3D Reconstruction of Indoor Scenes Using Stereo Images

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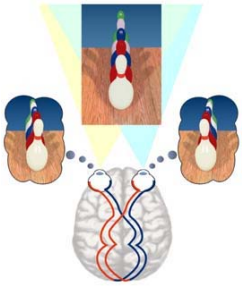
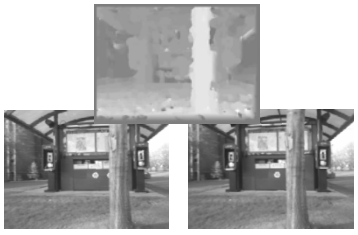
Introduction

This summer in the Future Computing Lab, my work focused on using stereo vision to reconstruct 3D environments from stereo photos of the office near the lab. The major challenges in this project are registering multiple overlapping 3D point clouds into the same coordinate space and interpolation 3D data that could not be validated by the stereo camera.



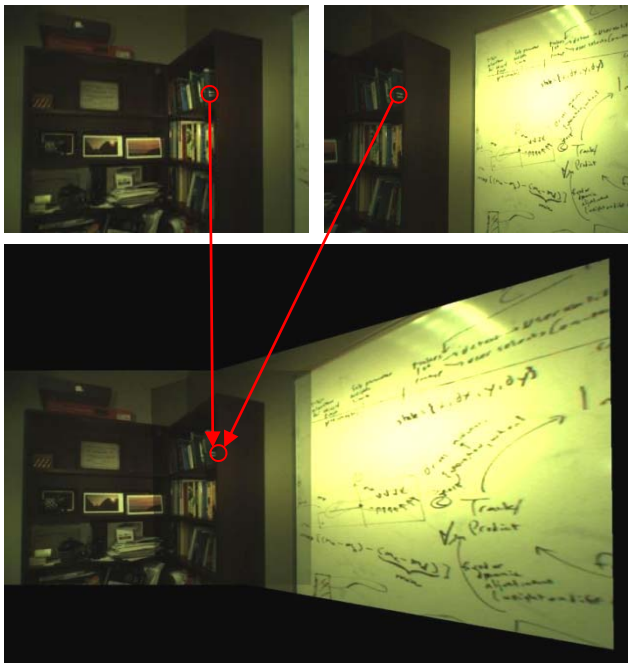


Human/Stereo Vision

The ability to perceive the 3D world is due to the fact that multiple images are processed at the same time. Slight differences in the images are due to the imaging devices being located a small distance from one another. The human brain and the computer can detect these difference to calculate how far away the things in the image are.

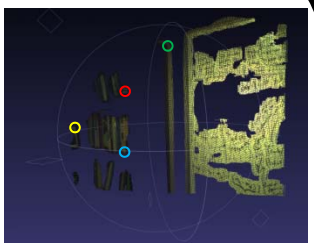
The Method

Using the images that are captured as part of the stereo process, an image-to-image matching can be performed on overlapping images.



The relationship between pixels in an image and points in 3D is found during the stereo processing. Once this image-to-image matching is performed, a relationship between pixels in adjacent images is know. The pixel-to-pixel relationship can then be used to find a point-to-point relationship in the 3D point clouds. Once several points have been matched, a rigid transformation be performed on the remaining points. This transformation will bring the matched points together and all the other points will follow.

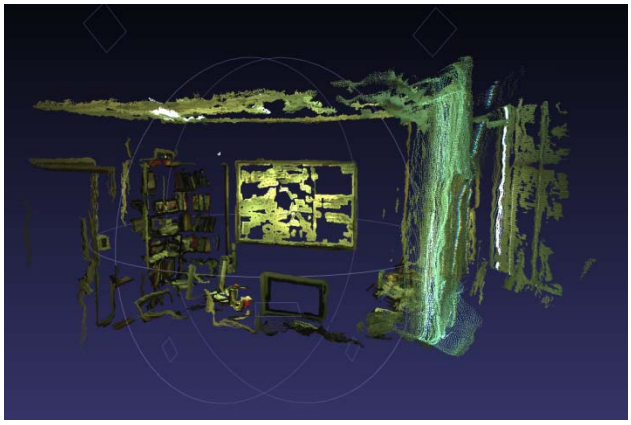
3D Point Alignment

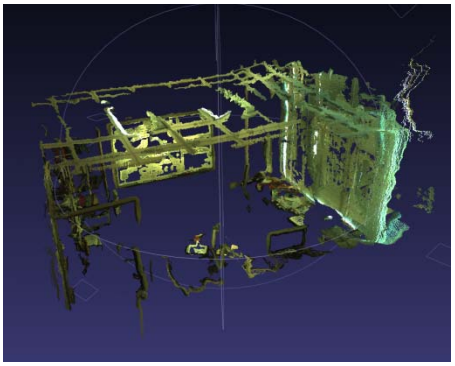


This process is then followed through all the over images to reconstruct a point cloud of the entire room.

Results

The point cloud featured in the following images was assembled from 36 stereo photos of an office.





Conclusion

So far in working on this project, we have found that using image-to-image matching can lead to the alignment of 3D data from stereo images. The alignment process has been scripted, but the image pairs needs to be discovered manually at this time. Images that are adjacent but do not contain unique features sometimes cause the matching to fail. If the over lapping portion of the images is too small the matching may also fail.

The accuracy of the 3D alignment is very heavily influenced by noise in the 3D measurements taken by the stereo processing. This means that the settings for the stereo processing must be set to very strict levels. Strict thresholds in turn lead to a limited number of 3D points that can be identified in each image.

Future Work

This project has been very challenging and the progress to this point is very promising. The work that remains includes finding a way to extract surfaces from the fully reconstructed point cloud. These surfaces will be needed to interpolate the remaining 3D points that could not be found in the stereo processing. Once all the surfaces have been fully textured, a 3D model can be generated for use as a virtual environment.