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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Notes

Point cloud feature extraction for ADA ramp compliance assessment

The Advance Highway Maintenance and Construction Technology (AHMCT) Research Center proposes to develop machine learning tools for automated Americans with Disability Act (ADA) curb ramps at pedestrian crossings (CRPC) feature extraction from point cloud Mobile Terrestrial Laser Scanner (MTLS) data.

Construction

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Project Title:
Point cloud feature extraction for ADA ramp compliance assessment

Task Number: 4189

Start Date: November 1, 2022

Completion Date: October 31, 2024

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WHAT IS THE NEED?

The purpose of this research is to develop, evaluate, and test automated algorithms that extract ramps from MTLS data and subsequently make quantitative measurements to ensure of their ADA compliance.

WHAT ARE WE DOING?

Develop machine learning tools for automated ADA CRPC feature extraction from point cloud MTLS data. This project will initiate with extensive literature review and feasibility study. The purpose of this phase of the study is to learn about the latest techniques in point cloud feature extraction and the associated limitations. AHMCT will further develop technologies that automate conduction of quantitative measurements from the extracted features to ensure of compliance and identify CRPCs that require repair or modification.

WHAT IS OUR GOAL?

The feasibility study will help identify ways in which the process of CRPC extraction can be simplified for the human operator. This can range from complete to partial automation in which human operator still participates in CRPC extraction in a limited role, hence, speeding up the process.

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WHAT IS THE BENEFIT?

The developed deep learning techniques and algorithms will be made available to Caltrans team for continuous use. This will be accompanied by guidelines on operator involvement in order to maximize the reliability of the overall process.

WHAT IS THE PROGRESS TO DATE?

Manual annotation is being done while evaluating various annotation approaches. The next task is to developed 3D convolutional networks for extraction of ADA ramps from point cloud data. In this stage machine learning networks extract the approximate location of the ramps in the form of a bounding box (see Fig. 1). Secondly is to develop deep neural networks for the purposes of segmenting the exact boundaries of the ADA ramps. Implementing and testing the segmentation methods were initiated as shown in Fig. 2. 3. An example shown in Fig. 3 is the extraction from preliminary result. Regarding the task on design of network for CRPC measurement, the processing takes place from the obtained results. Some preliminary results on such measurements is shown in Figures 4 and 5.

The next steps for this task are to manage the project with in-house annotation efforts, as well as development and testing of convolutional networks for ramp bounding box and segmentation extractions for the design of networks for CRPC extraction. Lastly, an effort to improve measurement extraction algorithms will continue for the design of networks for CRPC measurement.

IMAGES

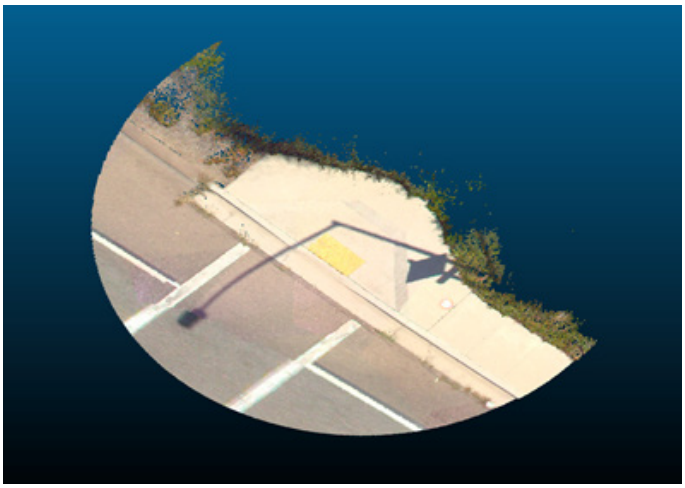

Image 1: Bounding box detection of ADA ramps.

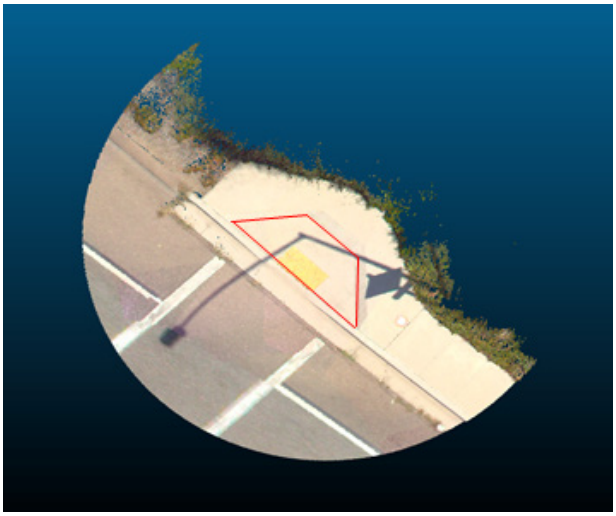

Image 2: Accurate segmentation of ADA ramp for a given bounding box extraction result.

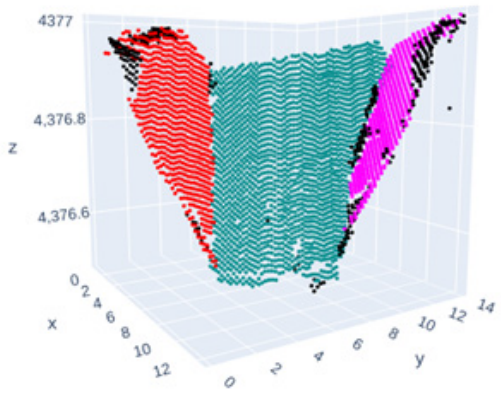

Image 3: Upon segmentation of the ramp, individual ramp planes (left and right flares as well as the main ramp) are extracted.

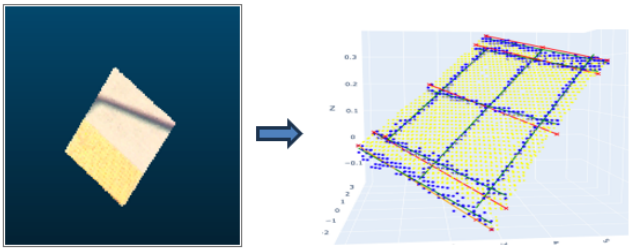

Image 4: Upon extraction of the main ramp, through geometrical analysis the running and cross slopes as well as ramp widths are measured (populated in the corresponding tables, shown in Image 5)

Ramp Slope (x.x%)		Ramp Cross Slope (x.x%)		Ramp Width (inches)	
A1	8.4%	B1	2.25%	C1	46.73
A2	7.74%	B2	2.34%	C2	46.81
A3	7.56%	B3	3.5%	C3	46.89
7.7% or less? ☐ Yes ☐ No		1.7% or less? ☐ Yes ☐ No		49.75" or greater? ☐ Yes ☐ No	

Image 5: An example set of extracted ramp slope, ramp cross-slope and ramp width. These are preliminary results. The algorithms are still in development.