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Railway sleeper detection and evaluation using Neural Radiance Fields and zero-shot models

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ABSTRACT

Railways are critical infrastructure requiring regular inspection and maintenance. Within the railway system, sleepers are directly related to operational safety and are subjected to frequent safety evaluations conducted either manually or via inspection vehicles. However, the extensive length of railway networks, extreme environmental conditions, and spatial constraints have limited the efficiency and scalability of traditional approaches. To address these challenges, the proposed framework enables efficient and precise evaluation of sleepers without service interruption, leveraging Unmanned Aerial Vehicle (UAV) imagery in conjunction with Neural Radiance Fields (NeRF) and zero-shot models. NeRF is employed to generate dense 3D reconstructions and synthesize close-up views of sleepers, while the zero-shot model is used to segment sleepers in synthesized close-up views without requiring additional training. This initial process effectively enables the clustering of Individual sleepers through RANSAC fitting based on the domain knowledge. Subsequently, segregated sleepers are evaluated by computing their center-to-center distances facilitating robust condition assessment for railway track maintenance. The performance of the proposed framework was validated using the Osong railway testbed, demonstrating both detection accuracy and evaluation efficiency for railway sleepers in accordance with established standards.

REFERENCES

Mildenhall, B., Srinivasan, P.P., Tancik, M., Barron, J.T., Ramamoorthi, R. and Ng, R. (2020), “NeRF: Representing scenes as neural radiance fields for view synthesis”, *ECCV*, 12357, 405–421.

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Liu, S., Zeng, Z., Ren, T., Li, F., Zhang, H., Yang, J., Jiang, Q., Li, C., Yang, J., Su, H., Zhu, J. and Zhang, L. (2023), “Grounding DINO: Marrying DINO with grounded pre-training for open-set object detection”, *arXiv preprint arXiv:2303.05499*.