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REVIEWER'S REPORT

Manuscript No.: IJAR-50650 Date: 15-03-2025

Title: Neural Radiance Fields in Space Applications : A Comprehensive Review

Recommendation:
Accept as it is……**YES……**
Accept after minor revision……
Accept after major revision ……
Do not accept (*Reasons below*) ……

Rating	Excel.	Good	Fair	Poor
Originality	√			
Techn. Quality		√		
Clarity		√		
Significance			√	

Reviewer's Name: Mr Bilal Mir

Reviewer's Decision about Paper: **Recommended for Publication.**

Comments (*Use additional pages, if required*)
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Reviewer's Comment / Report

Title & Abstract: The title accurately reflects the content of the paper, providing clarity about its scope. The abstract effectively introduces the concept of Neural Radiance Fields (NeRF), emphasizing their potential in space-related fields. The discussion on applications, challenges, and future directions establishes a solid foundation for the review. The keywords are relevant and appropriate for indexing and retrieval purposes.

Introduction: The introduction provides a strong background on NeRF and its significance in space technology. The discussion highlights the importance of 3D reconstruction and visualization for space exploration and remote sensing. The inclusion of traditional methods such as LiDAR and stereo photogrammetry offers a comparative perspective, reinforcing the necessity of NeRF in overcoming their limitations. The cited references to foundational works enhance the credibility of the discussion.

Background & Importance in Space Technology: The background section clearly explains the technical underpinnings of NeRF, emphasizing its capability to generate photorealistic 3D models from sparse image datasets. The discussion on NeRF's volumetric properties and neural network-driven interpolation provides a comprehensive understanding of the topic. The importance of NeRF in space technology is well-articulated, outlining its potential applications in satellite imaging, planetary

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exploration, and autonomous navigation. The discussion on real-time rendering and astronaut training underscores the broader impact of NeRF in the field.

Scope of Review: The scope of the review is well-defined, with a clear emphasis on NeRF's adaptation for space applications. The identification of challenges, such as varying lighting conditions and computational constraints, adds depth to the discussion. The inclusion of NeRF's role in enhancing satellite imagery, aiding spacecraft navigation, and creating simulated environments ensures a broad yet focused coverage of the topic.

Discussion of Applications: The paper effectively explores NeRF's application in space-related domains. The discussion on high-resolution 3D reconstruction of planetary surfaces is insightful, as it highlights the importance of detailed topographic data for mission planning. The application of NeRF in satellite data visualization and space debris monitoring is particularly relevant, given the increasing number of objects in Earth's orbit. The exploration of NeRF in real-time mission planning and autonomous systems integration demonstrates the potential of this technology in enhancing decision-making processes in space missions.

Challenges & Limitations: The paper provides a thorough discussion on the challenges associated with applying NeRF in space applications. Key challenges such as noise in space data, occlusions, and computational demands are well-addressed. The discussion on the need for optimized NeRF models for space-based applications highlights an area for future research. The computational efficiency concerns are particularly relevant, as space missions often operate with limited onboard processing capabilities.

Future Directions: The discussion on integrating NeRF with advanced technologies such as machine learning, autonomous systems, and real-time rendering presents valuable insights. The potential for NeRF to contribute to mission planning, astronaut training, and space environment simulations is promising. The identification of open research questions ensures that future studies can build upon the existing knowledge base.

Figures & Data Representation: The inclusion of a figure illustrating the increasing number of NeRF-related publications enhances the discussion, demonstrating the growing interest in this field. Proper citations ensure the credibility of the data presented.

Overall Evaluation: The paper successfully provides a comprehensive review of NeRF's applications in space exploration and remote sensing. It effectively balances technical details with broader implications, making it valuable for researchers and practitioners in the fields of machine learning, computer vision, and space science. The structure is logical and well-organized, ensuring clarity and coherence throughout the discussion. The references to foundational and recent works strengthen the paper's academic rigor.

Conclusion: The review paper is well-structured, informative, and insightful, covering both the theoretical and practical aspects of NeRF in space applications. The discussion on future directions ensures relevance for ongoing research. The paper serves as an excellent resource for understanding the intersection of NeRF and space technology.