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Construct and maintain a highway digital twin from multi-modal data

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Background & Motivation

- Current modelling process requires much human effort
- Some modalities can provide complementary information
- Explore the possibilities of using all available modalities of data to improve the reconstruction process

Objectives

1. Register thermal information with other modalities of data (geo-referenced point cloud data)
2. Anomaly and defect detection in GPR data for asphalt and concrete pavement
3. Use multiple modalities of data to improve the object/defect recognition

Research Summary

- Develop a framework that segment pavement into individual lanes and store the relative information into graph database
- Defined a framework to generate thermal point cloud from the thermal images
- Process the GPR data and annotate the resulted segments for machine learning model
- Design network architecture to classify GPR segments into different classes

Point cloud-to-Graph

Constructing geometric digital twins of highways at present still demands substantial human effort. Unlike most previous work that uses deep learning models to segment point clouds of highways into class level or object instance level, we further segment pavements into a more detailed level (lanes, hard shoulders, central reserves). The central curves of each lane marking are fitted in a two-step method, approximated by a polynomial and then converted into the Frenet coordinated system.
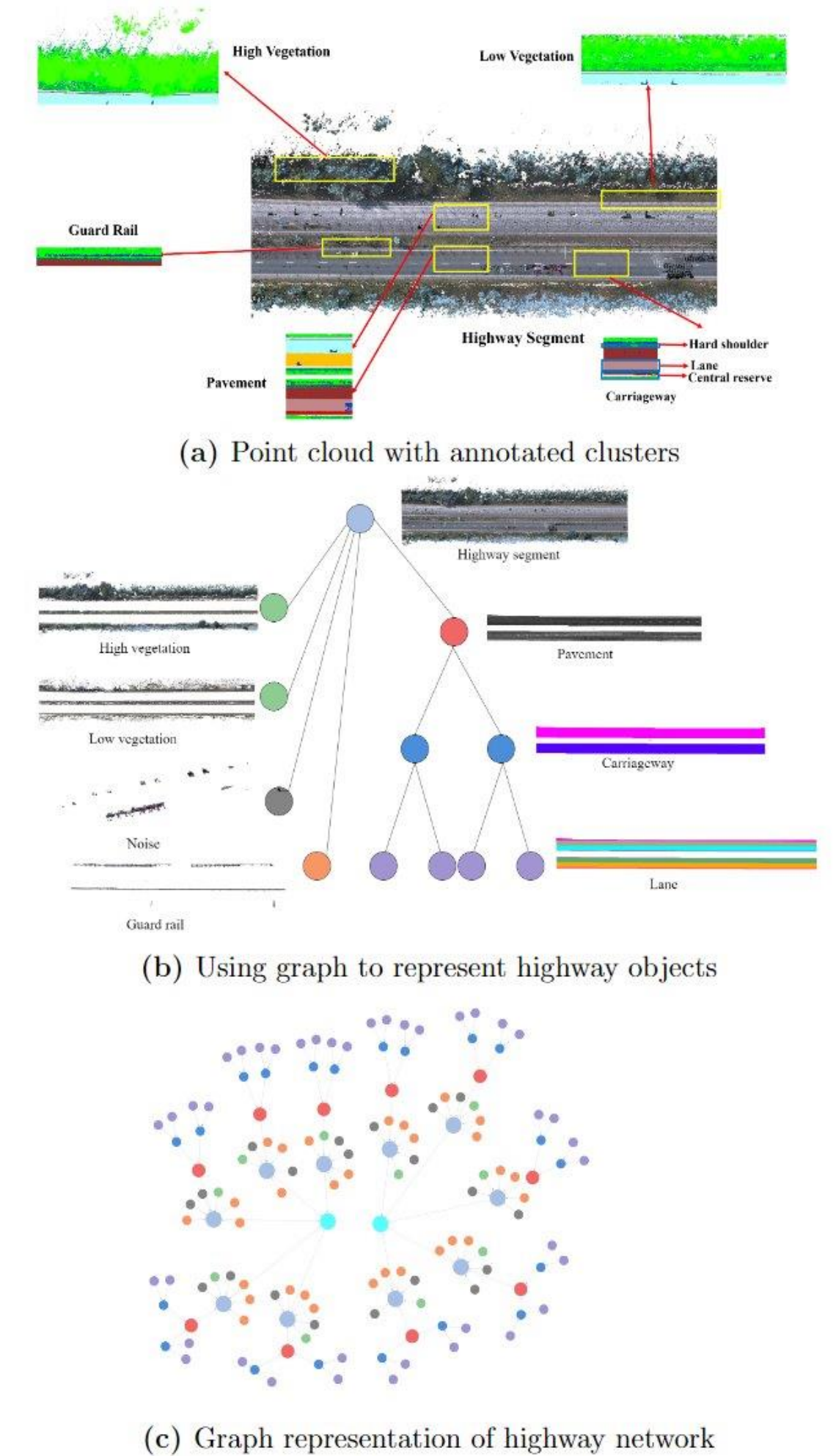

(a) Point cloud with annotated clusters

(b) Using graph to represent highway objects

(c) Graph representation of highway network

Fig. Scan to graph for highways [1]

What next?

1. Prepare more annotated GPR data with more classes
2. Design more networks for GPR segment classification
3. Use unsupervised process to analyse GPR data, trying to distinguish anomaly from huge amount of data
4. Prepare experimental samples for collect GPR data with ground truth

Acknowledgements

References:

[1] Pan, Y., Wang, M., Lu, L., Wei, R., Cavazzi, S., Peck, M. and Brilakis, I., 2024. Scan-to-graph: automatic generation and representation of highway geometric digital twins from point cloud data. Automation in Construction, 166, p.105654.