**Motivation**
- Time-of-flight (TOF) cameras are useful for many applications
- Due to system power constraints or multi-camera inference, TOF cameras cannot always acquire depth

**Rigidity Assumption**

**From Frame 1 to 2, the patch undergoes rotation, \( R \), and translation, \( T \)**

\[
x_1 = \frac{f}{2} \cdot x_1 \\
x_2 = \frac{f}{2} \cdot x_2 = \frac{f}{2} \cdot (Rx_1 + T)
\]

Approximate \( R \) with angular velocity, \( \omega \), because the time between frames is small:

\[
x_2 = \frac{f}{2} \cdot x_2 (Rx_1 + T) \approx \frac{f}{2} \cdot x_2 (x_1 + \omega \times x_1 + T)
\]

Exploit collinearity:

\[
x_2 \times (x_1 + \omega \times x_1 + T) = 0
\]

The pixel wise motion of a locally rigid patch must follow the rigidity assumption

**Non-Rigid Depth Estimation Algorithm**

**3D Point Partitioning:** Group all rigid points together

**Constrained Motion Estimation:** Estimate the pose of each rigid region

**Obtaining Depth:** Reproject each point and interpolate

Use the rigidity assumption along with RANSAC to identify rigid regions

**Consistency Constraint**

\[
\omega_1 \times X_1 + T_1 = \omega_2 \times X_1 + T_2
\]

Solve least squares formulation that minimizes the rigidity assumption while maintaining the consistency constraint

**Algorithm Evaluation**

- Sequentially estimate depth for our synthetic sequences and those in [2]
- Evaluate with percent mean relative error (MRE)

**Key Contribution:** Estimate depth maps with a mean relative error of 0.37% (0.48% for sequences in [2])

**References**

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