HARNESSING ARTIFICIAL INTELLIGENCE, ROBOTICS AND VIRTUAL REALITY FOR ENHANCED ASSESSMENT OF INFRASTRUCTURE IN SMART CITIES

by
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ABSTRACT

The roads in the US received a "D" grade on the 2021 report card for America's infrastructure by the American Society of Civil Engineers (ASCE). Poor road conditions are generally responsible for traffic accidents and vehicle damage, which result in additional expenses for drivers in terms of vehicle repairs and operating costs. To maintain a satisfactory pavement condition over an extended period of time, frequent inspections should be conducted, and any issue should be promptly addressed through effective maintenance practices. However, the current practices are hindered by issues of subjectivity, delayed responsiveness, and high costs. This study aims to develop innovative solutions that harness Artificial Intelligence (AI), robotics, and virtual reality (VR) to enhance pavement quality in smart cities.

An autonomous system has been developed that relies on crowdsourced RGB-D data to assess road conditions. A cost-effective data acquisition system that can be mounted on multiple vehicles, was developed. Armed with a substantial dataset of RGB-D pavement surface data, this study explores the effectiveness of various depth encoding techniques and RGB-D data fusion methods, using pothole detection as a case study. Comprehensive experiments were conducted to evaluate the effectiveness of defect detection using deep convolutional neural networks (DCNN). This study further considers all types of pavement defects to provide a comprehensive evaluation of pavement conditions. The Pavement Surface Evaluation Rating (PASER) for asphalt pavement is used as a case study. The establishment of an expert system for pavement condition evaluation involves the classification and quantification of pavement data. The system also facilitates the tracking of identified defects and repair work, providing up-to-date information on pavement deterioration and maintenance.

Another aspect of this study is the improvement of pavement maintenance quality. To enhance the effectiveness of pavement maintenance tasks, this study developed immersive VR modules that provide technical staff with a supplementary platform for training. The training materials focus on two essential pavement maintenance operations: crack sealing and patching. These modules include an interactive decision-making module for evaluating the quality of operations, as well as a hands-on task-performing module for crack sealing machinery preparation and the procedure of full-depth patching.