Master 2 Internship Proposal:
A Neural Network Approach for Point Cloud Compression Artifact Removal

Context

Point Cloud (PC) is a popular 3D representation format enabling some immersive forms of interaction and communication. It plays an important role in Augmented Reality (AR) and eXtended Reality (XR) technologies which aim to transform different sectors such as entertainment, cultural heritage and healthcare. In this respect, many efforts are currently made in Europe and around the world to improve these creative technologies and promote their adoption in the industry.

A typical PC based immersive system involves different processing steps from content capture to display which often result in various kinds of degradation. For instance, at the acquisition stage, point clouds obtained with 3D devices or image based reconstruction techniques often suffer from noise and outliers [1, 2]. Moreover, PC coding at low bitrate as well as rendering may produce different types of artifacts (geometric distortion, color distortion, false edges, etc) which will impact the quality of user experience [3]. Therefore, it becomes necessary to develop efficient algorithms to enhance the quality of the generated as well as the processed PC data.

Objective

With the ultimate goal of producing high realistic 3D reconstruction and visualization, this internship aims to improve the visual quality of point clouds. More precisely, we will focus on the compression artifact removal aspect. While such post-processing step has been widely investigated in the context of image and video compression, only very few works have been developed in the context of PC compression [4, 5]. Thus, the main objective of this internship is to design a new approach taking advantages of wavelets and neural networks [6]. It should be noted here that combining wavelets with neural networks have recently shown promising results in the context of image restoration [7, 8, 9, 10].

References

[1] P. Hermosilla, T. Ritschel, T. Ropinski, "Total Denoising: Unsupervised Learning of 3D Point Cloud Cleaning", *IEEE International Conference on Computer Vision*, Nov. 2019.

[2] M.-J. Rakotosaona, V. La Barbera, P. Guerrero, N. J. Mitra, M. Ovsjanikov, "POINTCLEANNET: Learning to denoise and remove outliers from dense point clouds" *Computer Graphics Forum*, vol. 39, no. 1, pp. 185-203, 2020.

[3] A. Javaheri, C. Brites, F. Pereira, J. Ascenso, "Point Cloud Rendering after Coding: Impacts on Subjective and Objective Quality", *IEEE Transactions on Multimedia*, vol. 23, pp. 4049-4064, Nov. 2020.

[4] L. Galteri, L. Seidenari, M. Bertini, and A. Del Bimbo, "Deep generative adversarial compression artifact removal," *in IEEE International Conference on Computer Vision*, pp. 4826-4835, 2017.

[5] A. Akhtar, W. Gao, L. Li, Z. Li, W. Jia, S. Liu, "Video-based Point Cloud Compression Artifact Removal", *IEEE Transactions on Multimedia*, June 2021.

[6] T. Dardouri, M. Kaaniche, A. Benazza-Benyahia, and J.-C. Pesquet, "Dynamic Neural Network for Lossy-to-Lossless Image Coding", *IEEE Transactions on Image Processing*, vol. 31, pp. 569-584, Dec. 2021.

[7] W. Bae, J. Yoo, and J. Chul Ye, "Beyond deep residual learning for image restoration: Persistent homology- guided manifold simplification", *in IEEE Conference on Computer Vision and Pattern Recognition workshops*, pp. 145-153, 2017.

[8] T. Guo, H. Seyed Mousavi, T. Huu Vu, and V. Monga, "Deep wavelet prediction for image super-resolution", in *IEEE Conference on Computer Vision and Pattern Recognition workshops*, pp. 104-113, July 2017.

[9] W. Liu, Q. Yan, Y. Zhao, "Densely Self-guided Wavelet Network for Image Denoising", *in IEEE Conference on Computer Vision and Pattern Recognition workshops*, June 2020.

[10] J.-J. Huang, P. L. Dragotti, "LINN: Lifting Inspired Invertible Neural Network for Image Denoising", *in European Signal Processing Conference*, Aug. 2021.