**Topic One – 3D CAT for Space Division**

Implement the Chordal Axis Transform (CAT) in 3D space and use it to divide the space for disjoint 3D mesh models. Show some examples.

**Reference**

Prasad L. Rectification of the chordal axis transform and a new criterion for shape decomposition[C]//International Conference on Discrete Geometry for Computer Imagery. Springer, Berlin, Heidelberg, 2005: 263-275.

Ma Y, Chen Z, Hu W, et al. Packing irregular objects in 3D space via hybrid optimization[C]//Computer Graphics Forum. 2018, 37(5): 49-59.

**Topic Two - Medial Axis Transform and Its Application for 3D Vision and Shape Analysis**

Medial Axis Transform (MAT) is an important concept in computational geometry. It has been widely explored for shape approximation, shape recognition, shape retrieval, shape segmentation, etc. Please implement an 3D MAT algorithm and one related application. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Li P, Wang B, Sun F, et al. Q-mat: Computing medial axis transform by quadratic error minimization[J]. ACM Transactions on Graphics (TOG), 2015, 35(1): 1-16.

Lin C, Li C, Liu Y, et al. Point2Skeleton: Learning Skeletal Representations from Point Clouds[J]. CVPR, 2021.

Lin C, Liu L, Li C, et al. Seg-mat: 3d shape segmentation using medial axis transform[J]. IEEE Transactions on Visualization and Computer Graphics, 2020.

Yang B, Yao J, Guo X. DMAT: Deformable medial axis transform for animated mesh approximation[C]//Computer Graphics Forum. 2018, 37(7): 301-311.

**Topic Three – 3D Object Modeling from Single Image**

Single camera is easy to acquire due to the popularity smart phone. 3D object modeling from single image become hotter and hotter because it has wide applications in people’s daily life. Please implement an algorithm to model 3D objects or humans from single image. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Pavlakos G, Choutas V, Ghorbani N, et al. Expressive body capture: 3d hands, face, and body from a single image[C]//Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2019: 10975-10985.

Li C, Pan H, Liu Y, et al. Bendsketch: Modeling freeform surfaces through 2d sketching[J]. ACM Transactions on Graphics (TOG), 2017, 36(4): 1-14.

Li C, Pan H, Liu Y, et al. Robust flow-guided neural prediction for sketch-based freeform surface modeling[J]. ACM Transactions on Graphics (TOG), 2018, 37(6): 1-12.

**Topic Four – 3D Object Perception from Point Cloud**

Point cloud provides exact depth information of objects in 3D space, which is helpful for 3D object detection or segmentation. Please implement an algorithm of 3D perception for indoor or outdoor scenarios. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Lecture 11 to Lecture 13

**Topic Five – Point Cloud Completion**

Point cloud captured by view-dependent sensors are not complete by sparse views. Partial point cloud will affect the algorithm performance on understanding. Thus, point cloud completion is important for downstream tasks, like reconstruction, perception, etc. Please implement an algorithm of point cloud completion. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Ren, Y., Cong, P., Zhu, X., & Ma, Y. (2022). Self-supervised Point Cloud Completion on Real Traffic Scenes via Scene-concerned Bottom-up Mechanism. ICME 2022.

Wen X, Li T, Han Z, et al. Point cloud completion by skip-attention network with hierarchical folding[C]//Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition. 2020: 1939-1948.

Wang, X., Ang Jr, M. H., & Lee, G. H. (2020). Cascaded refinement network for point cloud completion. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 790-799).

Huang, Z., Yu, Y., Xu, J., Ni, F., & Le, X. (2020). Pf-net: Point fractal network for 3d point cloud completion. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 7662-7670).

**Topic Six – 3D Scene Reconstruction from Images**

3D scene reconstruction can benefit robotics and is also important for creating digital world. Multiple-view images can provide the depth info and are usually used for scene reconstructing. Recently, neural representation-based scene reconstruction is popular. Please implement an algorithm of 3D scene reconstruction for indoor or outdoor scenarios. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Mildenhall, B., Srinivasan, P. P., Tancik, M., Barron, J. T., Ramamoorthi, R., & Ng, R. (2020, August). Nerf: Representing scenes as neural radiance fields for view synthesis. In European conference on computer vision (pp. 405-421). Springer, Cham.

Martin-Brualla, R., Radwan, N., Sajjadi, M. S., Barron, J. T., Dosovitskiy, A., & Duckworth, D. (2021). Nerf in the wild: Neural radiance fields for unconstrained photo collections. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 7210-7219).

Barron, J. T., Mildenhall, B., Tancik, M., Hedman, P., Martin-Brualla, R., & Srinivasan, P. P. (2021). Mip-nerf: A multiscale representation for anti-aliasing neural radiance fields. In Proceedings of the IEEE/CVF International Conference on Computer Vision (pp. 5855-5864).

**Topic Seven – 3D Reconstruction from Multimodal Data**

3D scene reconstruction can benefit robotics and is also important for creating digital world. Multiple-view images and point cloud are usually used for scene reconstructing. Multimodal data have their own pros and cons and can be complementary. Please implement an algorithm of 3D scene reconstruction based on multi-modal data. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Deng, K., Liu, A., Zhu, J. Y., & Ramanan, D. (2021). Depth-supervised nerf: Fewer views and faster training for free. arXiv preprint arXiv:2107.02791.

Ost, J., Laradji, I., Newell, A., Bahat, Y., & Heide, F. (2021). Neural Point Light Fields. arXiv preprint arXiv:2112.01473.

Rematas K, Liu A, Srinivasan P P, et al. Urban Radiance Fields[J]. arXiv preprint arXiv:2111.14643, 2021.

**Topic Eight – 3D Deformation or Morphing**

Deformation and morphing are basic for CAD design and animation. Please implement an algorithm of deformation or morphing, like skeleton-based, or mesh-based methods. If you choose to use others’ code as your baseline, improvement by your team is required. Use enough experiments to show the superiority of your idea.

**Reference**

Lecture 7