Assignment 5

Task 1

a) $x' = sRx + t$ (1)

$$\begin{cases} v' = x'_2 - x'_1 \\ v = x_2 - x_1 \end{cases} \Leftrightarrow \begin{aligned} v' &= sRx_2 + t - (sRx_1 + t) \\ &= sR(x_2 - x_1) \\ &= sRv \quad (2) \\ &= s\begin{pmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{pmatrix} v \quad (2) \end{aligned}$$

Assumption: v and v' are known $\Rightarrow$ θ can be calculated using trigonometry:

$$\sin(\theta) + \cos(\theta) = \sqrt{2}\cos\left(\theta - \frac{\pi}{4}\right)$$

Subtitute θ to (2) $\Rightarrow$ s is solved

Use θ and s to solve $\begin{pmatrix} t_x \\ t_y \end{pmatrix}$ using $\begin{aligned} x'_1 &= sRx_1 + t \\ x'_2 &= sRx_2 + t \end{aligned}$

Example d) $x_1 : \left(\frac{1}{2}, 0\right)$ | $x_2 : \left(0, \frac{1}{2}\right)$

$x'_1 : (0, 0)$ | $x'_2 : (-1, -1)$

$$\begin{cases} v = \left(-\frac{1}{2}, \frac{1}{2}\right) \\ v' = (-1, -1) \end{cases} \Rightarrow v' = sRv$$

$$\Leftrightarrow \begin{bmatrix} -1 \\ -1 \end{bmatrix} = s\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}\begin{bmatrix} -0.5 \\ 0.5 \end{bmatrix}$$

$$\Leftrightarrow \begin{bmatrix} -1 \\ -1 \end{bmatrix} = s\begin{pmatrix} -0.5\cos\theta & -0.5\sin\theta \\ -0.5\sin\theta & 0.5\cos\theta \end{pmatrix}$$

$$\Leftrightarrow \begin{bmatrix} 2 \\ 2 \end{bmatrix} = s\begin{pmatrix} \cos\theta & \sin\theta \\ \sin\theta & -\cos\theta \end{pmatrix}$$

$$\Leftrightarrow \begin{cases} s^{-1} = \dfrac{\sin\theta + \cos\theta}{2} \\ s^{-1} = \dfrac{\sin\theta - \cos\theta}{2} \end{cases} \Leftrightarrow \tan\left(\theta - \frac{\pi}{4}\right) = 1 \quad \cos\theta$$

$$\Leftrightarrow \begin{bmatrix} \theta = \frac{\pi}{2} \text{ (true)} \\ \theta = \frac{3\pi}{2} \text{ (false)} \end{bmatrix}$$

$$\Rightarrow s^{-1} = \left(\sin\frac{\pi}{2} + \cos\frac{\pi}{2}\right)\frac{1}{2}$$

$$\Rightarrow s = 2$$

$$\begin{bmatrix} \theta = \frac{\pi}{2} \\ s = 2 \end{bmatrix} \text{ and } x'_1 = sRx + t \Rightarrow t = \begin{bmatrix} 0 \\ -1 \end{bmatrix}$$

Task3 Answer questions

a) How the program works: • A face cascading classifers was predefined

- The program uses this classifier to extract ROI or faces from recorded video from webcam
- The qualified "faces" go through another selection in ". goodFeaturesToTrack " function
  The conditions were set by user
- Trackable points finally marked on frames

b) Problem:

The program does not track well if the face is moving

Solotion → increase number of required points P_0

then the program will not reset the detection so often.