CS 763 | Computer Vision | Assignment 1

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Question 1

The question required us to change the pose of a base human skeleton given the joint angles of all the joints. We had to complete the functions `angles2rot.m` and `transformPose.m`. The former return a rotation matrix for euclidean coordinates from rotation angles. We used the following equations.

$$R_x(\theta) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix} \tag{1}$$

$$R_y(\theta) = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix} \tag{2}$$

$$R_z(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{3}$$

$$R = R_z(\alpha)\, R_y(\beta)\, R_x(\gamma) \tag{4}$$

R represents a rotation whose yaw, pitch, and roll angles are α, β and γ, respectively.
For `transformPose.m` we made a tree of joint hierarchy of the skeleton, which we then utilised for recursively calling `rotate()` function on the children joints of the rotated joint.

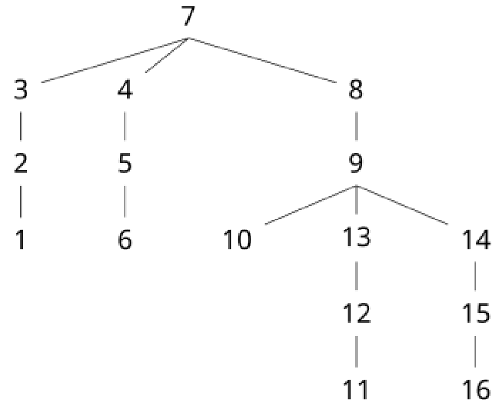
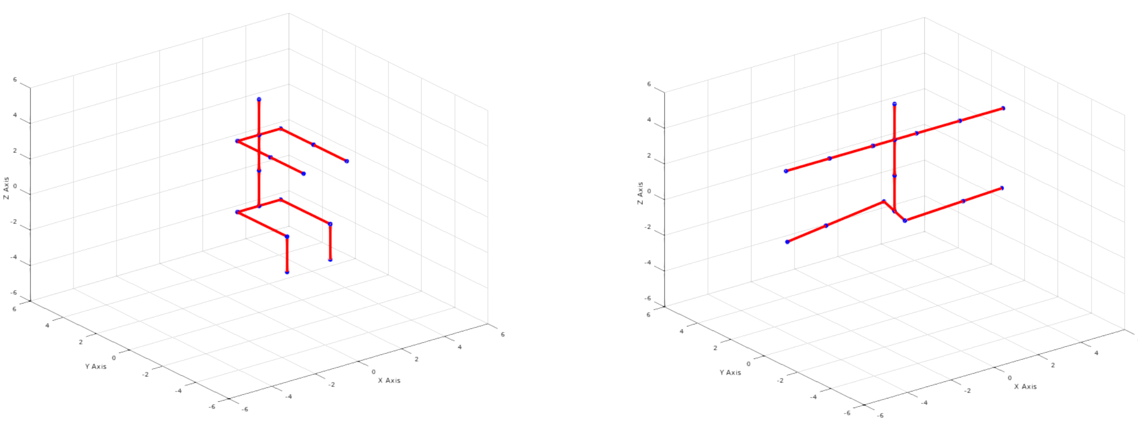


Figure 1: Body Tree generated from kinematic chain

The output of the 2 inbuilt test cases in `myScript.m` are included below.



((a)) Sitting

((b)) Forward Split

Figure 2: Transformed poses of the included test cases

Question 2

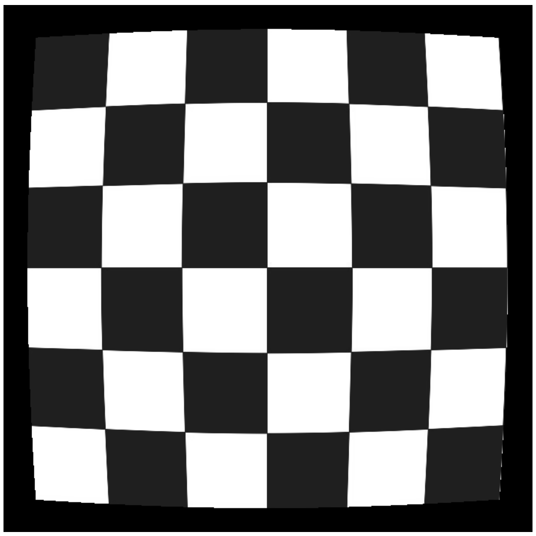
The question requires us to perform distortion correction. The Barrel distortion has been undistorted using the iterative approach in our code. We had to complete the `radUnDist()` function subsequently warping the image intensities using the `interp2()` function. The distortion model used to distort the images is as follows

$$\mathbf{x_d} = \mathbf{x_u}(1 + q_1 r(\mathbf{x_d}) + q_2 r^2(\mathbf{x_d})) \tag{5}$$

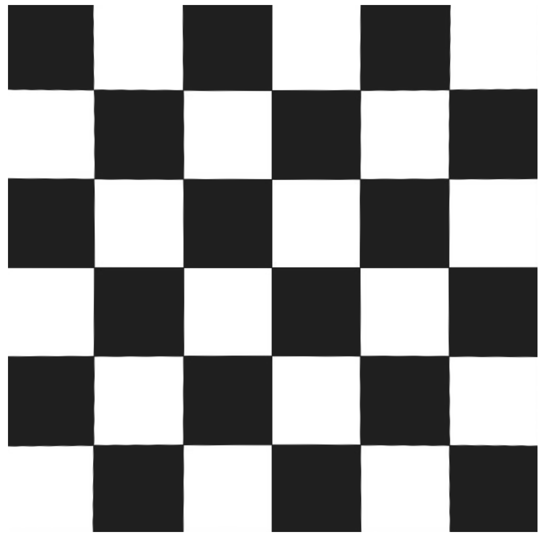
We implemented `radUnDist()`, which un-distorts/corrects the image using the distortion parameters $\mathbf{q} = (q_1, q_2)$. We use x_d as the initial seed and iterate `nSteps` times as follows.

$$\mathbf{x_1} = \mathbf{x_d}(1 - q_1 r(\mathbf{x_d}) - q_2 r^2(\mathbf{x_d})) \quad (6)$$
$$\mathbf{x_{v+1}} = \mathbf{x_d}(1 - q_1 r(\mathbf{x_v}) - q_2 r^2(\mathbf{x_v})) \quad (7)$$

Here are the distorted and then un-distorted/corrected images.



((a)) Distorted



((b)) Corrected

Figure 3: Checkerboard

((a)) Distorted

((b)) Corrected

Figure 4: Chrysler skyline

Question 3

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix} * \begin{bmatrix} t \\ 1/t \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ 1/t \\ t \end{bmatrix} = t \begin{bmatrix} 1/t \\ 1/t^2 \\ 1 \end{bmatrix} = \begin{bmatrix} 1/t \\ 1/t^2 \\ 1 \end{bmatrix}$$

Question 4

Question 5

Question 6

The question requires us to calculate the height of the person on the right, let us name hi, Bob. The height comes out to be approximately **203 cm**. We arrive at this result using property that all the parallel lines vanish at the horizon.

Consider another identical Christ to be standing at the exact place as Bob. We draw a line connecting the feet of both the positions of Christ ($\mathbf{F_1}$ and $\mathbf{F_2}$) and a line connecting the head of both the Christ($\mathbf{H_1}$ and $\mathbf{H_2}$). $\mathbf{H_2}$ lies on the line from Bob's head to feet. Obviously, the lines connecting both Jesus will be parallel in real world geometry and thus their projections on the image plane will meet at the Horizon at a certain point $\mathbf{X}$.

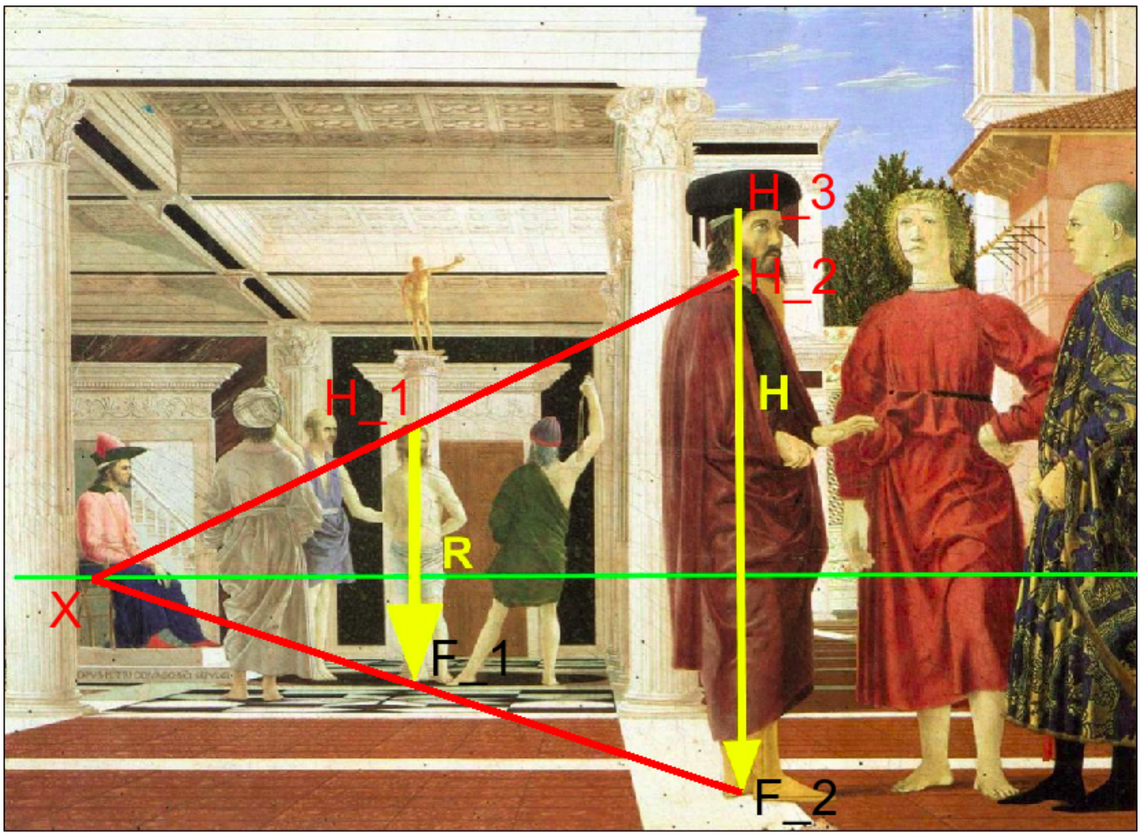


Figure 5: Geometric construction used

Subsequently we draw another line which connects head of Bob($\mathbf{H_3}$) to the point $\mathbf{X}$. We observe by using cursor that

$$\mathbf{F_2} = (745, 797), \mathbf{H_3} = (745, 217), \mathbf{F_1} = (423, 682), \mathbf{H_1} = (423, 434), \text{Horizon}: y = 580$$

Using a line's equation :

$$\frac{y - y_1}{x - x_1} = \frac{y_1 - y_2}{x_1 - x_2} \text{ for } (x1, y1), (x2, y2) \text{ on the line}$$

X lies on the horizon on the line containing F_1 and F_2, which gives,

$$\mathbf{X} = (110, 580)$$

Now, by definition, $\mathbf{H_2}$ will lie on the line joining $\mathbf{X}$ and $\mathbf{H_1}$, giving

$$\mathbf{H_2} = (745, 283)$$

We take the proportional length of Bob to the height of Christ($\mathbf{R}$) placed at Bob's position.

$$\frac{\mathbf{H}}{\mathbf{R}} = \frac{\mathbf{H_3F_2}}{\mathbf{H_2F_2}}$$

Substituting our pixel coordinates, we get

$$\mathbf{H} = 180 * \frac{797 - 217}{797 - 283} = 203cm$$