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1. Data Description for project: Roundabout Connected/Automated Vehicle Active Inference Control Strategies to Improve Safety for All Users

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Project description

The data collected will be produced from the project, “Roundabout Connected Automated Vehicle Active Inference Control Strategies to Improve Safety for All Users”. The purpose of the project is to implement roadside sensing and autonomous connected vehicle architecture that will perceive and broadcast sensor state estimates of Vulnerable Road Users (VRUs) and Vehicle traffic within unsignalized, roundabout intersections. The proposed project is broken into two phases. Specifically, the first phase (e.g. Phase-I) focuses on developing and deploying roadside sensing infrastructure to perceive the VRU and vehicle-based traffic maneuvering and interacting within a typical urban roundabout design, and to then generate standardized messages (BSM) to accurately describe and broadcast the state estimates to connected/autonomous vehicles.

Generated data and collection methods.

Several sensor-based datasets will be collected from roadside and onboard CAV sensors temporally aligned with a common date-time reference. We plan on all data collection experiments will be conducted under naturalistic driving and traffic conditions entering and within an actual urban roundabout. Due to practical data transfer limitations and the anticipated size of the collected datasets, most raw data will be initially harvested either within edge-based, or local processors. The collected and processed data are described as follows:

1. Video data which capturing vehicle and VRUs (Vulnerable Road Users) maneuvering and crossing events approaching and within a roundabout intersection. Video data that are exemplars for training and validation for perception, classification, and motion prediction models will be retained. A standard video compression format will be selected that is compatible with several playback and data manipulation processing software (H.264, H.265, or MP4 formats).
2. Processed data of vehicle and VRU state estimates (position and velocity), classification predictions (ped/bike/vehicle type), boundary and their ‘tracklet’ IDs to construct trajectories. Such data will be stored using comma separated (CSV) file formats. In addition the trajectory data will contain information to link the resolved trajectories with their raw sensor source representations; for example, pixel locations and region of interests for 2D images, and 3D bounding regions and their locations for 3D sensor output.
3. BSM processed data. Similarly, the trajectory data processed to Basic Safety Message data will be generated associated with the aforementioned state of all sensor estimated and detected users.
4. 3D point cloud data over time. LiDAR data described within the common reference frame that will be used to described trajectory information of vehicles and VRUs. Data representing the exemplars for training and validation of perception and classification, and prediction algorithms will be retained.
5. Ground-truthed/labeled datasets, will contain manually labeled and identified road users, and the objects of interest bounding boxes data. We intend to use csv text format to represent these elements. This may be a subset of the retained dataset.

6. Timestamped CAV ego-sensor datasets containing vehicle state estimates (DGPS Kinematic, vehicle speed) for drive-thru maneuver scenarios during intersection sensor data collection periods. A representative subset of the other onboard sensor collected data (Radar, LiDAR, and front-facing cameras) will be provided that complies with PURR storage allocations.
7. Source-code for displaying, fusing, outputting, ingesting, and post-processing of collected data.

Anticipated data collection periods

A specific daily, or weekly schedule will be determined and activated/de-activated throughout the project period by project team members. Such periods may include, AM/PM, and mid-day peak conditions, as well as possible weekend traffic periods. Data should express variability in environmental, seasonal, traffic, and lighting conditions.

Human subjects

We do not anticipate any individual human subject data to be collected, or any privacy concerns for the field data.

Broader impacts of the data (value and user-base)

Such an ensemble sensor dataset of in-vehicle and roadside at the roundabout in diverse environmental and traffic conditions, will provide a unique opportunity to further research spanning robotics and autonomous vehicles (counterfactual and simulation studies), sensing and perception, AI, and urban traffic management and operations within the University of Minnesota and partnering CCAT institutions. The data will advance the U of Minnesota Robotics MS program and related courses, such as machine learning and computer vision, by providing students with project opportunities. The Robotics MS program, for example, is heavily focused on research. All students need to complete at least a capstone project. As the number of students grows (it is currently the fourth-largest program in the College of Science and Engineering), the data collection and organization will impact a variety of these capstone projects by giving students the opportunity to blend machine learning and computer vision with robotics. Hands-on activity modules using the data and associated research results for summer robotics camps (ongoing for 15 years) and Center for Transportation summer camps could be developed to spark participant interest in STEM related fields.

The datasets may also be useful for practitioners and traffic engineers to further their understanding of traffic behaviors in roundabout intersections and the efficacy of roadside and in-vehicle sensors.

Management plan

Data to Be Managed

The research efforts will involve two types of data: (i) physical and (ii) digital. The physical level refers to the components of the systems (e.g., roadside sensors, communication and power interfacing hardware, and processing hardware) that will be either modified or developed. Digital data will include the datasets collected and metadata (e.g., technical specifications documents, papers, reports, bills of materials, etc.). The metadata data documentation will follow DMP guidance set forth as described for NSF standards (<https://dmptool.org/general> guidance). The datasets, described earlier, consists of both raw data and processed data to be managed. The raw data are sensor outputs (roadside or CAV video and LiDAR). The processed data are vehicle and pedestrian tracks, as well as sensor calibration data. The database will also provide references published articles or reports that use or generate the data.

The PI, Morellas, and Co-PI Morris, will have full access control to the data in order to add, or modify, information during the course of the project (metadata, and data). The PI or Co-PI may grant similar access

to additional U of Minnesota project team members (staff or students). The Regular version control backups with entered change logs, will be stored to a separate, password protected, University of Minnesota repository will be done by the team members as a safeguard against accidental modifications or deletions.

Expected Data

The project will create hardware, processed sensor data, and software. The collected data will provide a unique combination of information about vehicle and vulnerable road user movements within a roundabout intersection. During the project, we plan to set up a database for the management and dissemination of this data. The data will be managed in accordance to the federal regulations. All data to be released will be labeled and documented, the involved hardware systems and their configurations will be listed, and example data ingestion and post-processing code will be provided. Finally, we will continuously support researchers and other users that utilize our data. The software includes three primary forms: 1) the software that provides the experimental framework (data collection and temporal synchronization from roadside and/or in-vehicle sensors), 2) the software for sensing different vehicles and VRUs, and 3) software developed for generative action sequence policies and environment state predictions.

Period of Data Retention

The data retention period within the University of Minnesota is five years after the conclusion of the project. We will release data as soon as we have them available to the distrob.cs.umn.edu and cse.umn.edu/mnri sites. Since this is Fundamental Research, we do not plan to place restrictions or delay their publication. Data will be disseminated through one, or more, of the following: seminars, workshops, papers, or webcasts. At the conclusion of the project, we will transfer the data that can be within the provided storage limits for PURR (Purdue University) conformant with the CCAT DMP, within the terms of deposit (<https://purrr.purdue.edu/legal/termsofdeposit>) and intend to license its dissemination through the CC-BY4 license, a Creative Commons License supported by PURR (<https://purrr.purdue.edu/kb/licensingrestrictions/licenses>).

Data Formats and Dissemination

Before submission to PURR at the conclusion of the project, the data will be posted on the websites. All the software code will also be available in the form of executable files until the code freezes (when source files will also be available). All the developed algorithms will be shared with the community without the involvement of royalties or licensing fees. At this stage, we plan to operate as an open source for this research project. A comprehensive website will contain all the software along with README files, containing descriptions of data files, variables, and instructions for any necessary processing and usage. We will also organize workshops at Minnesota Robotics Institute (MnRI) event and explore similar opportunities at conferences. The goal is to create a venue where all the challenges are discussed.

2. Change Log

Version	Date	Description
1.0	12/14/2024	Initial draft release submission to CCAT