PredRecon: A Prediction-boosted Planning Framework for Fast and High-quality Autonomous Aerial Reconstruction

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Existing Aerial Reconstruction Approaches

- **Explore-then-exploit method**: Need two scanning trails → Task completion inefficiency
- **Prior-based method**: Planning entirely based on prior information → Task cannot be fully automated
- **Exploration-based method**: Distribute significant time to explore unknown regions → Unsatisfactory efficiency due to exploration

Our Prediction-boosted Planning Framework

1) A surface prediction module (SPM), which directly infers the complete target surfaces from partial reconstruction information and facilitates efficient global coverage of the target without wasting significant time on extra exploration.

2) A hierarchical planner based on SPM, which sufficiently considers MVS-related factors on the fly and global coverage, achieving higher reconstruction quality and efficiency.

Surface Prediction Module (SPM)

**Predict the whole surfaces of the target from partial map to decrease redundant flight.**

**Surface Prediction Module (SPM)**

- **Transformation**: Input -> Transformation
- **Surface Prediction Module**: Predicted Internal Space
- **Point Cloud**: Generate path with higher reconstruction quality

Hierarchical Planner

**Global Coverage Path Planning**

- **Efficiently & Completely & Fast cover surfaces**

Experiments

1. **Path planning and 3D reconstruction results in challenging scenarios.**

- Best efficiency (path length and time) & reconstruction quality (F-score)

\[ F = \frac{2 \times Precision \times Recall}{Precision + Recall} \]

2. **Real-time capability**

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<tbody>
<tr>
<td>~26.8</td>
<td>~93.5</td>
<td>~0.5</td>
<td>~3.7</td>
<td>~124.7</td>
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3. **Point cloud completion performance**

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<thead>
<tr>
<th>Method</th>
<th>F-score (%)</th>
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<tr>
<td>ours SPM</td>
<td>68.693</td>
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<tr>
<td>PCN [15]</td>
<td>65.720</td>
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Paper, code, and video are available: https://github.com/HKUST-Aerial-Robotics/PredRecon