Continuous and Automatic Registration of Live RGBD Video Streams with Partial Overlapping Views

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Figure 1: *Successful registration of two viewpoints sharing small amount of overlap (The two figures on the left show RGB images, and the right figure shows the registered point cloud).*

Abstract

This paper presents a novel method for automatic registration of video streams originated from two depth-sensing cameras. The system consists of a sender and receiver, in which the sender obtains the streams from two RGBD sensors placed arbitrarily around a room and produces a unified scene as a registered point cloud. A conventional method to support a multi-depth sensor system is through calibration. However, calibration methods are time consuming and require the use of external markers prior to streaming. If the cameras are moved, calibration has to be repeated. The motivation of this work is to facilitate the use of RGBD sensors for non-expert users, so that cameras need not to be calibrated, and if cameras are moved, the system will automatically recover the alignment of the video streams. DeReEs [Seifi et al. 2014], a new registration algorithm, is used, since it is fast and successful in registering scenes with small overlapping sections.

1 Background and Contributions

Extensive research has been conducted on multiple depth sensing camera systems that all require calibration. Miller et al.[Miller et al. 2013] proposed a method for auto-calibrating multiple depth sensing cameras where camera calibration is unsupervised and based solely on analyzing the optical flow of peoples' movements captured from two cameras. Unlike [Miller et al. 2013] the solution proposed here is not dependent on users' motion. Depth sensors need not to be calibrated. Instead, DeReEs is used, an algorithm based on matching corresponding features between two RGDB images that finds a transformation based on the 3D coordinates of the input images. The method we propose provides near interactive rates, since it registers scenes in about 7 fps (145 milliseconds), while Miller et al.s method is reported to take about 10 minutes to obtain a single registration. Furthermore, current experiments indicate that the proposed algorithm can run faster. Our objective is to support frame rates close to 30 fps.

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2 Implementation of RGBD Video Stream Registration

RGB images are constantly being uploaded on GPU to find their corresponding features using OpenCVs SURF. Then, point clouds are registered and streamed through the network using Octree point cloud compression to be viewed at the receiver's end. Applying continuous registration on video streams tends to cause a "flicker effect" stemming from the fact that each 3D registration matrix may be slightly different from the previous one and continuously updated. To avoid this effect and provide a smoother viewing experience, two improvements are implemented to account for the following scenarios.**1- When cameras are stable:** We implemented a memory mechanism that keeps the best transformation according to a metric which is the highest number of true feature pairs. Each time a new transformation is found, features are compared to the metric and if a higher number of features is found, the transformation matrix and its success metric will be updated. **2- When cameras have moved:** Camera movement detection has been implemented. For each camera, we use RANSAC to obtain a homography matrix from the comparison of two subsequent frames from the same camera. We then take the next frame from the camera to apply RANSAC between the second and the third frames. If the difference between the new homography matrix and the previous one is larger than a certain threshold, then we say the camera is moved. As soon as one of the cameras is moved, the memory is erased and gets updated with new registration information. Results show a successful registration of viewpoints that is robust to camera movements. For a video showing several usage scenarios to which our system can adapt, please visit `http://www.cs.mun.ca/~omeruvia/research/research.html`.

References

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