DetectFusion: Detecting and Segmenting Both Known and Unknown Dynamic Objects in Real-time SLAM
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Abstract
Simutaneous Localization and Mapping (SLAM) jointly estimates a 3D map of an unknown environment and the pose of an RGB/RG-D camera. Most contemporary SLAM systems (1) assume that the scene is static and (2) do not assign object semantics to their 3D maps!

Approaches for SLAM in dynamic environments
- reconstruct non-rigid objects (e.g., a single moving person)
- reconstruct only the static background and ignore dynamic objects
- reconstruct multiple rigid dynamic objects (our approach)

The key system component of our approach is the generation of instance object masks to reconstruct and track multiple semantic object maps independently, in addition to the static background map.

Our RGB-D SLAM runs in real time and can robustly handle semantically known and unknown objects that can move dynamically in the scene.

Method

1. Instance Segmentation


- convexity cue: segment concave surfaces.
- distance cue: segment based on depth discontinuity.

2. Motion Segmentation

Combine the geometric segmentation and ICP residual heatmap to ignore unknown dynamic object pixels during reconstruction and tracking.

Result

Our RGB-D SLAM reconstruct multiple moving objects with semantic labels. Non-rigid objects are ignored from tracking and mapping.

Quantitative results
1. Tracking performance
We evaluated the tracking accuracy on TUM dataset. Our method outperformed dynamic SLAM methods on the highly dynamic sequences.

2. Runtime performance
Our method achieved 22 FPS while performing segmentation in every frame. (GTX1080Ti, Core i7-6950X 3.4GHz CPU, 64GB RAM)

Comparison

System Static Object Instance Motion Real-time
Map Segmentation Segmentation Rate
ElasticFusion [3] ✓ ✓ ✓ ✓
StaticFusion [4] ✓ ✓ ✓ ✓
CoFusion [5] ✓ ✓ ✓ ✓
MaskFusion [6] ✓ ✓ ✓ ✓ keyframe-rate
Mid-Fusion [7] ✓ ✓ ✓ ✓ Offline
Ours ✓ ✓ ✓ ✓ frame-rate

References