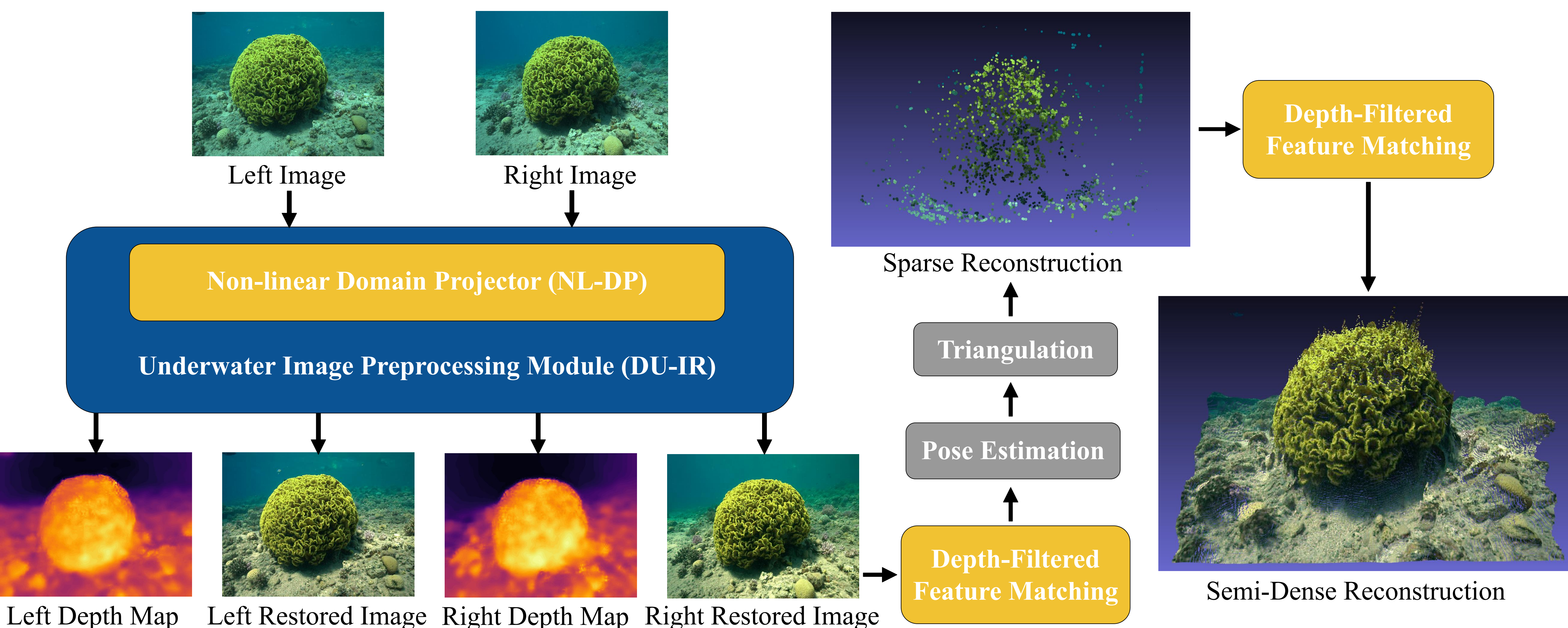


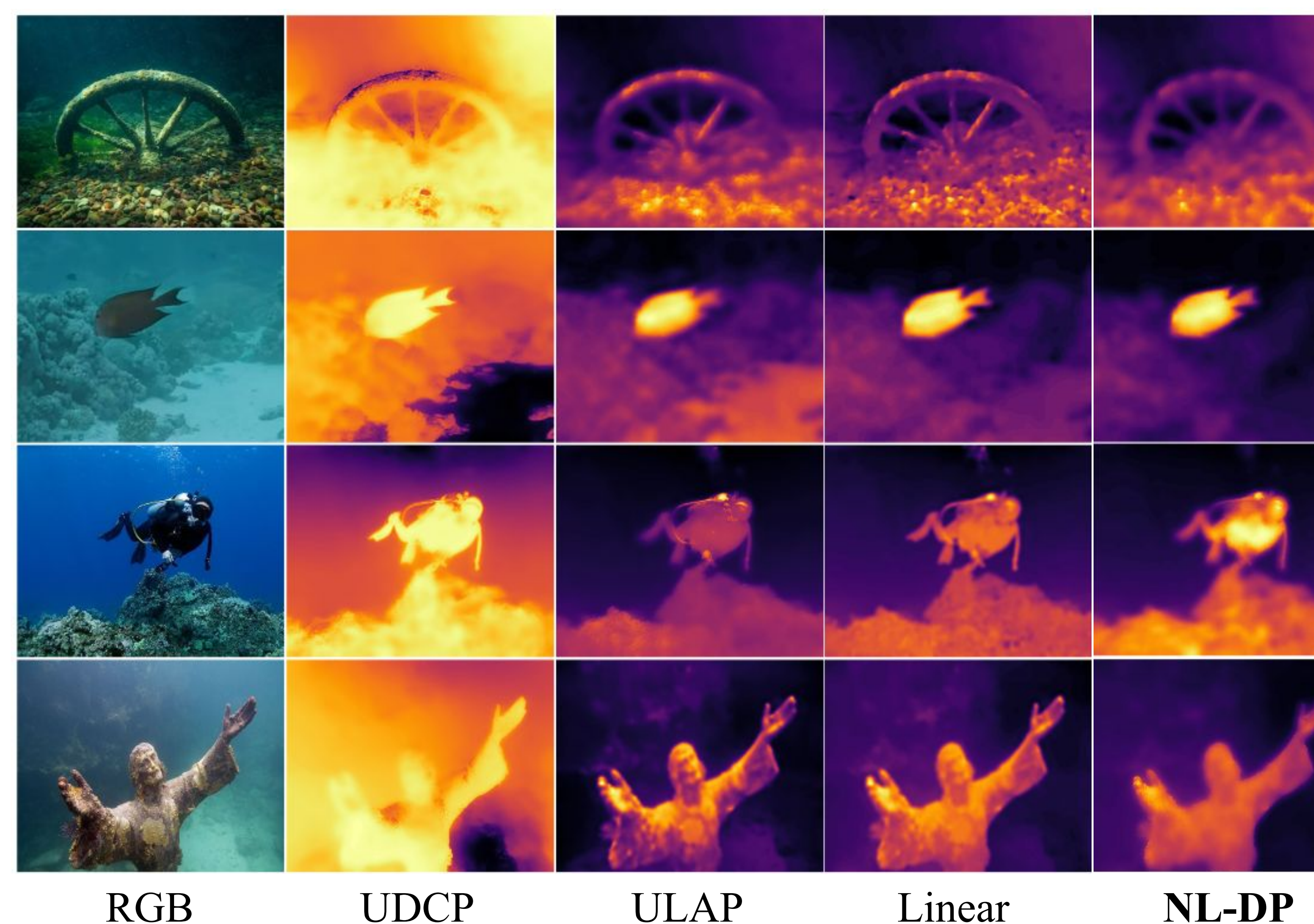
SDU-SfM Architecture: Depth-Guided Underwater 3D Reconstruction

- An end-to-end 3D reconstruction pipeline for degraded environments
 - Offer 3 times faster inference speed than SOTA pipelines, feasible for use by low-power underwater robots
 - Recover all valid points in the depth map include non-overlap areas
 - Reduces dependence on 2D feature matching, robust to degraded environments



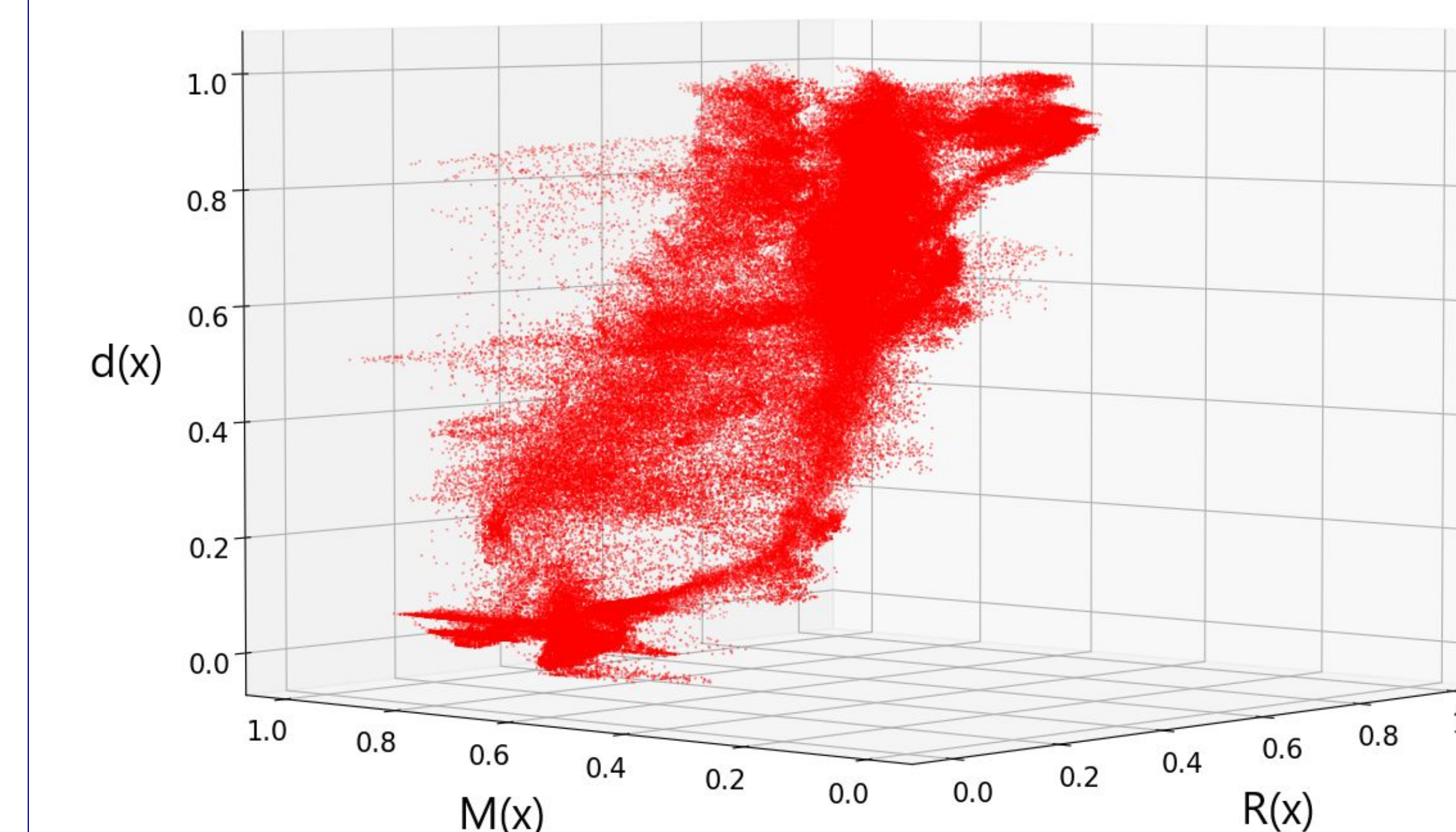
NL-DP: Non-Linear Domain Projection

- Enables computationally lightweight underwater depth estimation by a novel nonlinear projection module based on the RMI input space (proposed in UDepth)
 - Provides 3D reconstruction pipelines depth information, which is less degradation-influenced



NL-DP: Visualization of the Distribution

- The scattered points are always gathered around a certain non-linear surface



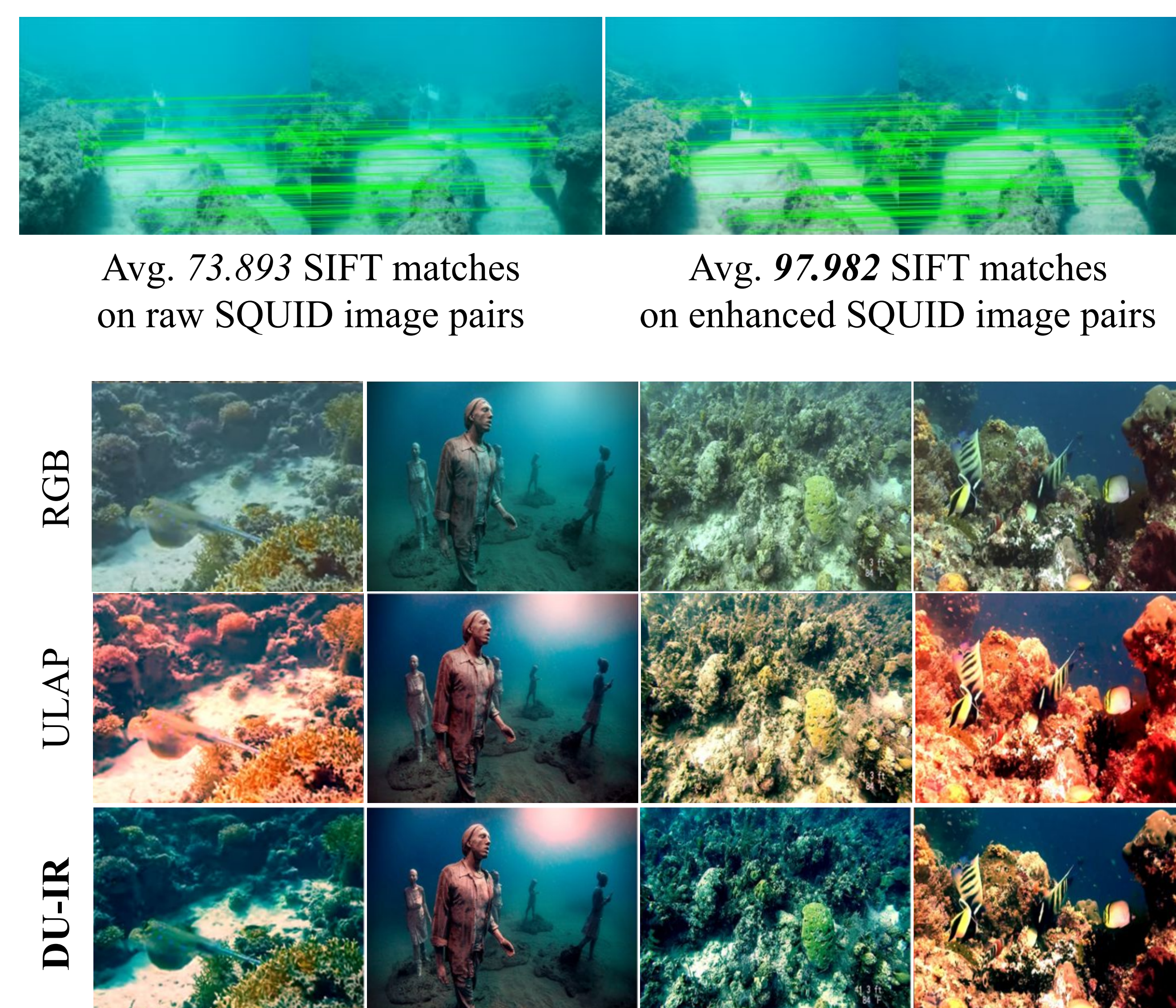
NL-DP: Training

- **End-to-end training:** USOD10K dataset (RGB-D)
- Mini-batch gradient descent + adaptive learning rate
- **7K** for training + **2K** for validation + **1K** for testing
- **Loss function:** Least-squared error

DU-IR: Depth-Guided Underwater Image Restoration

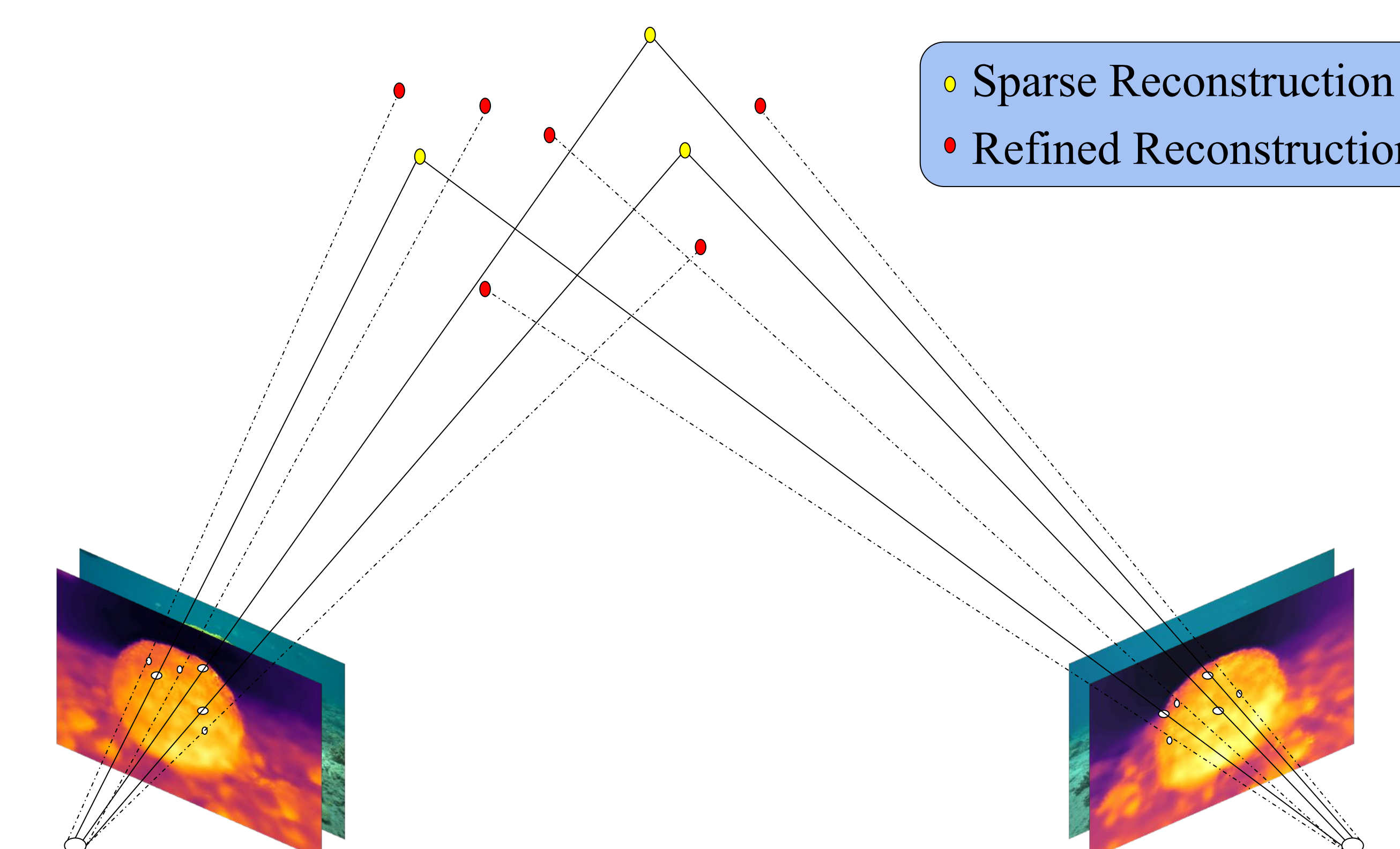
- An underwater image restoration module based on the Jaffe-McGlamery image formation model (enhanced by NL-DP)

- Recovers the 3D structural details of the underwater image without ignoring the patch-wise local information
- Extends our novel **NL-DP** module to better estimate two key optical parameters of the Jaffe-McGlamery model, the background light (**BL**) and the transmission map (**TM**)
- Provides more reconstructable 2D feature matches to improve the accuracy of camera pose estimation and sparse reconstruction
- **Suffers less hue shift** and achieves better clarity and color recovery
- **Provides consistent performance** across all major waterbody types



Geometric Interpretation

- **Sparse Reconstruction:** Epipolar geometry
- **Sparse to Semi-Dense:** Depth scale alignment



- **2D Features:** Provide camera pose and scaling factor
- **Depth map:** Provides feature matching mask and facilitate a refined scene reconstruction

Performance Comparison

