Image Based Modeling

A way to create 3D Models from a Single Picture

Xie Zhaoming

Supervised by

Professor Quan Long

Introduction

The purpose of this project is to reconstruct 3D Models from a single image. To achieve this goal, we require user to input reference points and sets of parallel lines.

In addition, we also implement algorithms to stitch multiple models together given information on face correspondence.

Project Details

Our project consists of the following parts:

Single View Metrology

Given enough user input, we can reconstruct a 3D models from a single image.

Figure 1.a 2D image of a cube.

Figure 1.b Snapshot of the 3D model constructed by our methods

Features Detection and Descriptors

We used Harris Features Detection Algorithm to automatically detect features in an images.

We also give descriptor to each feature using MOPS (Multiscale Oriented Patches Descriptors).

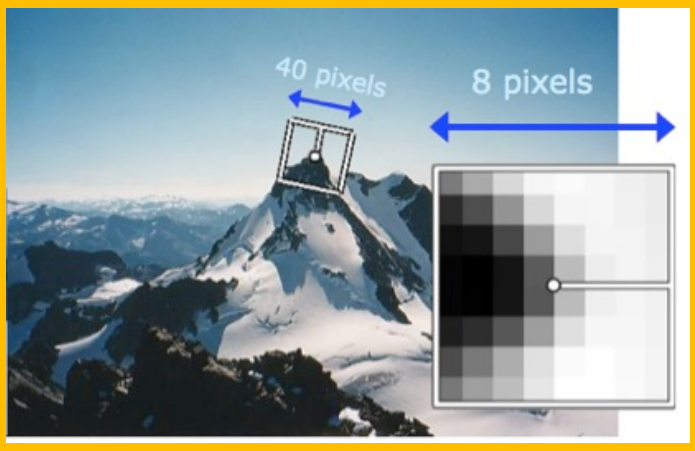

Figure 2 Illustration on how the MOPS work.

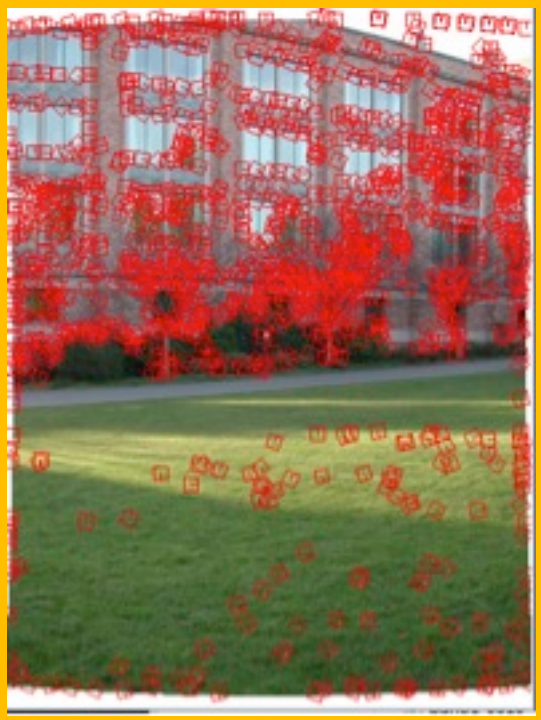

Figure 3 Features Detection using our program. The detected features are shown are red squares.

Features Matching and Alignment

For features in different images, we can use the descriptors to see how close features in different images are. We use the ratio difference to filter out ambiguous matches.

We then use the matches to find a mapping between two images according. Because the matching algorithms are not perfect, a small number of matches result is wrong, such wrong result is called outliers. To reject outliers, we use RANSAC (Random Sample Consensus) method to estimate the mapping. The mapping allow us to stitch 2 images together to create a Panorama or to stitch two 3D models together.

Figure 4. The first two images are photo taken of the same box from different angles. Using features matching and RANSAC we are able to apply transform to the first image to produce the third image, which transform the box to the same orientation as the second box.

Figure 5. The first two images are testing images Panorama. The third images is the result of the Panorama. Using features matching and alignment.

Stitching Models Together

Since the alignment algorithms are not really accurate enough for direct mapping. We make use of the knowledge that similar faces between different models share common vertices. Instead of directly mapping, we first identify the correspondences between vertices using the alignment result. Then using this correspondences, we can then find a mapping in 3D between this vertices.

Another challenges come from that most of the 3D models we constructed only have faces with 4 vertices, which is not enough for estimating a 3D transform. We assume the 3D transform consist of only translation and rotation, thus deduce the degrees of freedom of the transformation matrix.

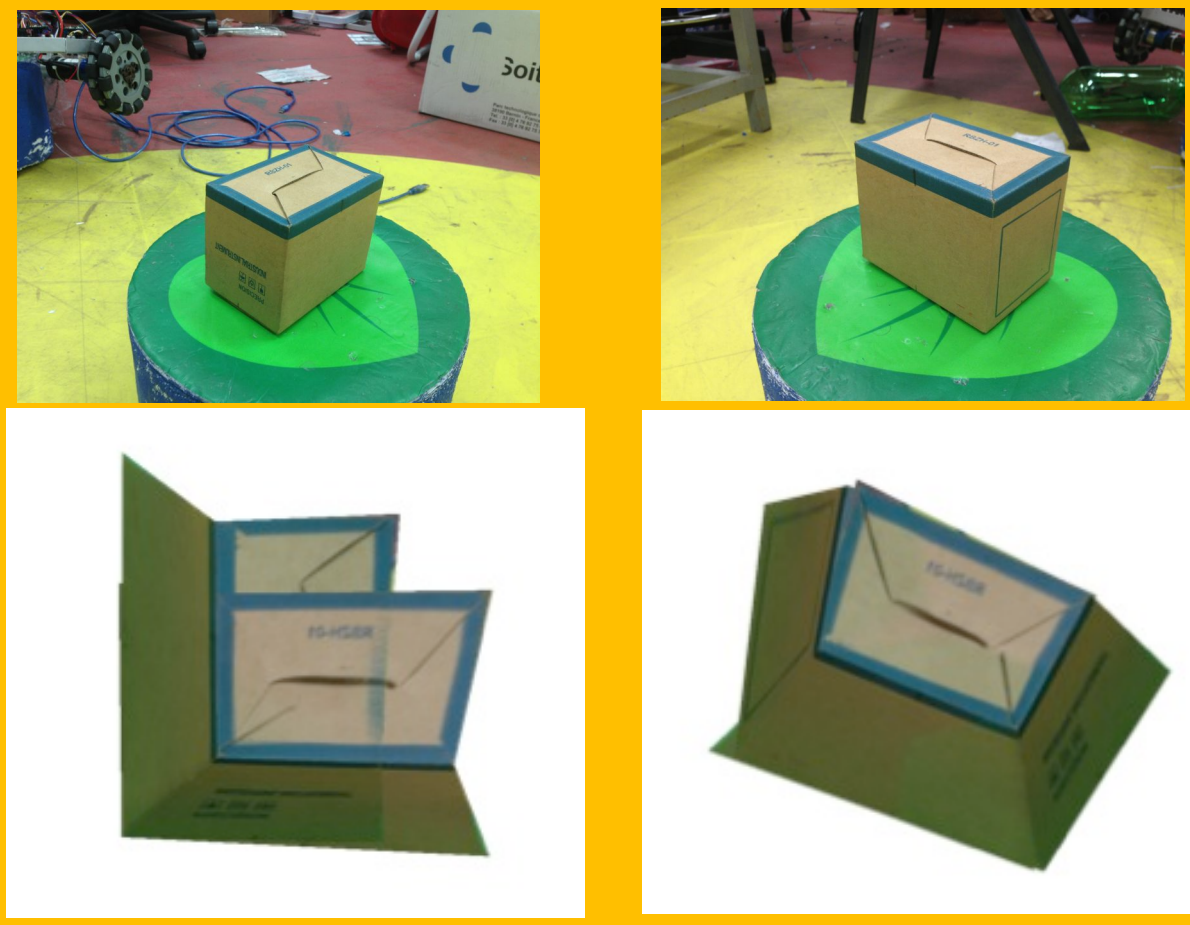

Figure 6. The first two images are photo taken of the same box from different sides. The third images show the misalignment of the 3D models after the initial reconstruction. The fourth image shows the result of the 3D models after applying our algorithms.

Conclusions

In this project, we explore techniques that can reconstruct a 3D model from a single image. We also try to stitch different models together using features detection, matching and alignment.

However, the techniques we apply has limitation on the 3D shape we are able to reconstruct and also suffer from inaccuracy when doing features matching and alignment. We will make further exploration in 3D reconstruction techniques in the future to overcome these limitations.