Foreground Segmentation with Efficient Selection from ICP Outliers in 3D Scene

Foreground segmentation serves in reconstructing 3D models of moving objects in the scene. The foreground appears as a secondary outcome indicated by outliers of the Iterative Closest Point (ICP). To form the foreground, many studies have filtered outliers by noise-removal approaches such as morphological filtration or graph optimization. They have not considered constraints rejecting these outliers, and just handled ICP outliers all together.

This study constructs 3D reconstruction of the environment using a moving RGB-D sensor. Alignment of new frames to the fused surfaces is achieved by ICP algorithm. Foreground objects are recovered from ICP outliers (Fig. 1.b) after considering its most relevant segments. The segmented foreground could be tracked in separated volumetric fusion to construct foreground objects independent from the static reconstruction. This would enable interaction and virtual reality applications.

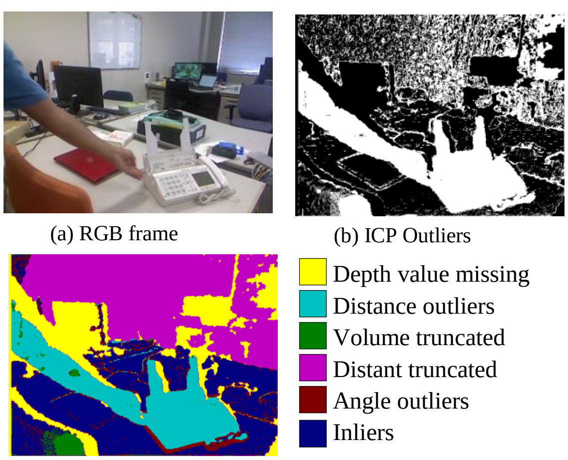
By tagging five different types of ICP outliers, we found out that noise-reduced foreground is located mainly in points violating distance constraint (Fig. 1.c). We propose a real-time method with an increase of 12% in quality (Fig. 2) using only bilateral filtration of distance outliers and distance truncation. Further details are available in the method's paper [1].

Our results suggest excluding distant depth points as well as angle/volume outliers from foreground segmentation to enhance processing time and quality. With that improvement, Graph-based refinements (e.g. GrabCut) are not required as well. Future work includes segmenting objects from the static environment once they start displaced.

Keywords: RGB-D, Dense 3D Reconstruction, Real-time, Foreground Segmentation

Reference

[1] Hamdi Sahloul, Jorge Figueroa, Shouhei Shirafuji, and Jun Ota, "Foreground segmentation with efficient selection from ICP outliers in 3D scene," in 2015 IEEE International Conference on Robotics and Biomimetics (ROBIO), Zhuhai, China, Dec 2015, pp. 1371-1376.



(a) RGB frame

(b) ICP Outliers

(c) Noise reduction by sub-outliers selection

Figure 1. Dataset frames and ICP outliers resulting from depth-frame alignment. (a) An RGB frame capturing some objects in-motion. (b) Corresponding ICP outliers. (c) Colored map showing distance outliers (in eggshell-blue color) used in proposed method.

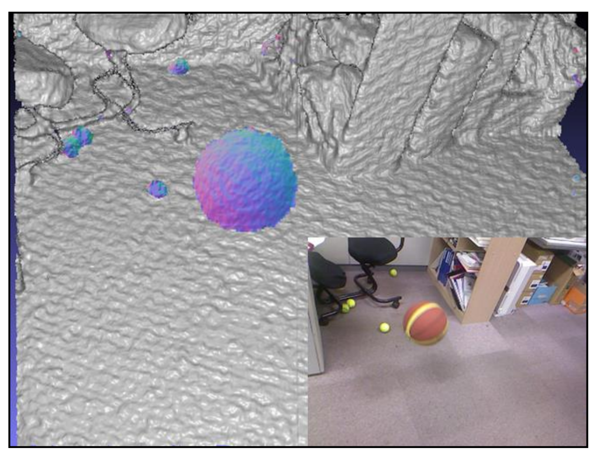


Figure 2. Main: A Phong shading surfaces of a reconstructed environment with the foreground represented as color-coded surface Normals. Proposed method results demonstrate a clean foreground of some balls while bouncing in the scene. Side: the corresponding RGB frame.