

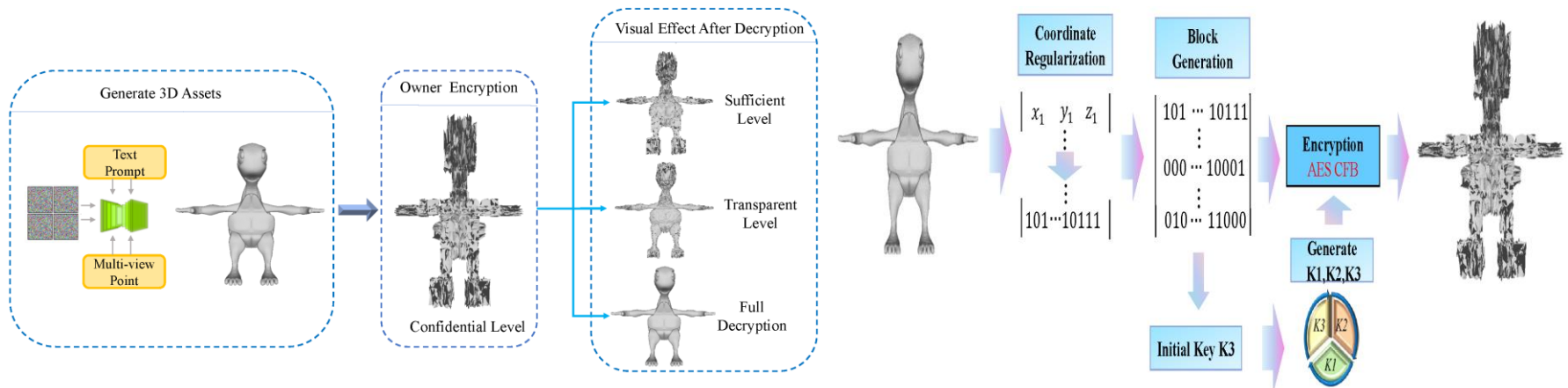
# A Generative 3D Asset Encryption Scheme with Tiered Visual Effects after Decryption

Zhongshuai WANG, Ruoyu ZHAO, Jiahao LI, Yiming WANG, Yushu ZANG, Rushi LAN, Xiaonan LUO

Frontiers of Computer Science, DOI: [10.1007/s11704-025-50333-z](https://doi.org/10.1007/s11704-025-50333-z)

# Problems & Ideas

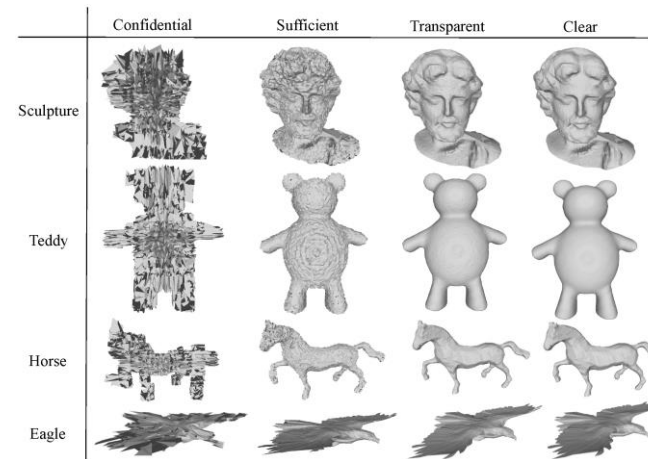
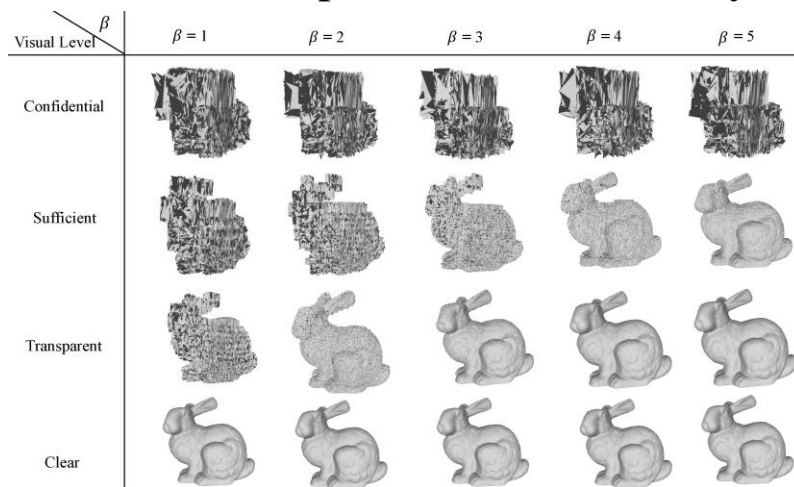
- Problems of conventional 3D models encryption:
  - 3D models encryption uses spatial perturbation, chaotic systems, etc., but these approaches often overlook visual effects.
  - Decrypted models also fail to meet diversified needs—they need to display tiered visual effects while ensuring content protection.
- Ideas: An encryption scheme for generative 3D assets that achieves tiered visual effects upon decryption.



Left: Examples of differentiated visual effects of the encrypted 3D assets. The owner encrypts the original model to a confidential level. Users with different key permissions can present different visual effects.; Encryption overall flow of the proposed scheme.

# Main Contributions

- Contributions:
  - We analyze the method of generating 3D assets using generative AI, and find that high-fidelity and fine-grained 3D assets can easily leak privacy. A fine-grained encryption scheme for 3D models is proposed that supports tiered visual effect decryption.
  - A novel coordinate regularization method is introduced, normalizing the 3D model coordinates into double precision binary according to the IEEE 754 standard.
  - We validate the feasibility and effectiveness of the proposed method on various datasets. Both encryption and tiered decryption achieve certain visual effects and improved time efficiency.



Different visual effect. Left: Bunny visual effects under different parameters, corresponding to tiered visual security levels after decryption; Right: The visual effect of tiered decryption of four different 3D models from the Princeton dataset.