Le Trung Son
D10203810

To compile and run the project

- The project is dependent on Eigen and OpenCV
- The project is built with the CMakeList.txt
- folder L and R containing the images are put in the same folder with executable
- Executable is built on Ubuntu 14.04

Algorithm for reconstruction

Triangulation

Since the extrinsic and intrinsics of two cameras are given, Direct Triangulation method with Condition 1 can be used. So the target is to derive this equation:

$$\begin{bmatrix} u\mathbf{p}_3^T - \mathbf{p}_1^T \\ v\mathbf{p}_3^T - \mathbf{p}_2^T \\ u'\mathbf{p}'_3{}^T - \mathbf{p}'_1{}^T \\ v'\mathbf{p}'_3{}^T - \mathbf{p}'_2{}^T \end{bmatrix} \mathbf{X}_{4\times1} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

where

$$\mathbf{P} = \begin{bmatrix} p_{11} & p_{12} & p_{13} & p_{14} \\ p_{21} & p_{22} & p_{23} & p_{24} \\ p_{31} & p_{31} & p_{32} & p_{34} \end{bmatrix} = \begin{bmatrix} \mathbf{p}_1^T \\ \mathbf{p}_2^T \\ \mathbf{p}_3^T \end{bmatrix}_{3\times4}$$

1x4 vector
1x4 vector
1x4 vector

$$\mathbf{p}_1^T = [p_{11} \quad p_{12} \quad p_{13} \quad p_{14}]$$
$$\mathbf{p}_2^T = [p_{21} \quad p_{22} \quad p_{23} \quad p_{24}]$$
$$\mathbf{p}_3^T = [p_{31} \quad p_{32} \quad p_{33} \quad p_{34}]$$

and u, v, u', v' are the image points

Image processing and correspondence

Image processing: the raw laser lines captured on images have to be thinned using morphological operations to result in one-pixel width line

Correspondence:

$$\mathbf{x}'^T \underbrace{\mathbf{F}\mathbf{x}}_{\mathbf{l}'} = 0 \qquad \mathbf{l}^T$$

This property of fundamental matrix is exploited to calculate correspondence. With an image point x and F fundamental matrix, an epipolar line on the other image is defined as l' = Fx.

A search through all the image points in the second image is done to find the corresponding image point

After the correspondence is solved, the two image points are put into triangulation algorithm and reconstructed for the 3D point