INFOMCV Assignment 2
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Summary

(Briefly explain your background subtraction method, your postprocessing and how you build the voxel model. Approx. half a page.)

We adjusted assignment 1 to use videos to perform the calibration for the cameras. We obtained the intrinsics and extrinsics with it. Background subtraction is based on a bruteforce adsdiff/threshold on all three HSV channels, then combined via bitwise_or. To build the voxel model we added two arrays. One to hold all voxels positions, and one to hold per voxel all 4 pixel positions of each camera. These arrays share the same index. This allows us to match the voxel array ID to the pixel array ID. Once we construct the voxel space, and we project their coordinates on each view to generate the pixel array. We then make a loop for each voxel, then since we share the same id we can instantly get its 4 pixels, check if per view on foreground if they lay on white pixel. If they lay on all 4 cameras a the same time, we push the voxel coordinate to the renderer.

Extrinsic parameters

(Include rotation matrix and translation for each of the four cameras. Approx. one third of a page.)

Cam1

Rotation Matrix **Rvecs**

$$\begin{bmatrix} 0.72306746 & -0.6907744 & 0.002041336 \\ 0.09565552 & 0.103053115 & 0.9900657 \\ -0.6841224 & -0.71568906 & 0.14059074 \end{bmatrix} [235.57646914672793 \quad 819.5515441115317 \quad 4596.107180994614]$$

Cam2

Rotation Matrix **Rvecs**

$$\begin{bmatrix} 0.99968517 & -0.024028005 & 0.0072295996 \\ -0.0073863855 & -0.0064427853 & 0.99995196 \\ -0.023980273 & -0.99969053 & -0.0066182367 \end{bmatrix} [-259.7277307922695 \quad 1478.8132257826453 \quad 3581.0798157058616]$$

Cam3

Rotation Matrix **Rvecs**

$$\begin{bmatrix} -0.23149142 & 0.97243947 & 0.027805772 \\ -0.05945487 & -0.042670526 & 0.99731857 \\ 0.97101843 & 0.2292175 & 0.06769413 \end{bmatrix} [-715.8035030990718 \quad 1237.446717476261 \quad 2405.18767545015]$$

Cam4

Rotation Matrix **Rvecs**

$$\begin{bmatrix} 0.6417071 & 0.76682794 & -0.013670536 \\ -0.08663384 & 0.090185516 & 0.9921498 \\ 0.76204103 & -0.63548523 & 0.12430593 \end{bmatrix} [-950.9641136239776 \quad 927.7630271222954 \quad 4034.533778276294]$$

Background subtraction

(Mention how you set the thresholds for your background subtraction (or the description of other parameters in your approach), and how it is determined if a pixel is foreground or background. If you use an approach with training a background model, explain how that works. Also include a foreground image for each of the four cameras. Approx. half a page.)

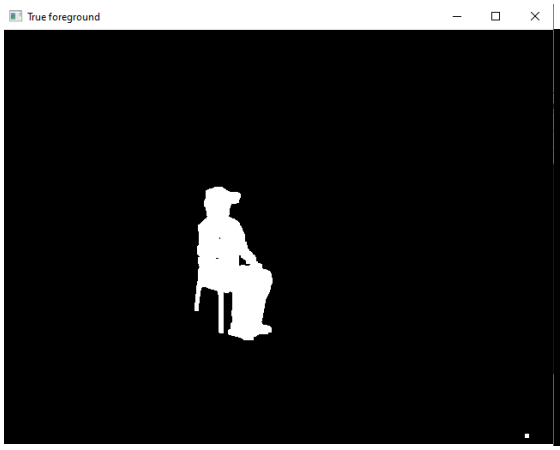
For the background, the first frame is taken from the video as it is, then each subsequent frame is added to it but the alpha value is increased between each iteration until there are no more frames left this is saved to a new image for each camera. During the live subtraction, we get the next frame via a counter then we convert it to HSV, blur it with gaussian blur and split it into 3 channels. The background image is loaded and also converted to HSV and split into 3 channels. The background subtraction is manual subtraction. First, the absdiff between each HSV channel on the precalculated background and the video frame is calculated. Second, the resulting **Mat** is thresholded on a

bruteforced value. Erosion is applied to remove any potential noise, which is followed up by dilation to fill the holes that erode might have caused. Each channel is cleaned from any noise except the person then at the end the 3 channels are combined using a bitwise_or operation.

Cam1

Cam2

Cam4



Cam3

Having noise on some images but not all is okay since those pixels won't match white color on all 4 cameras and won't be displayed.

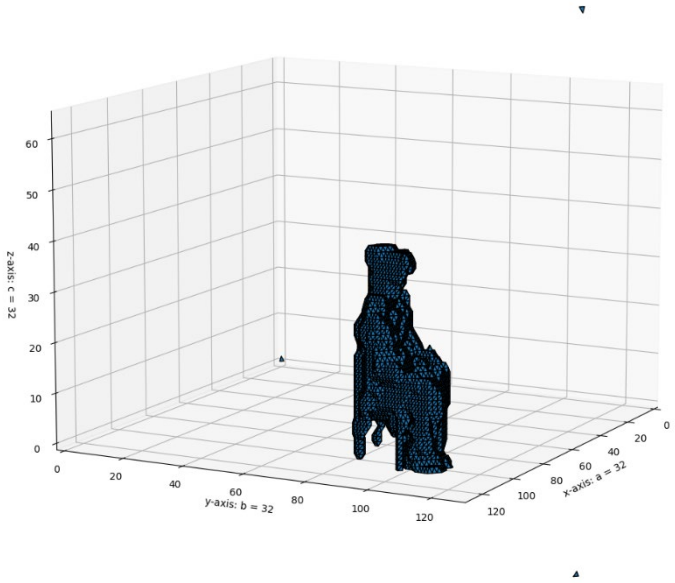
```
threshhold_h = 13
threshhold_s = 13
threshhold_v = 75
```

Choice tasks

(Indicate which ones you did, and how you did them; Approx. one third of a page.)

Coloring the voxel model: The color of the voxel is determined by the average color value of the pixel from each view

Surface mesh: The code is taken mainly from Marching Cubes and adjusted to make it fit our program. First, we had to convert our voxel data into a format that can be interpreted as a continuous surface, which is done using interpolation. We create a binary array of the voxel space that stores which voxels should be displayed by setting the corresponding element to 1. Since our voxel coordinates can be negative, we need to shift them/make them non-negative. That is done by determining the minimum value for each axis and subtracting the minimum from the coordinate value. Then we scale up our binary array to increase the resolution and feed that array into the measure.marching_cubes method.



Background subtraction speed-up: Use multithreading to parallelize the background subtraction for each camera, such that it isn't done one after another.

Voxel reconstruction: Not working! Still wanted to include it here, though, as we got part of it working. The intention was to not loop through all voxels and reconstruct everything but only check the voxels that have changed in the foregrounds. What is working is the foreground difference. So there is one list that stores the pixels for each camera where the foreground has new white pixels, and another list that stores the pixels for each camera where the previous foreground had white pixels but has black pixels now (so pixels removed). We didn't manage to create a proper lookup table for this but if we had one, this would work.

Link to video

(Link to a video (Youtube, Vimeo, Wetransfer, etc.) clearly showing the 3D reconstruction of the input videos. Make sure the link is accessible by r.w.poppe@uu.nl and m.doyran@uu.nl.)

YouTube link: https://youtu.be/hbFs1jyRzwM