A Feasibility Study for Increasing Pedestrian Safety

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Current Project Status

- Just submitted revised IRB study application
    - Recruitment of volunteers
    - Planned activities
    - Collecting, storing and protecting data
    - Specified use of Chameleon and CHI@Edge resources
    - Human subject training
- Learning to use CHI@Edge
    - Created project – "Edge on the Border"
    - Currently having some problems with authentication creating container or problems running the container once created
    - Some experience – have used AI containers on PSC Bridges-2 GPU nodes
- Pricing LiDAR devices
- Investigating data analysis and machine learning techniques for near-miss analysis
- Getting access to sample data sets

Motivation

- Across the city of El Paso, there have been 1,261 traffic incidents involving pedestrians and motorists since 2015, and roughly 10.5% were fatal, resulting in 119 deaths.
- Downtown El Paso and the Chihuahuita neighborhood have the highest density of collisions involving pedestrians.
- Across the U.S., the pedestrian death rate rose during 2020 despite fewer miles driven during the pandemic.
- 2019 pedestrian fatality total was the highest in 30 years, exceeding the previous 30-year high from 2018 and up nearly 50 percent over the past decade.
- It is crucial to determine the factors contributing to this increase, identify high risk areas, and develop mitigation strategies in order to save lives and prevent injuries.

Goals of this Study

- Determine requirements for the number and most effective placement of LiDAR sensors and video cameras needed to collect near-miss data.
- Devise a plan for procuring, installing, and maintaining LiDAR devices and video cameras and meeting associated computing and communication requirements, including costs and involvement of city government and stakeholders.
- Devise a plan for collecting, managing, and providing access to data for conducting near-miss analysis.
- Develop a strategy for optimizing where to carry out data processing and analysis – i.e., on edge computing devices vs. the cloud datacenter.
- Evaluate data analysis and machine learning techniques to determine best approaches for near-miss analysis.

LiDAR

- Stands for Light Detection and Ranging.
- LiDAR sensors work by transmitting a stream of laser light into the environment. When the light hits an object, it is reflected back to the sensor. As the laser scans, the sensor creates a three-dimensional rendering of the object by measuring the amount of time it takes for the reflected light to return.
- LiDAR systems can distinguish between cars, trucks, pedestrians and bicycles.
- Roadside LiDAR systems have no facial recognition capability and thus do not violate citizens' privacy.
- Data can be converted into information about vehicle and pedestrian trajectories.

Near-miss Analysis

- A pedestrian-vehicle near-miss is defined as a situation in which a vehicle had to abruptly brake or swerve to avoid striking a pedestrian or a pedestrian had to take sudden evasive action to avoid being struck.
- Near-miss analysis on a much larger dataset allows crashes to be predicted more reliably than using crash datasets.
- Near-miss data can help identify where improvements such as additional crossings, reduced speed limits, speed bumps, or better lighting are needed.

Near-miss Analysis Literature

Junxuan Zhao, Hao Xu, Hongchao Liu, Jianqing Wu, Yichen Zheng, Dayong Wu, Detection and tracking of pedestrians and vehicles using roadside LiDAR sensors, Transportation Research Part C: Emerging Technologies, Volume 100, 2019.

Jianqing Wu, Hao Xu, Yongsheng Zhang, Renjuan Sun, An improved vehicle-pedestrian near-crash identification method with a roadside LiDAR sensor, Journal of Safety Research, Volume 73, 2020.

Jianqing Wu, Hao Xu, Yichen Zheng, Zong Tian,
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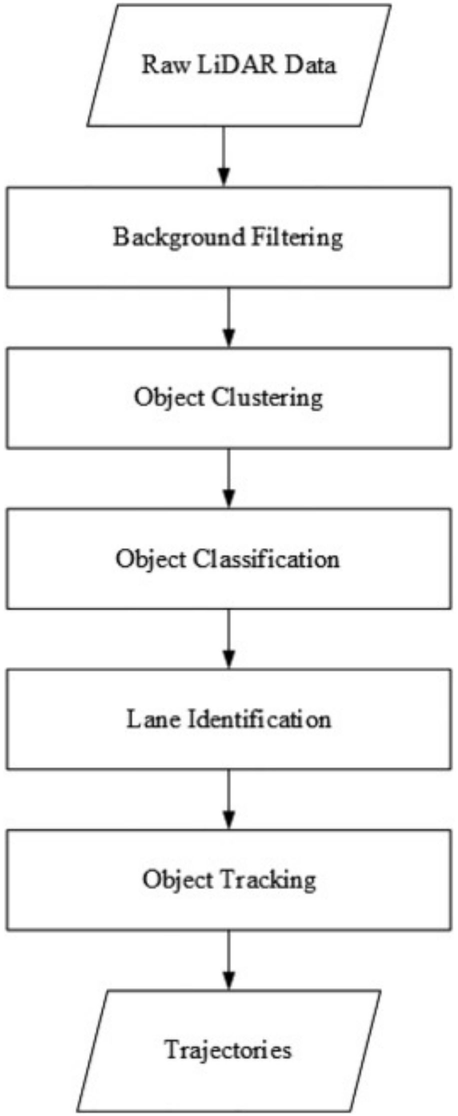
Accident Analysis & Prevention, Volume 121, 2018.

Wu J, Xu H, Tian Y, Pi R, Yue R. Vehicle Detection under Adverse Weather from Roadside LiDAR Data. Sensors (Basel). 2020 Jun 17;20(12):3433. doi: 10.3390/s20123433. PMID: 32560568; PMCID: PMC7348835.



Sample Datasets

- ASU Pedestrian LiDAR Scenes (APLS) Dataset
  - https://asulidarset.github.io/
  - https://github.com/asulidarset/APLS-sample
  - Data collected using Velodyne HDL-32e device
  - Process using Velodyne Dataset Utilities
    - https://github.com/michaelsaxon/velodyne-dataset-utils
- Velodyne datasets and Veloview visualizer
  - https://velodynelidar.com/downloads/#software%20first
- Chattanooga MLK Smart Corridor
  - UT-Chattanooga collaboration with Chattanooga DOT
  - New NSF grant for expansion (LiDAR sensors, shared access)

Requirements and Plans for CHI@Edge Testbed

- Ideally would like to connect our LiDAR sensors and video cameras to the CHI@Edge infrastructure
- Orchestrate data and computation from edge to cloud considering
  - Performance optimization
  - Privacy constraints
- Evaluate different options for edge servers
  - Video analytics on the edge requires more computational power
  - Specialized processors for lower power consumption (e.g., GPUs or NPUs/TPUs for machine learning)
- Evaluate strategies for data transfer, storage, and access with respect to
  - Performance
  - Reproducibility
  - Privacy and confidentiality
  - Sharing with other researchers

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