Camera Pose Filtering with Local Regression Geodesics on the Riemannian Manifold of Dual Quaternions
Intuition

Smoothing 2D signal using local regression lines

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Linearize pose space locally and perform similar smoothing
Pose Paremetrization of $SE(3)$

Motion as pose sequence in [dual] quaternion space

Quaternion and translation

$H_1 \times \mathbb{R}^3$

- Rotation part non-Euclidean
- Geodesics on hypersphere
- Rotation

$p \mapsto q \cdot p \cdot \bar{q}$

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Dual Quaternion in $\mathbb{DH}_1$

$Q = r + \epsilon s$

- Non-Euclidean space
- Geodesics on Study quadric
- Displacement

$P \mapsto Q \cdot P \cdot \hat{Q}$

Robust Motion Stabilization

Principle component local regression

- $H_1$ and $D H_1$ are Riemannian manifolds
- Calculate log and exp
Robust Motion Stabilization

Local filter methods

1. PCA
2. wPCA
3. IRLS
Riemannian Geometry

Lie groups and parallel transport

- $H_1$ and $DH_1$ are Lie groups
- exp and log at identity are sufficient

Riemannian Geometry

Lie groups and parallel transport

- $H_1$ and $DH_1$ are Lie groups
- $\exp$ and $\log$ at identity are sufficient

$$\exp(Q) = \sum_{k=0}^{\infty} \frac{Q^k}{k!}$$

Experiment 1

Synthetic Data

Rigid Body Motion with Noise
Experiment 1

Synthetic Data
Rigid Body Motion with Noise
Synthetic Evaluation

Dual IRLS compared to other methods
Real Data Evaluation

Quantitative comparison

- Stereo tracking dataset [1]
- Natural hand movements in cooperative robotics
- Accurate pose sequence

➢ No dual-space gain for reliable data

Experiment 2

RGB-D Data
- Kinect Fusion Pose Filtering
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Conclusion and Discussion

Results and Outlook

➢ Use shape of space for regression

Advantages

✓ Parameter-free online smoothing
✓ Outlier-aware IRLS method
✓ Dual quaternion robustifies filtering
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Disadvantages

▪ Dense sampling needed

Future work

– Include pose uncertainty
– Video stabilization
THANK YOU!
Grazie mille!

Questions?

Poster Session at 2 pm