FACT SHEET

High-Resolution Micro Traffic Data from Roadside LiDAR Sensors for Connected-Vehicles and New Traffic Applications

PROJECT TITLE

High-Resolution Micro Traffic Data from Roadside LiDAR Sensors for Connected-Vehicles and New Traffic Applications

STUDY TIMELINE

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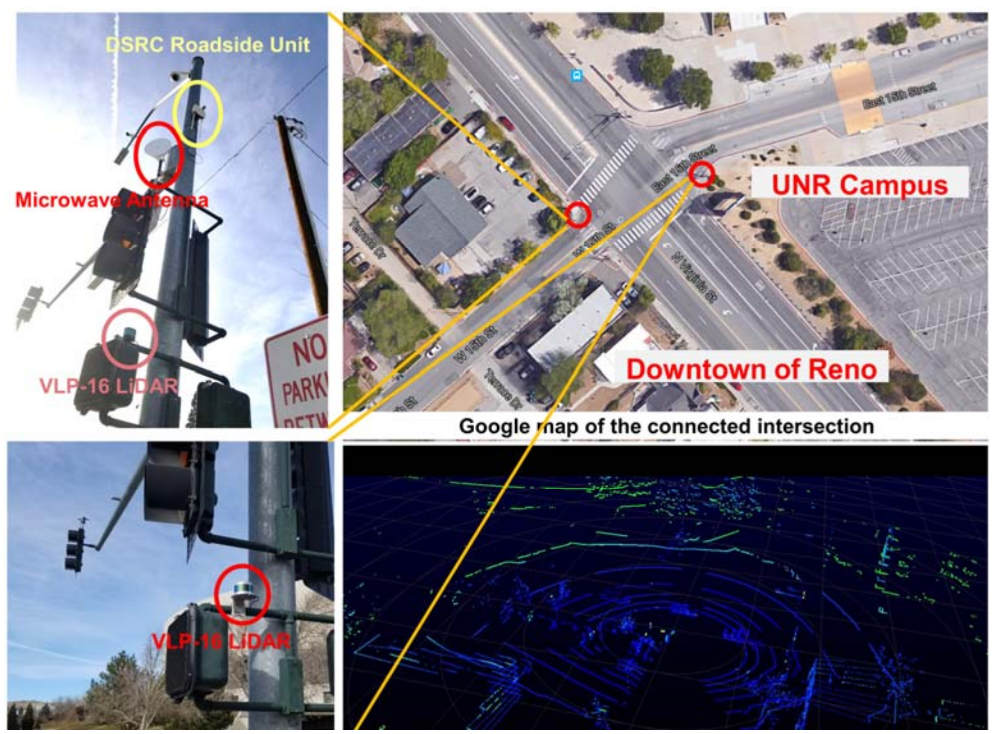
Introduction

New traffic systems and applications, such as connected and autonomous vehicles and near-crash analysis, require traffic flow information with more details and higher accuracy - specifically, all-traffic trajectories not provided by traditional traffic sensors. 360-degree light detection and ranging LiDAR sensors can provide high resolution data because they detect surrounding objects with high accuracy and frequency and are not influenced by light conditions. The project team explored LiDAR sensors to solve this need and developed algorithms specifically for roadside LiDAR sensing systems. Due to sensor installation and data characteristics, methodologies for roadside LiDAR data processing are different from the methods used in autonomous vehicles technologies.



Methodology or Action Taken

The project team developed a procedure for roadside LiDAR data processing, including major steps of background, object clustering, identification of road user types, tracking road users in different data frames, and output of traffic trajectory data.

This project developed a procedure, including multiple algorithms, for generating high accuracy multimodal traffic trajectories with roadside 360-degree LiDAR sensors. The developed data-processing procedure first excludes points of background objects such as road surface, trees, and poles; then, it clusters left points into objects that are multimodal travelers; it further classifies those objects into pedestrians, vehicles and other road user types. The procedure calculates each road user's location with x-y-z coordinates of clustered points and estimates their speeds based on time difference and location change in continuous data frames. Finally, trajectories including road user type, location, speed and

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FURTHER RESOURCES

https://www.nevadadot.com/home/showdocument?id=16037 direction information are obtained. To demonstrate applications of roadside LiDAR, this project applied trajectories from roadside LiDAR for prediction of pedestrians crossing roads, pedestrian-vehicle near-crash analysis, and detection of wildlife animals crossing highways. The major achievements of this project are summarized below:

1) Development of an automatic LiDAR background filtering algorithm
2) Development of an algorithm to extract trajectories of road users from roadside LiDAR data
3) Development of an algorithm to identify different road users with roadside LiDAR data
4) Development of an integrated procedure for processing high-resolution cloud points from roadside LiDAR and extracting multimodal traffic trajectories
5) A pilot application of roadside LiDAR to detect and predict pedestrians crossing roads based on LiDAR trajectory data
6) A pilot application of roadside LiDAR to define and extract near-crash events
7) A pilot application of roadside LiDAR to detect wildlife animals crossing a highway

Conclusions or Next Steps

Road-side LiDAR is new technology to fill the data gap of unconnected multimodal traffic in connected and autonomous traffic systems and will innovate traffic engineering/research areas with all-traffic trajectory data that was not available in traditional traffic sensing systems. The methods for processing roadside LiDAR and pilot applications of using LiDAR trajectory data will serve as a foundation for new connected/autonomous traffic infrastructure advanced by 360-degree edge LiDAR sensors. Applications of real-time and offline LiDAR trajectory data are being studied.

Potential Impacts and Benefits

This project developed methodologies for obtaining high-accuracy all-traffic trajectories with 360-degree LiDAR sensors deployed at the roadside. The data processing procedure developed in this project provides trajectory-level movement status of all road users in the sensing range that can be an intersection, an arterial or a city road network with roadside LiDAR sensors deployed. The all-traffic trajectory data are essential to connected and autonomous vehicles to perceive traffic situations or threats outside the “sight of view” of onboard sensing systems. The data could also bring revolutions to conventional traffic engineering areas. For example, accurate pedestrian trajectories can be used for pedestrian behavior studies to improve pedestrian safety; Roadside LiDAR can trigger pedestrian signals automatically according to real-time location, speed, and direction information. LiDAR equipment will continue to get less expensive enabling widespread installation at major intersections and roadway segments. There is potential for LiDAR to bring down pedestrian fatalities significantly with targeted deployments in urban area intersections. Each fatality resulted in an average discounted lifetime cost of $1.4 million (NHTSA, 2015 data). Nevada had a total of 79 pedestrian fatalities in 2018 and more than 100 pedestrian fatalities in 2019. Potential benefits from appropriate applications of LiDAR are estimated to be nearly $9M per year for Nevada.