Computer Vision II: Assigment #1

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1.

If the line connecting the sphere center and the pinhole is perpendicular to the image plane, the silhouette will be a circle. Otherwise, the silhouette will be an ellipse.

2.

Listing 1: Collect the coordinates of n hand-clicked points on an image.

```
function [ Pts ] = CollectPts( ShowLabel )
    %Select points from the current showing figure. Right-click to select
    %the last point and finish.

    hold on;
    bb=1;
    a=1;
    A=[0,0];
    while bb==1
        [x,y,button]=ginput(1);
        A=vertcat(A,[x,y]);
        if ShowLabel>0
            text(x,y,num2str(a),'BackgroundColor',[1 1 1]);
        else
            plot(x, y, '+');
        end

        a=a+1;
        if button==3
            %right click to select the last point and finish selection
            break;
        end
    end
    A(1,:)=[];
    A=horzcat(A,ones(size(A,1),1));
    Pts=A';

    hold off;
end
```

Listing 2: Draw a line with homogeneous coordinates.

```
function   PlotHomo( line )
    a=line(1,1);
    b=line(2,1);
    c=line(3,1);
    syms x y;
    ezplot(a * x + b * y + c);
    colormap([0, 0, 1]); %blue line
end
```

3.

(a)

The homogeneous coordinates of the four points are

$$\begin{aligned}\boldsymbol{a} &= (6, 8, 1)^T \\ \boldsymbol{b} &= (3, 7, 1)^T \\ \boldsymbol{c} &= (4, 2, 1)^T \\ \boldsymbol{d} &= (8, 6, 1)^T.\end{aligned}$$

The homogeneous coordinates of the four edges are

$$\begin{aligned}\boldsymbol{l_1} &= \boldsymbol{a} \times \boldsymbol{b} = (0.0556, -0.1667, 1)^T \\ \boldsymbol{l_2} &= \boldsymbol{b} \times \boldsymbol{c} = (-0.2273, -0.0455, 1)^T \\ \boldsymbol{l_3} &= \boldsymbol{c} \times \boldsymbol{d} = (-0.5, 0.5, 1)^T \\ \boldsymbol{l_4} &= \boldsymbol{d} \times \boldsymbol{a} = (-0.0714, -0.0714, 1)^T.\end{aligned}$$

The two vanishing points are

$$\begin{aligned}\boldsymbol{v_1} &= \boldsymbol{l_1} \times \boldsymbol{l_3} = (12, 10, 1)^T \\ \boldsymbol{v_2} &= \boldsymbol{l_2} \times \boldsymbol{l_4} = (2, 12, 1)^T.\end{aligned}$$

(b)

The homogenous coordinates for the horizon line is

$$\boldsymbol{h} = \boldsymbol{v_1} \times \boldsymbol{v_2} = (-0.0161, -0.0806, 1)$$

Therefore its expression is

$$-0.0161x - 0.0806y + z = 0$$

4.

(a)

Let $\omega' = \theta\omega$. According to the formula given by Logarithm of $SO(3)$

$$\begin{aligned}
\theta = ||\omega'|| &= \cos^{-1}\left(\frac{\text{tr}(R)-1}{2}\right) \\
&= cos^{-1}\left(\frac{0.1729 * 3 - 1}{2}\right) \\
&= 1.8138 \\
\omega = \frac{\omega'}{||\omega'||} &= \frac{1}{2\sin(\theta)}\begin{bmatrix} r_{32} - r_{23} \\ r_{13} - r_{31} \\ r_{21} - r_{12} \end{bmatrix} \\
&= \frac{1}{2\sin(\theta)}\begin{bmatrix} 0.9739 + 0.1468 \\ 0.9739 + 0.1468 \\ 0.9739 + 0.1468 \end{bmatrix} \\
&= (0.5773, 0.5773, 0.5773)^T
\end{aligned}$$