3D Reconstruction Using Stereo Camera

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1 Motivation

3D maps have always been of tremendous use in the field of robotics. A major section of the gaming and animation industry relies entirely on 3D maps of various location sites in order to keep their games realistic. This also increases efficiency by reducing the time and resources spent on creating complete structures for the game. 3D map of the surrounding is crucial for optimized and accurate navigation for robots. This can be extended to designing better navigation for the blind. Applications of 3D maps can be found in Civil Engineering Industry as well.

2 Introduction

One of the main requirements to create 3D maps is to have a sense of depth of the image. The current range finders like Kinect and real sense camera work on IR and do not do well when taking images in the outside environment. This is one of the main reasons for using stereo camera to calculate the depth. Hence, we aim to build an application that constructs 3D map of the surrounding using stereo camera(s).

One of the major assumptions we are making while capturing images and constructing 3D maps is that there will be only stationary objects in the scene under consideration. If time permits, we will be extending our project to moving objects as well.

3 Project Plan

The ultimate goal of the project is to create a bot with stereo camera that can build 3D map of its surroundings.

We plan to achieve this by the following objectives -

3.1 Objective 1

We will be using rectification algorithm to get rectified images from a stereo camera[1]. If we do not get satisfying results, we will use calibration app present in Matlab to calibrate the cameras and create rectified images.

3.2 Objective 2

We will then use a global or semi-global matching algorithm to get the disparity from the rectified stereo images. We have run all the algorithms mentioned on middlebury page on rectified images. We will also test the images with a semi-global algorithm[2][3]. The algorithm with the most accurate and compatible results will be used.

3.3 Objective 3

Once we have achieved the point clouds, we aim to stitch these together to get more dense and informative point clouds. We are referring to the final project report by a team from last year - 'Terrain maps from multi view Stereo Imagery' by Manish Chandra Reddy (EE13B1024), Udbhav Vyakarnam(EE13B1037) and Hriday Samboju (EE13B1027). The team successfully stitched two point clouds together. We will be extending this to multiple point clouds. We will first implement using the same technique and then focus on optimizing it. Currently, we are understanding various techniques for cloud stitching. We are also working on realizing an optimal match of image patches through a Convolutional Neural Network (CNN) to reduce the stereo-matching cost[4]. To familiarize ourselves with the inner working of a CNN, we will concentrate on scenes with stationary objects. Our final goal for Objective 3 will be achieving an optimized stitching of multiple point clouds for creating dense and informative 3D map.

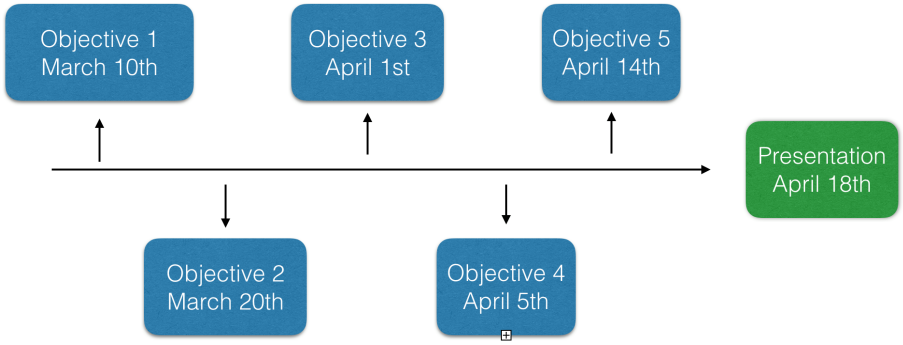

Figure 1: Tentative Time-line

3.4 Objective 4

Before building the robot directly, we will build a 3D map of a room or a hall. The idea is to take images of a place at different angles of rotation so that we can make a 3D map of the area. Post this, we will install the camera on the robot and focus on obtaining the 3D map of its surroundings.

3.5 Objective 5

Once we have our 3D map from Objective 4, we aim to identify objects in the map. We will use this information to help the robot decide if a certain path is to be traversed through or not. This can be achieved through a CNN.

4 Acknowledgements

We would like to express our gratitude to Prof. Sumohana Channappayya at IIT Hyderabad for giving us this opportunity to explore image processing through the domain of stereo vision. We are looking forward to extend the learning to solve problems in the field of artificial eyesight and gaming industry.

5 References

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