ECSE 6650 Computer Vision Project 3

Point Tracking and 3D Reconstruction from Motion

Due date: 11:59 pm, 12/8, 2019

In this project, you will implement the Kalman tracking method to track a moving polyhedron and use the factorization method to recover its 3D shape and motion. You will be given a sequence of images, containing a moving polyhedron. Manually identify the vertices of the polyhedron at the first frame and subsequently implement the Kalman filter to track the vertices from frame to frame until the last frame. Recover the 3D motion and structure of the polyhedron from the tracked vertices using the factorization method. Specific tasks include

1. initialize the Kalman trackers
2. implement the Kalman filtering method to track the feature points
3. implement the factorization method to recover the 3D motion (rotation) and structure of the polyhedron

Note when implementing the Kalman filter, pay attention to the following

- For detection, you can use SSD method to detect each vertex by finding the location of the bounding box in next frame that has the highest correlation with the initial bounding box for the same vertex in the first frame.
- During detection, you can set a rectangular search region centered at the predicted position with the width and length equal to two times of the square root of the covariances (i.e., diagonal elements) Σ_t^-

Prepare a report that includes the followings:

- introduction
- discuss the theory of Kalman filtering and factorization method
- discuss the experiments and their results. For tracking, the results should include tracked 2D coordinates for each frame, their covariance matrices, and a plot of the trace of the covariance matrix over frames. For structure from motion part, the results should include the estimated 3D motion and 3D structure, that is, which way it moves, the rotation matrices, and 3D

This can be a team project with a maximum of two members in the team. Clearly define the role of each team member. As usual, submit your report, codes, and results via email.