



The Hong Kong University of Science and Technology

Department of Mathematics

PHD THESIS EXAMINATION

A Study of 3D Learning in Computer Vision and Science

By

Miss Jiamin WU

ABSTRACT

The rapid advancement of deep learning has significantly propelled 3D learning, enabling transformative applications across computer vision and biomedical sciences. This dissertation focuses on advancing 3D reconstruction and novel view synthesis in computer vision, as well as 3D structure generation in scientific domains. In vision, we develop machine learning frameworks to reconstruct intricate 3D models from single 2D images and sparse RGB inputs, leveraging 3D Gaussian representations for efficient rendering to generate novel views. We further innovate in novel view synthesis by generating photorealistic scene perspectives from reconstructed models or limited images, employing differentiable rendering and Detection Transformer architectures to mitigate artifacts and relax rigid pose constraints. By explicitly linking poses and 3D assets in canonical space, our approach outperforms prior methods in object and scene reconstruction benchmarks, enhancing applications in virtual reality, object recognition, and digital content creation. In biomedical sciences, we introduce a conditional diffusion model to generate 3D ligand structures guided by protein surfaces, accelerating drug discovery. Additionally, we design a deep learning-based scoring function to evaluate ligand-protein binding affinities from pairwise distances, enabling efficient candidate selection. Together, these contributions bridge cutting-edge techniques in vision and science, demonstrating the versatility of deep learning in shaping 3D understanding and generation.

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Thesis Examination Committee:

- Chairman** : Prof. Kristiaan NEYTS, ECE/HKUST
- Thesis Supervisor** : Prof. Yuan YAO, MATH/HKUST
- Member** : Prof. Jianfeng CAI, MATH/HKUST
- Member** : Prof. Dong XIA, MATH/HKUST
- Member** : Prof. Lei ZHANG, Info Hub HKUST-GZ (*via online mode*)
- External Examiner** : Prof. Ruimao ZHANG, Sch of Electronics & Communication Engrg/
Sun Yat-sen University (*via online mode*)

(Open to all faculty and students)

The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).