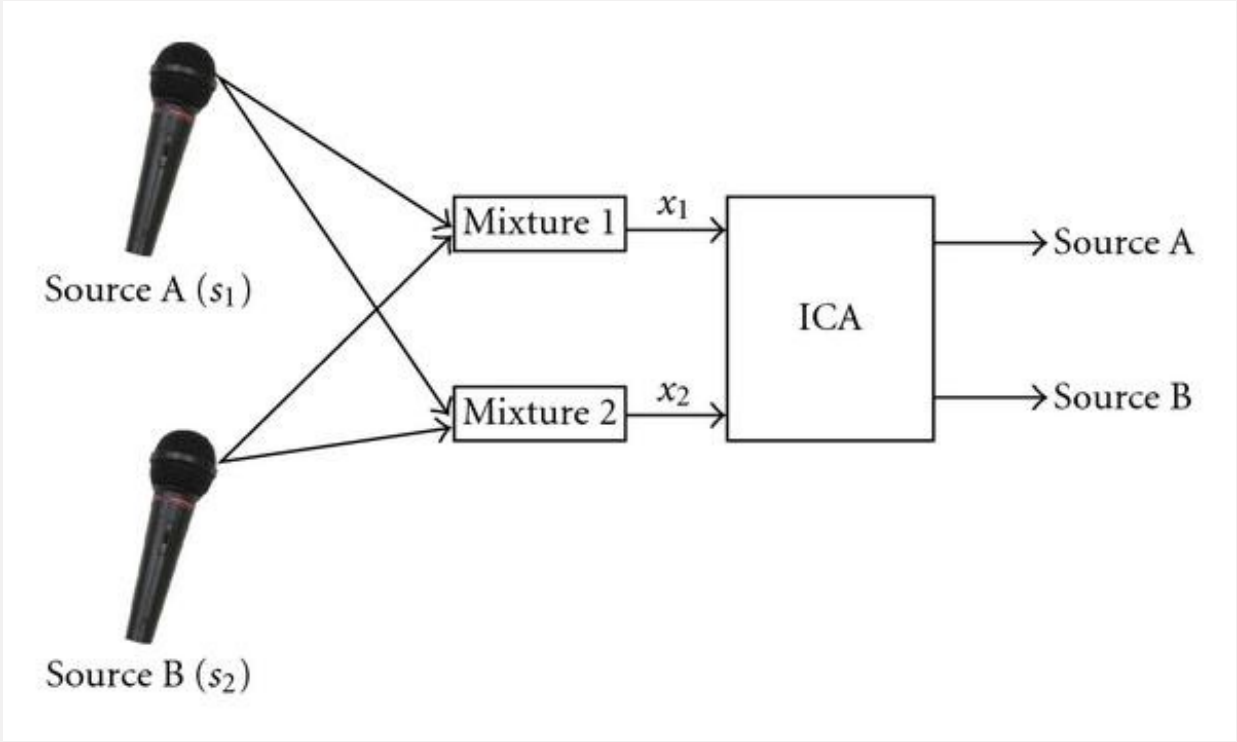


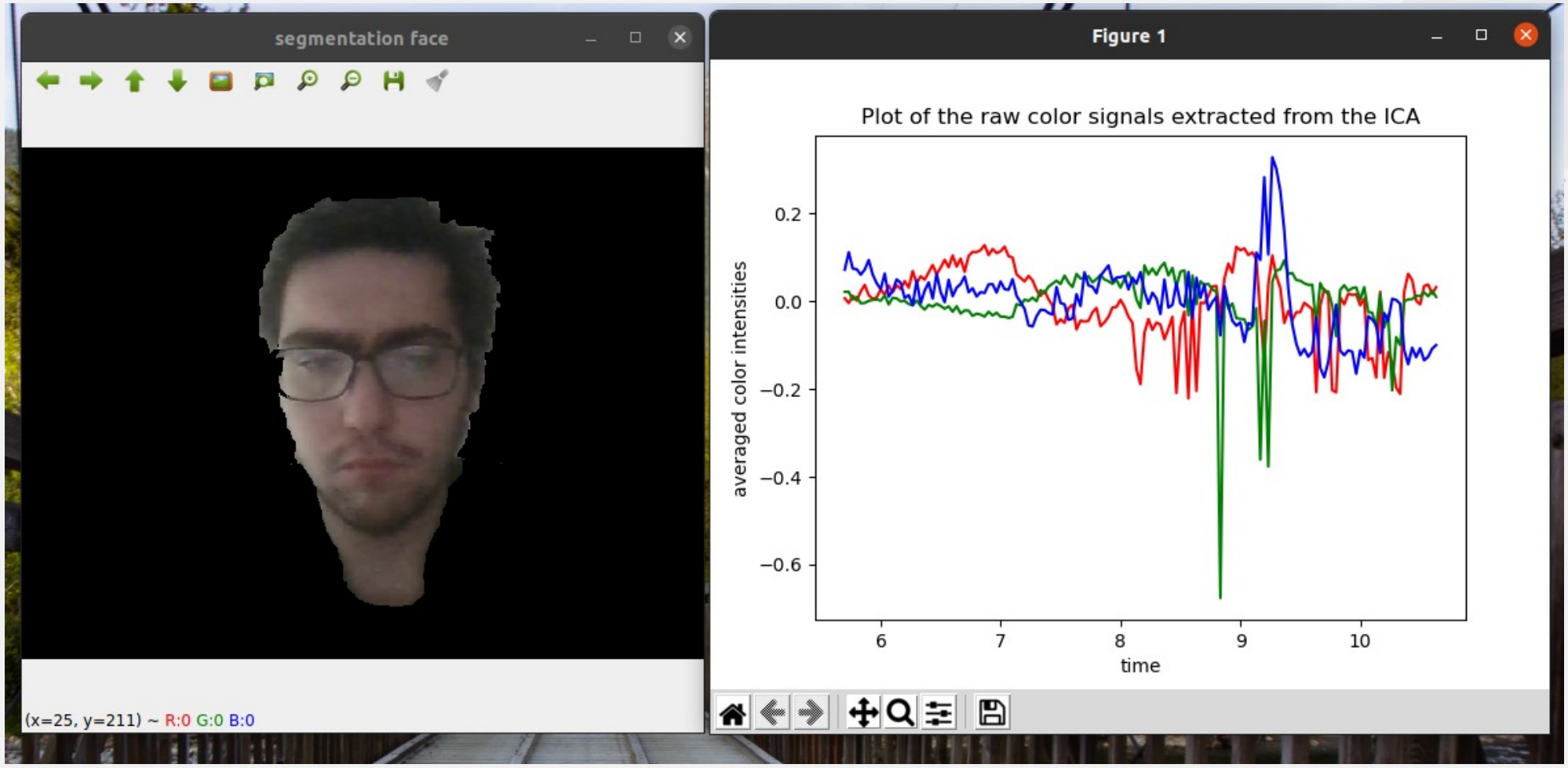
Forehead

Face Segmentation

Step 3: Extract heart rate from ROI

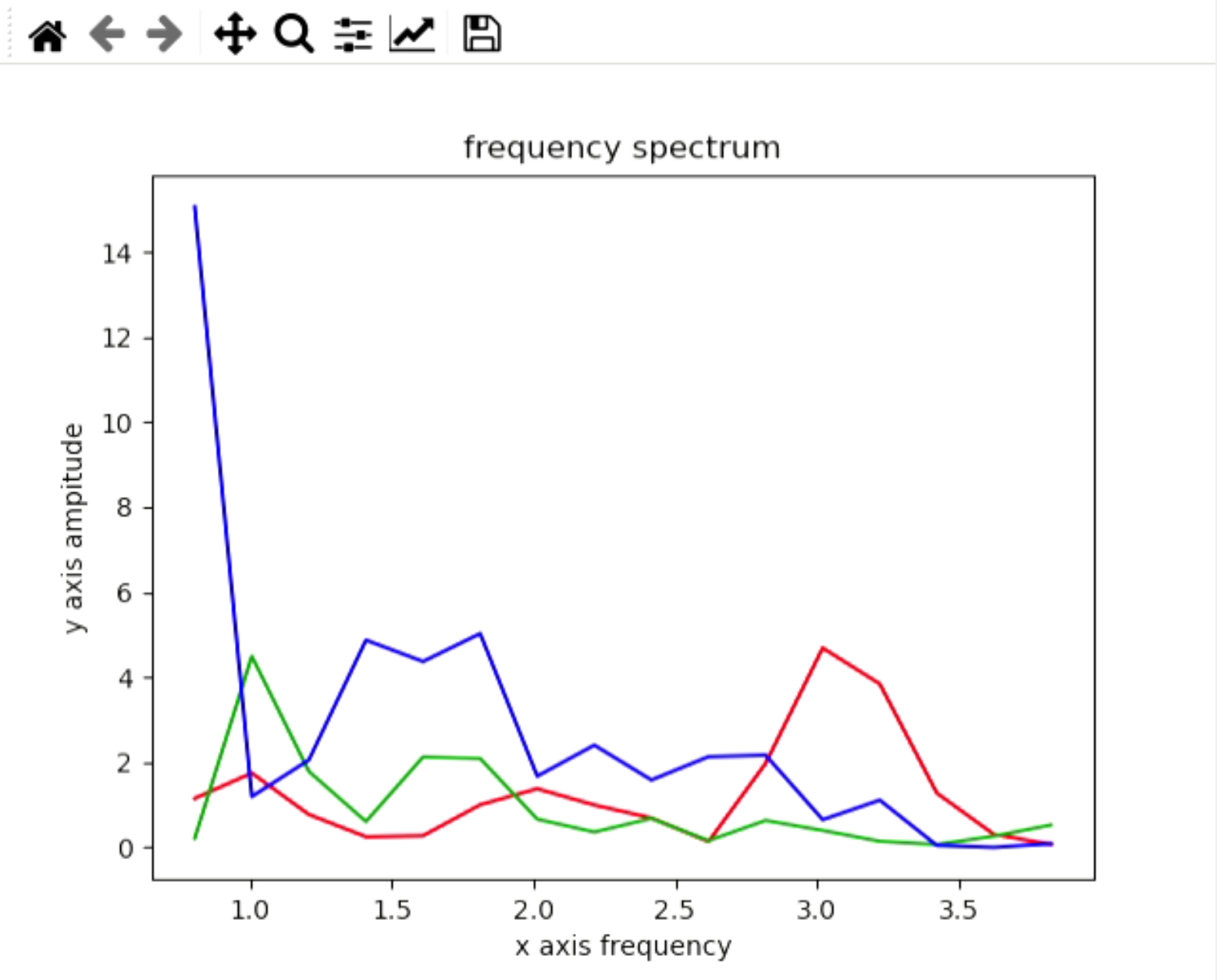
- Calculate the average values for RGB color channels of the ROI
- Use Independent Component Analysis (ICA) to extract the source signals from the observed mixed color signals.



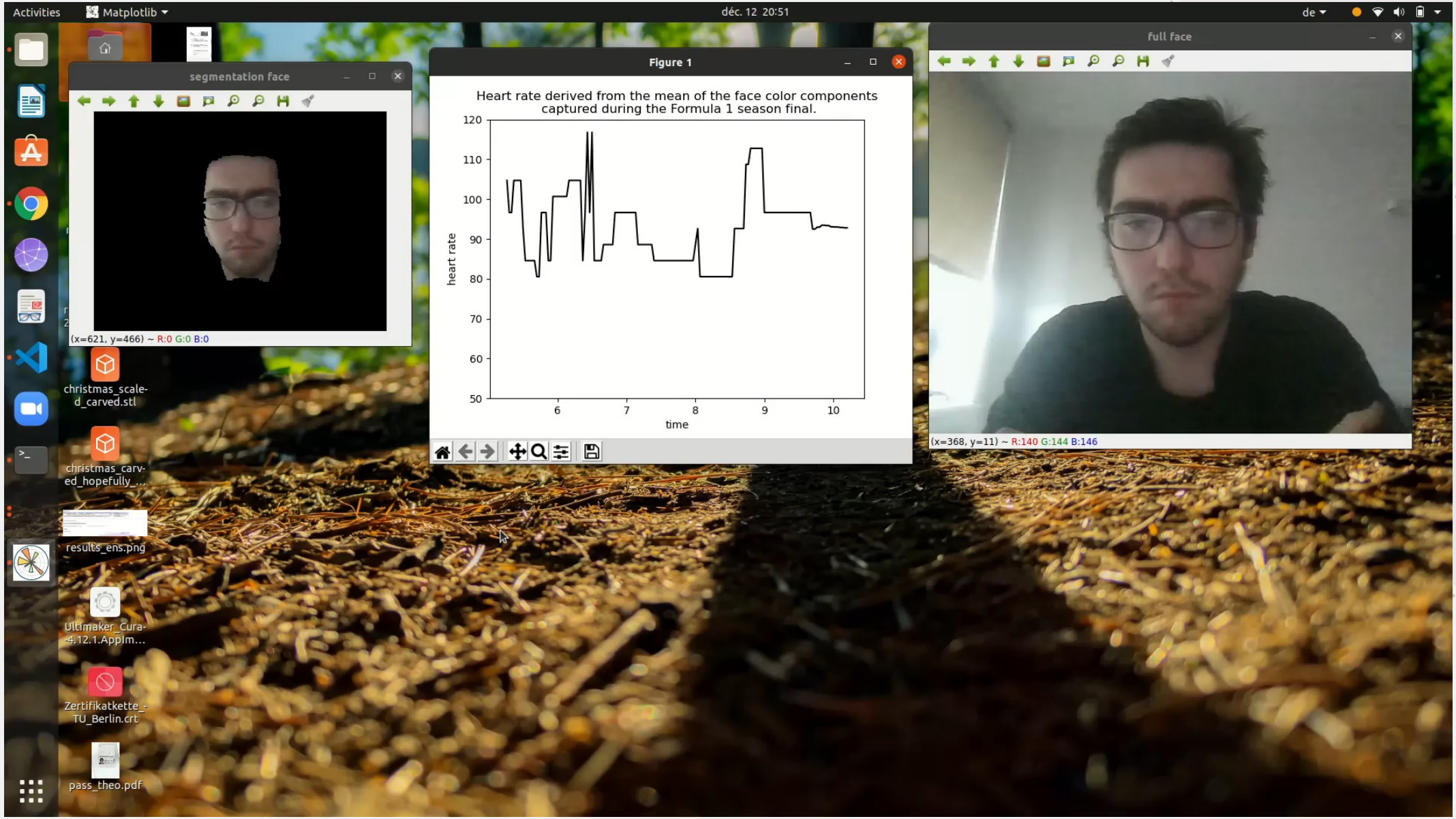

segmentation face
(x=25, y=211) ~ R:0 G:0 B:0
Figure 1
Plot of the raw color signals extracted from the ICA
averaged color intensities
0.2
0.0
−0.2
−0.4
−0.6
6
7
8
9
10
time

Step 3: Extract heart rate from ROI

- Calculate the average values for RGB color channels of the ROI
- Use Independent Component Analysis (ICA) to extract the source signals from the observed mixed color signals.
- Transform the signals on time into signals on temporal frequency using **Fourier Transformation**



Convert the frequency with highest amplitude in the range from 0.75 to 3 Hz to bpm and plot the result over time


Activities
Matplotlib
déc. 12 20:51
de
segmentation face
(x=621, y=466) ~ R:0 G:0 B:0
Figure 1
Heart rate derived from the mean of the face color components
captured during the Formula 1 season final.
heart rate
time
120
110
100
90
80
70
60
50
6
7
8
9
10
full face
(x=368, y=11) ~ R:140 G:144 B:146
christmas_scaled_carved.stl
christmas_carved_hopefully_...
results_ens.png
Ultimaker_Cura-4.12.1.AppIm...
Zertifikatkette_-_TU_Berlin.crt
pass_theo.pdf

Conclusion

- The Method works well, when the person is sitting still and the lighting is uniform
- The accuracy is around 5-10 bpm.
- Instabilities occur, when there is no uniform light, the head moves too much, the person wears make-up…
- Nevertheless, this provides a method for contactless heart rate measuring

References

[1] https://www.hindawi.com/journals/isrn/2011/672353/fig1/

[2] Ming-Zher Poh, Daniel J. McDuff, and Rosalind W. Picard. Non-contact, automated cardiac pulse mea-surements using video imaging and blind source separation.Opt. Express, 18(10):10762–10774, May 2010

[3] Christian Jutten and Jeanny Herault. Blind separation of sources, part i: An adaptive algorithm based onneuromimetic architecture.Signal Processing, 24(1):1–10, 1991