OUTLIERS REMOVAL & CONSOLIDATION OF DYNAMIC POINT CLOUD

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Introduction

Goal: A novel method identifying and removing outliers from a dynamic point cloud sequence, achieving fast execution times and plausible reconstruction results.

Overview of our Method

- Creating the Spatial-Temporal Matrices

$$\mathbf{E}_i = \begin{bmatrix} \mathbf{v}_{i_1}(1) & \mathbf{v}_{i_1}(2) & \dots & \mathbf{v}_{i_1}(n) \\ \mathbf{v}_{i_2}(1) & \mathbf{v}_{i_2}(2) & \dots & \mathbf{v}_{i_2}(n) \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{v}_{i_f}(1) & \mathbf{v}_{i_f}(2) & \dots & \mathbf{v}_{i_f}(n) \end{bmatrix} \quad \forall\ i = 1, m$$

- Exploiting Outliers Sparsity via RPCA

$$minimize \quad \|\mathbf{S}\|_* + \lambda\|\mathbf{N}\|_1, \quad subject\ to \quad \mathbf{S} + \mathbf{N} = \mathbf{E}$$

- Identifying and Removing Outliers ($\epsilon > 10^{-4}$)
- Creation of Weighted Graph Laplacian Matrix
  1. The spatial coherence between connected vertices.
  2. The similarity of the motion vectors between connected vertices.
  3. A prioritization ranking.

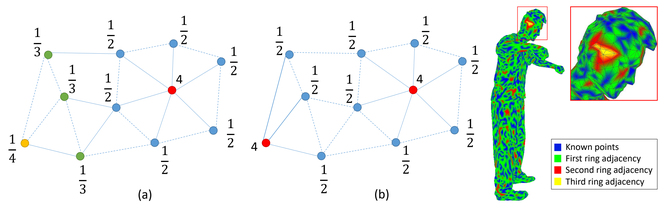


Figure: Different values of prioritization factor per each point.

- Weighted Laplacian Interpolation

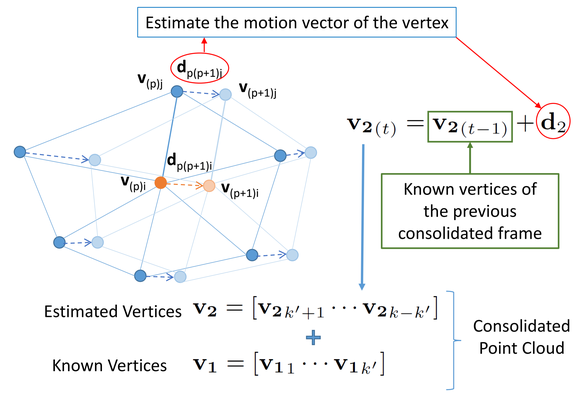
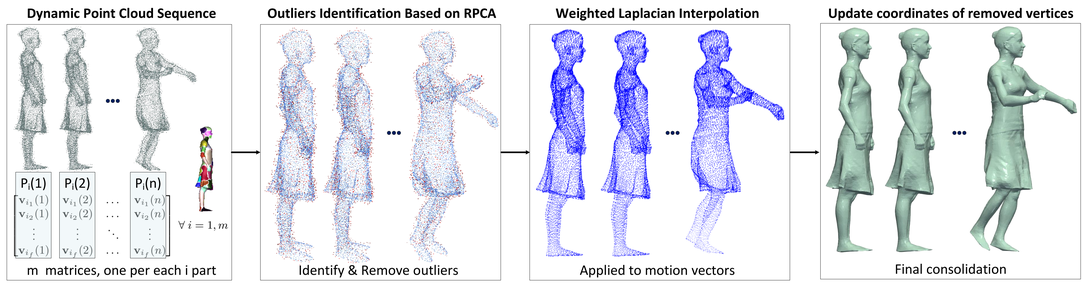


Figure: Update the coordinates of the previous reconstructed point cloud in order to define the new estimated position.

Outliers Removal Scheme of Dynamic Point Clouds



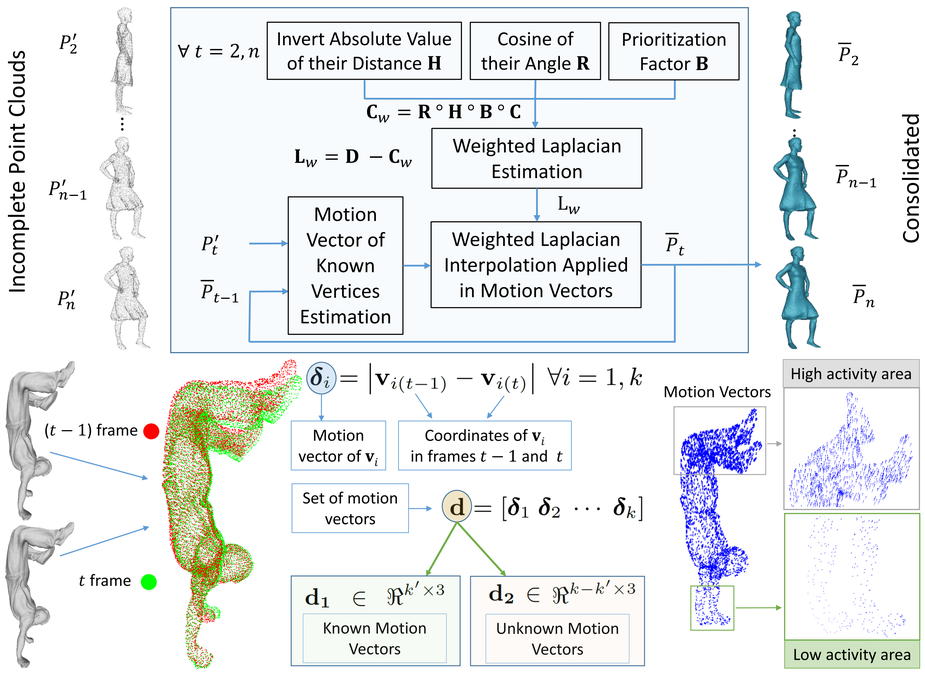


Figure: Weighted Laplacian Interpolation Schema.

Performance Evaluation

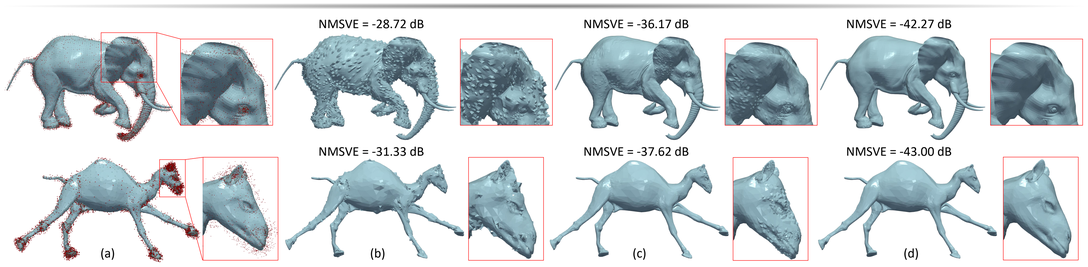


Figure: (a) Original mesh and point cloud with 20% of outliers, reconstructed models using: (b) Liu-Chan method in [1], (c) the low-rank matrix of RPCA, (d) our approach. (Elephant frame 33, Camel frame 36).

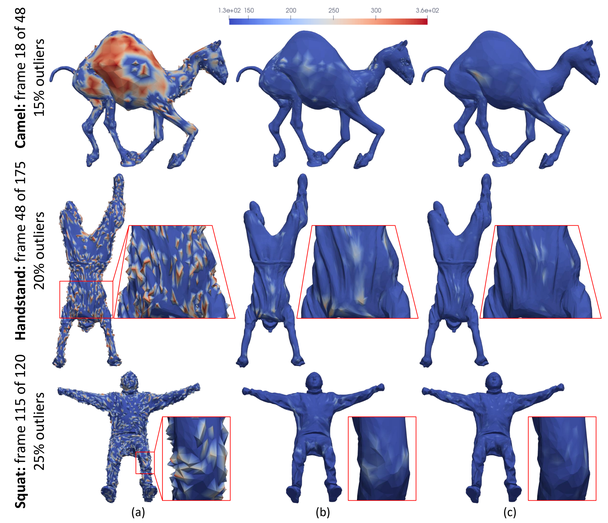


Figure: Heatmap visualization of reconstructed models, using: (a) Liu-Chan method in [1], (b) the low-rank matrix of RPCA, (c) our approach.

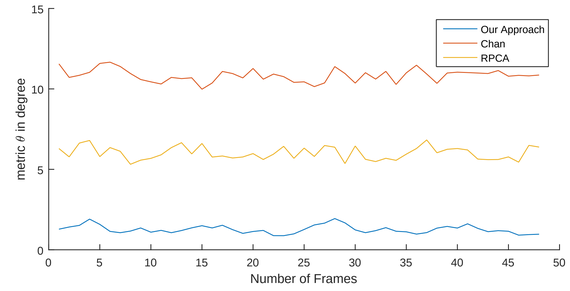


Figure: Value of metric θ per each frame of the animated model (Camel).

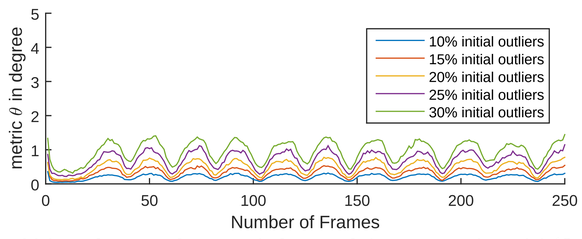


Figure: Value of metric θ per each frame of the animated model (Squat).

Conclusions

We presented a two-step approach which efficiently mitigates the outliers from an unorganized point cloud sequence.
An extensive evaluation study verifies the effectiveness of our approach as proved by a variety of different metrics.

[1] Shengjun Liu, Kwan-Chung Chan, and C. C. Wang
Iterative consolidation of unorganized point clouds
IEEE Computer Graphics and Applications, vol. 32, no. 3, pp. 70-83, May-June 2012.