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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Notes

Point cloud feature extraction for ADA ramp compliance assessment

The Advanced 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

MAY 2024

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

Task Number: 4189

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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?

Task 1 - Manage Project: Three panel meetings were conducted between January and April 2024. Regular internal weekly meetings between the staff and team members are being held to discuss the issues and track the progress of the study.

Task 2 - Literature Review and Feasibility Study: This task is completed.

Task 3 - Manual Annotation: Development of the annotation procedure has been completed. This includes annotation instructional video which describes the step-by-step annotation process. This video was shared with a third-party company, which was hired to perform annotations in conjunction with the in-house annotations. Also, three additional ADA MTLS dataset from District 3 Survey were obtained. The new datasets were then post-processed to add colors and classification. ADA ramp measurement data from Caltrans were obtained which will allow comparison of the results of the algorithm. This task is in progress. Additional measures have been taken to put task schedule recovery into effect.

Task 4 - Design of Networks for CRPC Extraction: There are two main challenges encountered in this quarter: First the data rarity and the other one is the high dimensionality of point clouds. This task is in progress.

Task 5 - Design of Networks for CRPC Measurement: There were continuous advancements in the measurement pipeline for ramps. The approach segments the ramp edges to find key points at 1/10th, 5/10th, and 9/10th of each edge that serve as initial references for measurement lines. Due to the nature of point clouds in the wild, there was a need to refine these initial lines to better fit the data by iteratively adjusting and validating against the geometric criteria of the ramps. The process involves identifying potential candidate points close to the initial reference lines and progressively discarding outliers that deviate more than 0.75 inches from the proposed fit. This iterative fit continues until no significant deviations are detected, ensuring the accuracy and reliability of the measurements. By applying these methods, a robust fit that accurately represents the ramp's physical characteristics, enhancing both the precision and efficiency of the ramp assessments has been achieved. This method has been applied not only to the main ramp but also to the flares and the gutter. This task is in progress.