AI-driven 3D Point Cloud-Based Highway Infrastructure Monitoring System using UAV

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ABSTRACT

Highway maintenance and infrastructure monitoring tasks often involve labor-intensive activities and long inspection times. Examples of these maintenance tasks include landscaping and lawn care, detecting damaged road segments, and identifying missing road signs. While several infrastructure monitoring methods have been proposed, many of them are only carried out using 2D images and do not fully utilize the 3D geometric information in the scene. Additionally, most methods often downscale the data and did not consider the fine resolution needed for inspection tasks. To efficiently automate the maintenance inspection tasks, this research proposes a new approach that combines a data collection framework using Unmanned Aerial Vehicle (UAV) with artificial intelligence (AI)-driven data processing techniques. Structure from Motion (SfM) is used to create dense 3D point clouds from image data and deep learning techniques are used to segment and classify different highway assets. Point cloud-based temporal change detection is carried out with a focus on grass height estimation for monitoring highway mowing operations. A field highway dataset is collected to evaluate the proposed method. Experimental results show that the method achieved 93% semantic segmentation accuracy and 6.31 cm root mean square error (RMSE) in grass height estimation.