Reliable Isometric Dense Point Correspondence from Depth

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ABSTRACT

We present an isometric point correspondence method relying on diffusion distance to handle challenges posed by commodity depth sensors, which usually provide incomplete and noisy surface data exhibiting holes and gaps. We formulate the correspondence problem as finding an optimal partial mapping between two given point sets, that minimizes deviation from isometry. We propose a novel iterative diffusion-based perfect matching algorithm to estimate correspondences reliably in this problematic setting. The experiments show that our method outperforms the baseline approaches which are based on point matching and capable of finding correspondences over depth frames exhibiting occlusions, large deformations and topological noise.

Figure 1: Results on a human pair of CPD (left), PR-GLS (middle) and our method (right)

CCS CONCEPTS

• **Computing methodologies** → *Shape modeling*;

KEYWORDS

Correspondence estimation, point-based, depth, noise, partial data

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1 INTRODUCTION

Although the field of 3d shape correspondence has become quite mature in the last decade, finding reliable correspondences from noisy depth provided by commodity depth sensors, exhibiting holes and large gaps, especially for non-rigid objects, is still an open problem for the success of various tasks in 3d computer vision and graphics. The depth data is incomplete by acquisition since objects can be sensed only from one direction; hence correspondences exist only partially. Also, due to holes and gaps, surface triangulation may be problematic; therefore, we need point-based matching techniques to overcome this challenges during correspondence estimation between depth frames. Our focus in this work is finding partial dense mappings between point clouds based on isometric cues, with as many reliable correspondences as possible. For this purpose we propose a novel diffusion distance and perfect matching based iterative matching and pruning algorithm.

2 DENSE CORRESPONDENCE ESTIMATION

Our input is a pair of point cloud representations obtained from depth frames of the object of interest. In the preprocessing step, we apply a standard keypoint detection technique, and then match the detected keypoints using a standard descriptor based matching algorithm [3]. Then, the initial correspondence computed in the preprocessing step is iteratively pruned and updated employing a diffusion-based perfect matching technique until convergence to find *base correspondences.* we do this by constructing a cost matrix using diffusion distance between the keypoints and base correspondences initially estimated via descriptor matching. Then, we apply perfect matching to find a new correspondence set and prune the outliers based on an isometric error criterion. Then, we update the current base set with the resulting smaller but more reliable set of correspondences. we gradually improve the base set until no more improvement achieved in terms of isometric error criterion. We then use the resulting base correspondences for estimating a dense set of correspondences. To this effect, we recursively subsample the point clouds into sub-patches relying on the base correspondences, and perform matching in a patch by patch basis, each time followed by elimination of outliers.

3 RESULTS AND CONCLUSION

We evaluate our dense correspondence algorithm in terms of deviation from ground-truth in comparison to baseline methods: CPD [2] and PR-GLS [1]. We achieved *1.2x* to *1.8x* improvement over different datasets in terms of resolutions and level of non-rigid deformations. In Figure 1, we visualize a sample pair from a human dataset with occlusion on the left leg as well as large deformation on the arms. Our algorithm performs well on these parts, while the other methods have complications. Also our algorithm leaves some parts of the point clouds unmatched, such as the left leg where there is no match due to severe occlusion.

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