Real-Time Registration of Highly Variant Color + Depth Image Pairs

Sahand Seifi, Afsaneh Rafighi, Dr.Oscar Meruvia-Pastor
Department of Computer Science
Memorial University of Newfoundland, Canada

INTRODUCTION

Depth cameras provide us with 3D images of the scene, which can be used to build a partial model of the scene. Multiple depth cameras or moving depth cameras might be used to capture the scene from different positions. In many applications, 3D images taken from different positions need to be aligned to be useful. 3D Registration is the process of finding the relative transformation between two 3D image pairs which allows us to transform one 3D image to the coordinates of the other.

OBJECTIVE

Current research on this topic :

- Existing registration techniques address this issue with image pairs that share most of the same scene contents through a large overlap.
- Most algorithms fall into local optimums because large non-overlapping regions introduce noise in the registration process.
- Other algorithms can align image pairs with smaller overlap, but they do not perform in real-time.

Our focus :

- To develop a solution to align color + depth image pairs with small overlapping regions, taken from the same scene from different positions in real-time (figure 1).
- To support large 3D transformations with 6 degrees of freedom.

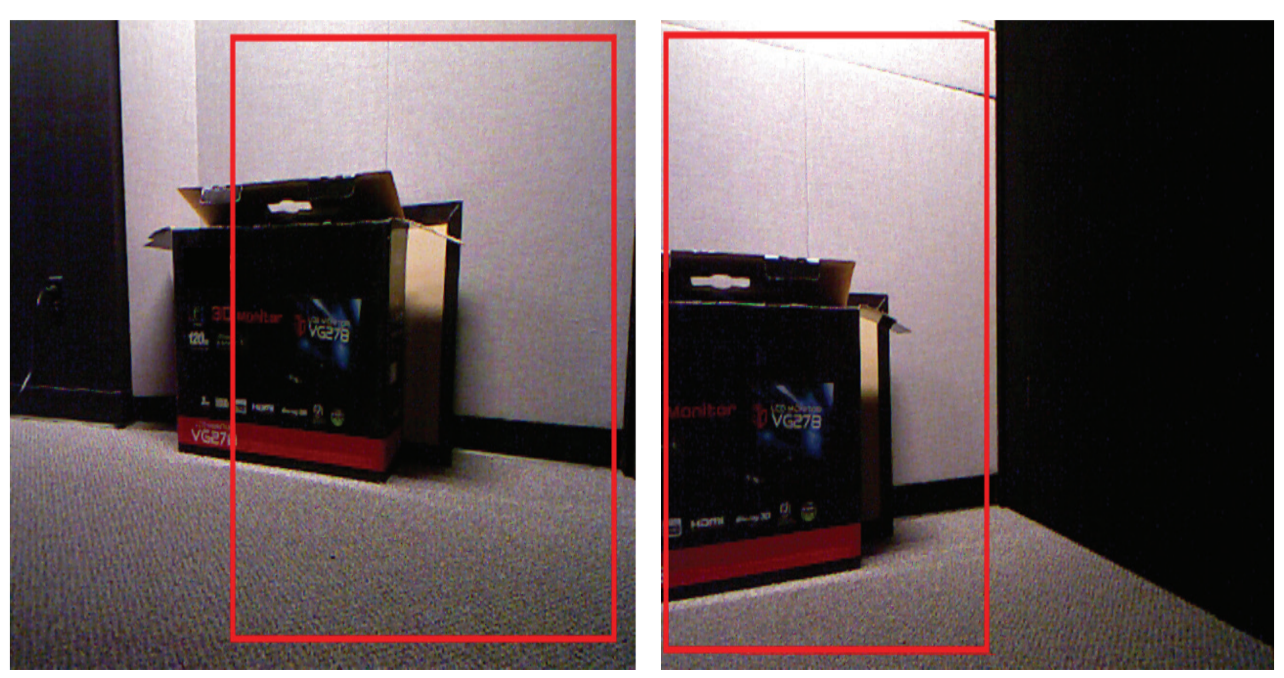


Figure 1. small overlapping regions

MATERIALS AND METHODS

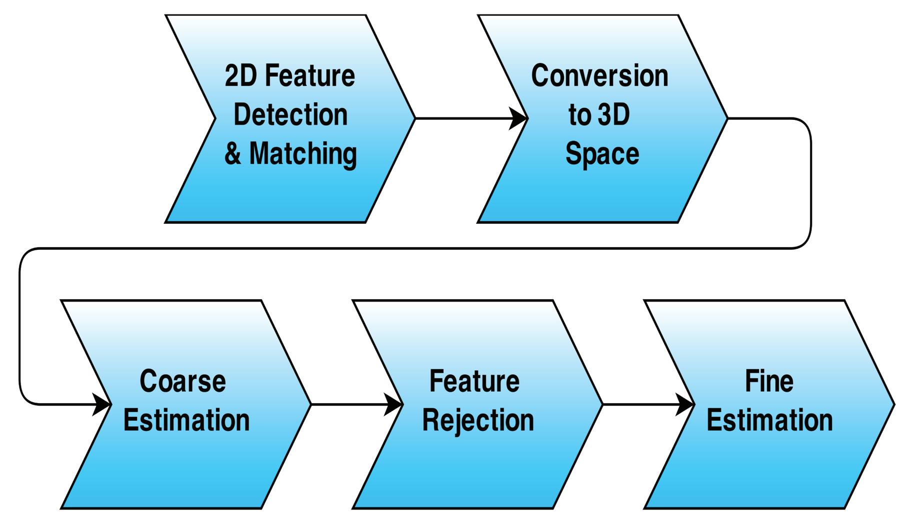


Figure 2 . 3d registration pipeline

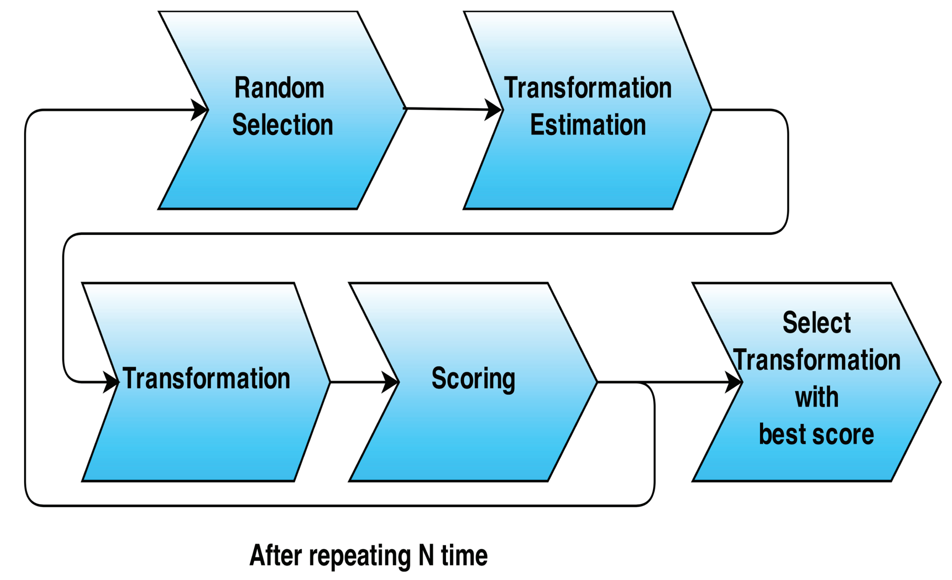
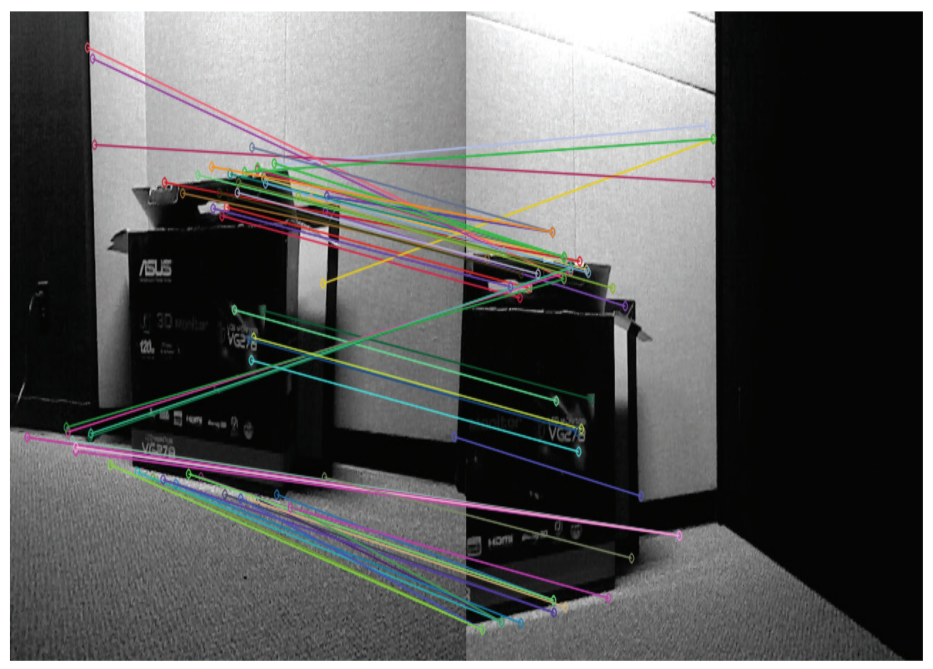


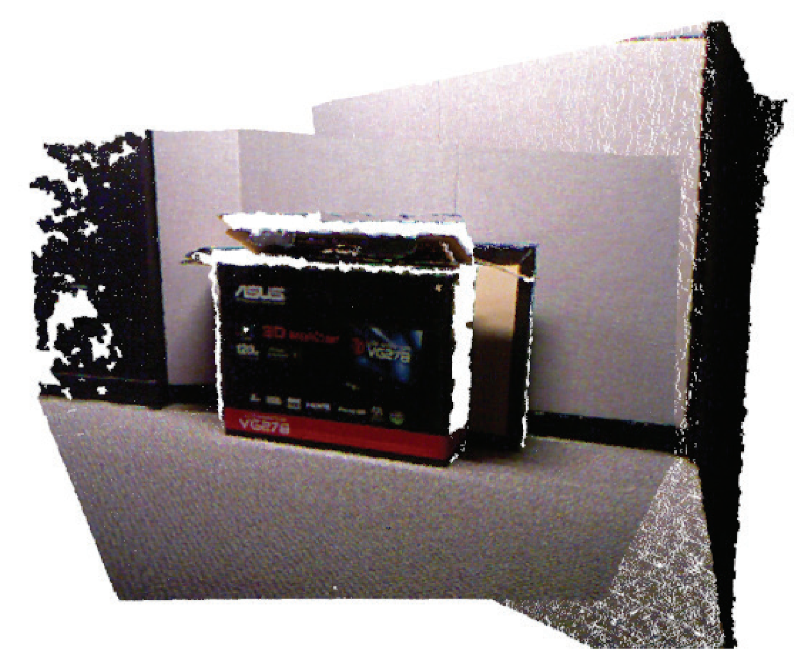
Figure 3. Coarse Transformation Estimation steps

The pipleline of the proposed registration method is depicted in figure 2. SURF[1] or ORB[2] 2D feature detection algorithms are used in the first step. Figure 3 shows the steps in finding a coarse transformation estimation. After finding T_c from these steps, T_c is applied to all feature pairs and those that have a greater distance than threshold are removed from the feature set. Finally, ICP[3] is used on remaining feature pairs to estimate the fine transformation.

RESULTS

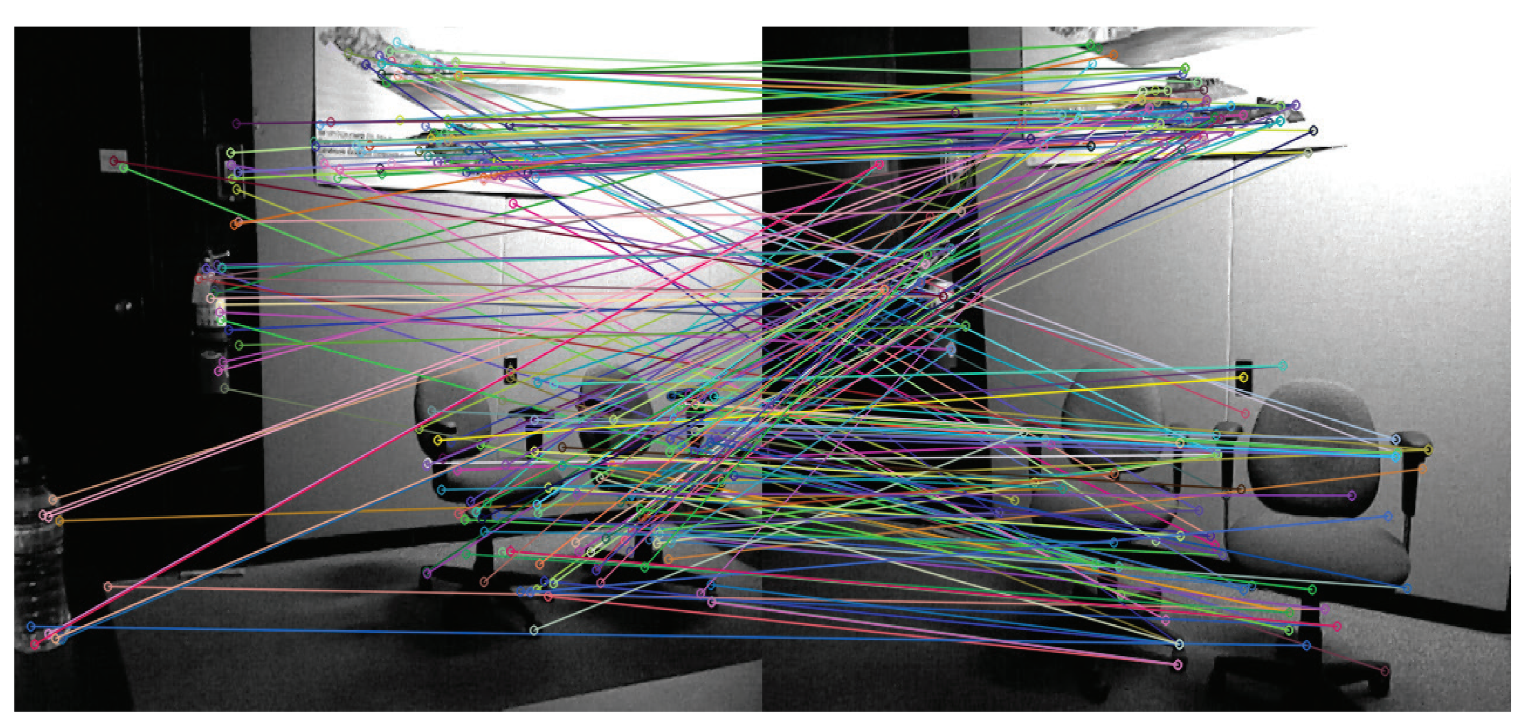


(a) 2d Feature Matching Result

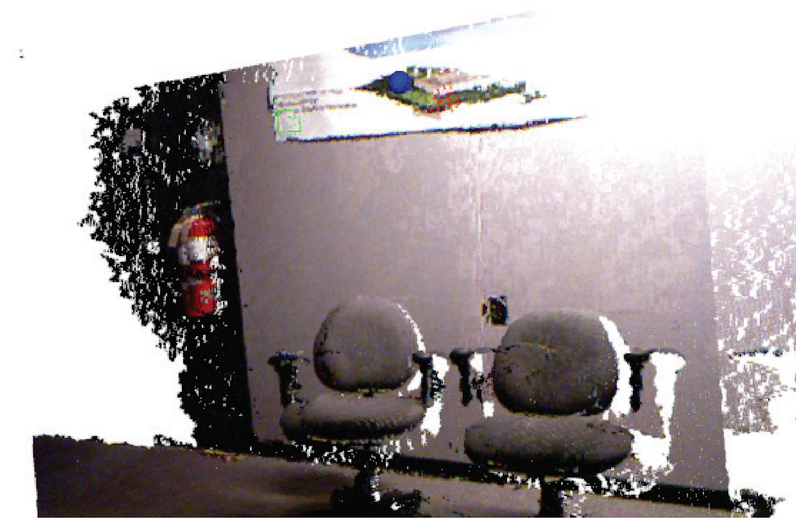


(b) Final Alignment Result

Figure 4. Pair A



(a) 2d Feature Matching Result



(b) Final Alignment Result

Figure 5. Pair B

To test this method, a Microsoft Kinect camera is used to capture color + depth images.

CONCLUSIONS

Data set	Step 1: No. of 2d features (time)	Step 2: No. of 3d feature pairs (time)	Step 3: No. of iterations (time)	Step 4: No. of remaining pairs(time)	Step 5: Time	Total Time	FPS
Scene A	57 (25.62ms)	54 (0.07ms)	70 (7.54ms)	16 (0.08ms)	3.09ms	36.4ms	27
Scene B	220(26.54 ms)	158 (0.12ms)	70 (21.66ms)	17(0.20ms)	1.69ms	50.21ms	19

Table 1. Performance Table

The algorithm runs in real-time and is not limited to fully overlapping image pairs or a very limited range of translation or rotation.

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[2]. E. Rublee et al. Orb: An efficient alternative to sift or surf. In Computer Vision (ICCV), 2011 IEEE International Conference on, pages 2564–2571, Nov 2011.
[3] P. Besl and N. D. McKay. A method for registration of 3-d shapes. Pattern Analysis and Machine Intelligence, IEEE Transactions on, 14(2):239–256, Feb 1992.

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