UNIVERSITY TRANSPORTATION CENTER
RESEARCH BRIEF

# 3D structural information sensing system (3D-SISS) based on Road-side Unit (RSU)

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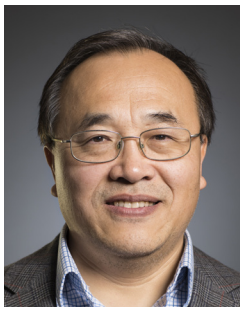


## Background

Environment perception and understanding remains a challenge for ADAS (Advanced Driver Assistance Systems). Specifically, precise 3D detection of vehicles and pedestrians, and understanding road users' intentions, are needed for roadway traffic decision making and parking assistance. This project aims to address the perception challenge by developing a cooperative perception method that fuses sensor information from vehicle-onboard and roadside devices, to extend sensing ranges and improve sensing reliability. Considering the limited computational and storage resources on the edge-side, edge-device-based artificial intelligence algorithms will be employed for enhancing the efficiency of the proposed methods without losing accuracy.

## Research Project

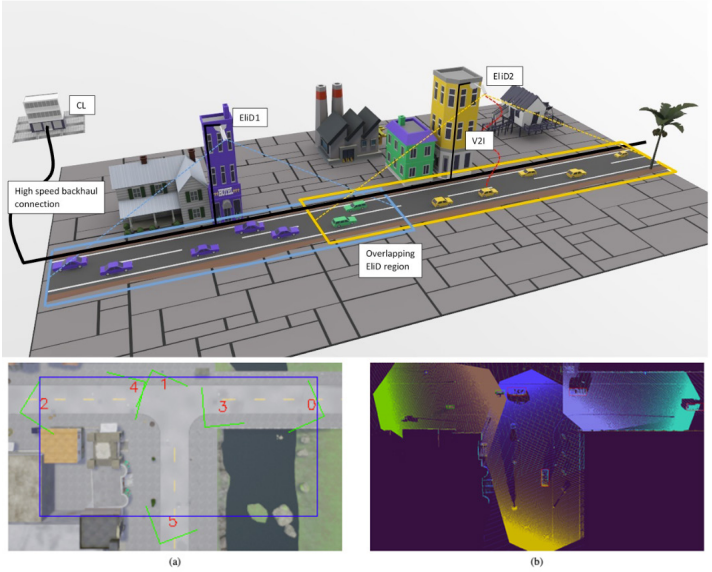
The research conducted in the project can be divided into four parts:

1) Vehicle Detection and Classification: Any object detection algorithm like SSD, YOLO, Mask-RCNN can be used in the system to realize vehicle detection. The input of the step is the image data collected by the surveillance camera system, and the output contains the region of interest (ROI) and the classification result (category with the highest confidence score).

2) Visible Keypoints Detection: The output ROI will work as the input in the step. Hourglass network (Newell et al., 2016) is employed to extract the features of the vehicles in multiple scales. With the integration of the features extracted in multiple resolutions, the algorithm can detect the predefined visible car-keypoints for the target vehicles.

3) Invisible Keypoints Prediction: Then the paper takes advantage of Keypoint Graph Neural Network (2D-KGNN) (Reddy et al., 2019) to predict the occluded keypoints based on the detected visible keypoints. The output of the step is the pre-defined the vehicle keypoints (including visible and invisible keypoints).

4) Automatic 2D keypoints to 3D structural information projection: There are two inputs of the step: 1) vehicle category determined in by object detector; 2) 12 vehicle keypoints determined by Hourglass Network and 2D-KGNN. Based on the vehicle category, the mean shape and the corresponding standard deviation of the vehicle are used to project 2D keypoints to 3D. Then, the camera calibration matrix is applied to the 3D keypoints to realize automatic camera calibration.




## ABOUT THE AUTHORS

The research team consisted of Yinhai Wang of the University of Washington.

## ABOUT THE FUNDERS

This research was funded by the Pacific Northwest Transportation Consortium, with additional support from the University of Washington.

## EXPECTED DATE OF COMPLETION

March 2023

## FOR MORE INFORMATION

https://depts.washington.edu/pactrans/research/projects/3d-structural-information-sensing-system-3d-siss-based-on-road-side-unit-rsu/