Introduction to Computer Vision

Problem Set 3 Report

Computer Engineering

Mert Can Çakmak
64160002

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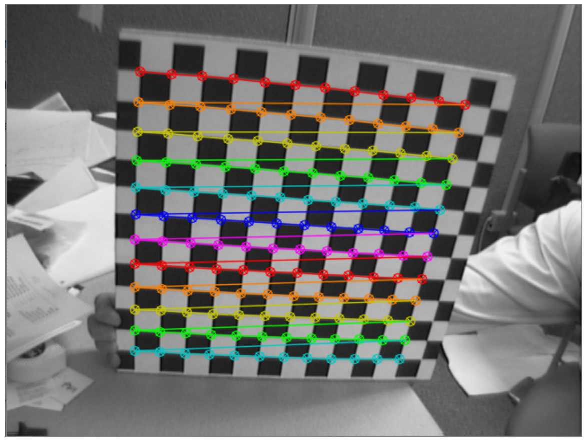
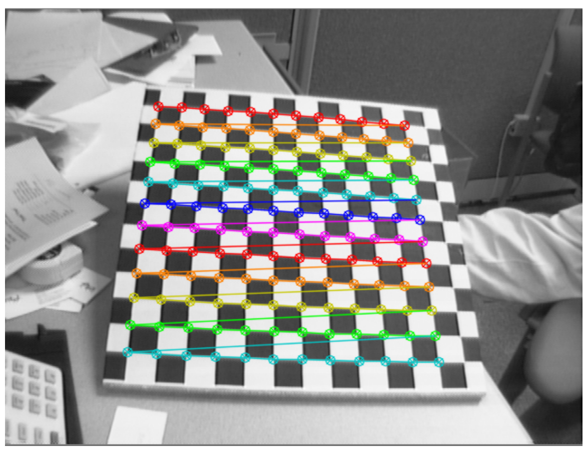
I select 12x12 grid size because when I using findChessboardCorners function, I got most number of True pictures for the given pictures.

The number of given pictures were 20 pictures and findChessboardCorners function found maximum 10 of them True.

I use cornerSubPix function to increase the accuracy of found corners.



Found corners example 1

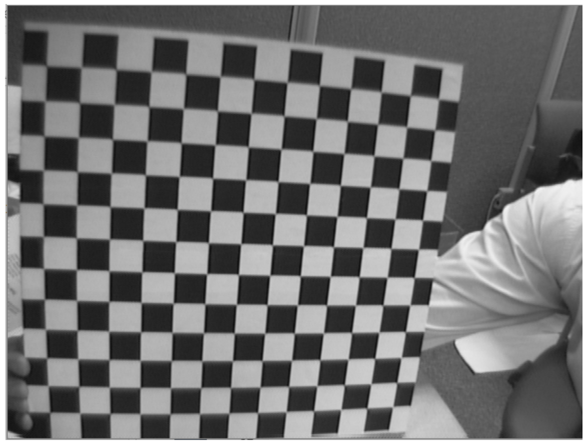


Found corners example 2

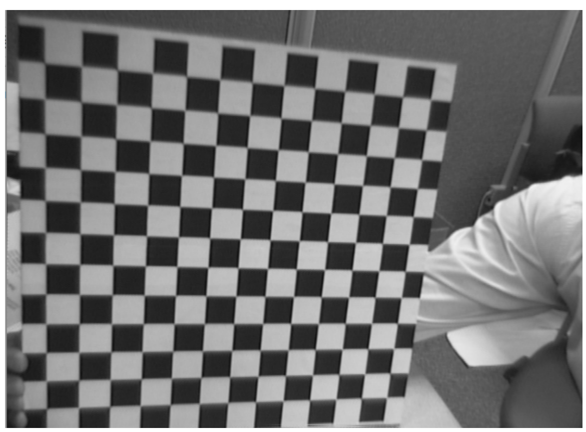
Using calibrateCamera function I got camera matrix, distortion matrix rotation vectors and translation vectors.

Using getOptimalNewCameraMatrix function I undistorted the images and crop them.

Before undistortion they have not straight lines for some edges.



Original Image



Undistorted Image

We can see that on the left side of the original image there is a distortion but when we undistort the image the left became straight line.

$$\mathbf{u} \simeq \begin{bmatrix} m_u & -m_u \cot\alpha & u_0 \\ 0 & \frac{m_v}{\sin\alpha} & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mathbf{R} & \mathbf{t} \\ \mathbf{0} & 1 \end{bmatrix} \mathbf{X}$$

$$= \begin{bmatrix} m_u f & -m_u f \cot\alpha & u_0 \\ 0 & \frac{m_v}{\sin\alpha} f & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mathbf{R} & \mathbf{t} \end{bmatrix} \mathbf{X} = \underbrace{\begin{bmatrix} m_u f & m_u s f & u_0 \\ 0 & m_u \gamma f & v_0 \\ 0 & 0 & 1 \end{bmatrix}}_{\text{intrinsic parameters}} \underbrace{\begin{bmatrix} \mathbf{R} & \mathbf{t} \end{bmatrix}}_{\text{extrinsic parameters}} \mathbf{X}$$

Notation to mean "up to a scale factor"

$$\mathbf{u} \simeq \underbrace{\mathbf{K} \begin{bmatrix} \mathbf{R} & \mathbf{t} \end{bmatrix}}_{\mathbf{P}} \mathbf{X}$$

Figure 5: Projection Matrix Formula

To be able to find projection matrix I use Rodrigues function to convert rotation vectors to rotation matrix then simply used the formula.

$$\mathbf{E} = [\mathbf{T}_x]\mathbf{R}$$

Essential Matrix
Formula

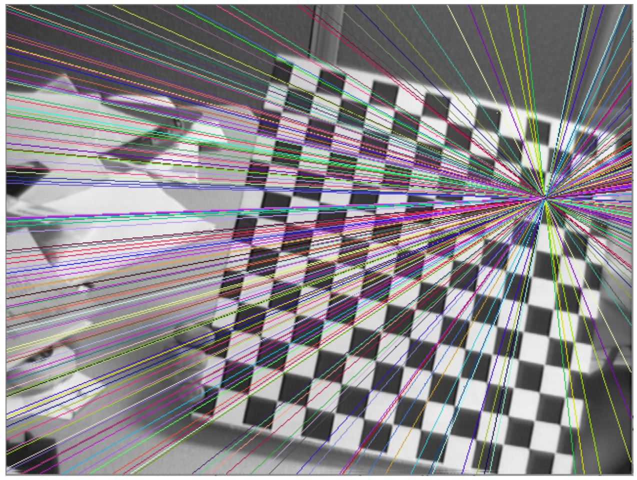
$$\vec{a} \times \vec{b} = \begin{bmatrix} 0 & -a_z & a_y \\ a_z & 0 & -a_x \\ -a_y & a_x & 0 \end{bmatrix} \begin{bmatrix} b_x \\ b_y \\ b_z \end{bmatrix} = \vec{c}$$

Cross Product Matrix Formula

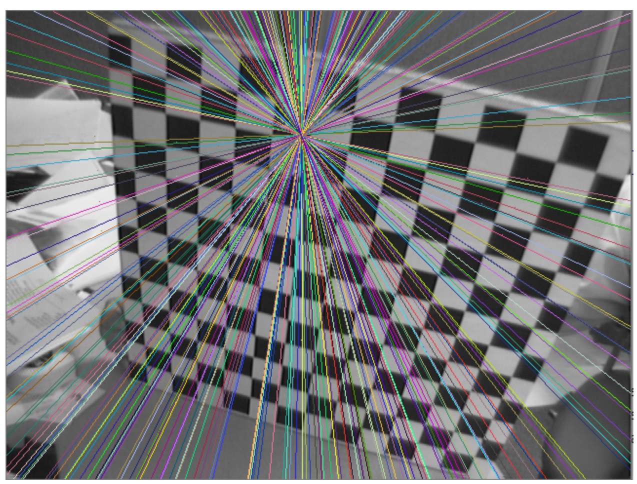
To find essential matrix I transform transition vectors to transition cross product matrix and multiply rotation matrix.

I used decomposeEssentialMat function to find rotation matrix and transition matrix from essential matrix. It returns 2 possible rotation matrix and transition matrix with unit values. To find right rotation matrix we can select a solution that gives positive Z.

A point in one image generates a line in the other on which its corresponding point must lie. This line is epipolar line.



Epipolar lines for the first image



Epipolar lines for the second image