PlaneMVS: 3D Plane Reconstruction from Multi-View Stereo

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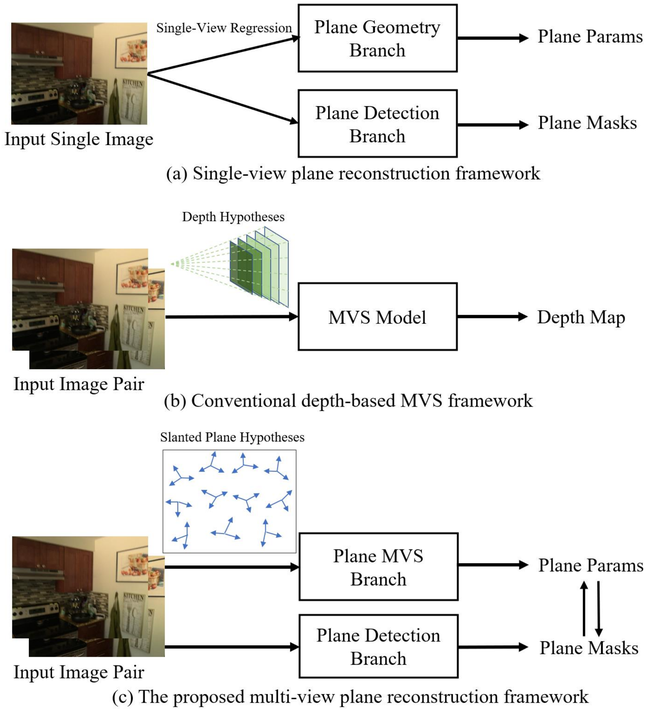

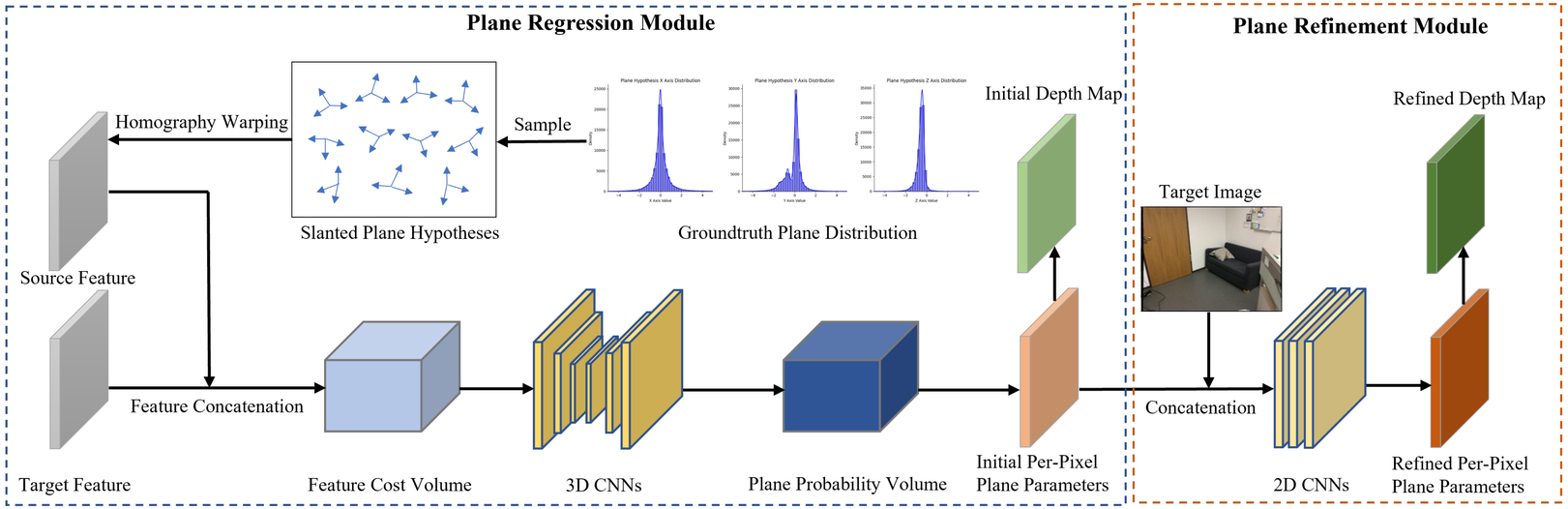

Key Idea

- Existing learning-based 3D plane reconstruction methods:
  - rely on single-view regression;
  - suffer from depth scale ambiguity.
- We propose *the first end-to-end framework* to reconstruct planes from multi-view stereo.
  - apply ***slanted plane hypothesis*** to regress planes in plane MVS branch;
  - decouple the problem into a *plane detection* branch and a *plane MVS* branch, associating them with the proposed loss for joint optimization.

- The homography between the two views can be determined with the plane parameter $(\boldsymbol{n_i}, e_i)$ with known camera poses:

$$H_i(\boldsymbol{n_i}, e_i) \sim \boldsymbol{K}(\boldsymbol{R} - \frac{\boldsymbol{t}\boldsymbol{n_i}^T}{e_i})\boldsymbol{K^{-1}}$$

Then we can regress $(\boldsymbol{n_i}, e_i)$ with an MVS framework with a set of ***slanted*** plane hypothesis.

- For plane detection branch, we adopt state-of-the-art plane detection algorithm, ***PlaneRCNN***, to predict plane masks.
- We propose a ***soft-pooling loss*** to build association between plane detection and plane geometry through the supervision of reconstructed planar depth map for joint optimization.
- For joint optimization on multiple tasks, we further apply the ***learnable uncertainty*** on different losses, and apply ***convex upsampling*** to retain the fine-grained geometric details.