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Performance Analysis of an Automated Vehicle

Two Sentence Elevator Pitch:
Automated driving requires that the intelligent system perceives the drivable corridors that are available for the vehicle and other traffic participants. Students on the Bosch team will use AI and/or machine vision techniques to create tools for analysis of performance of autonomous vehicles. This project includes a summer internship at Bosch in Plymouth, MI working for a leading automotive supplier.

Abstract:
Automated driving requires that the intelligent system perceives the drivable corridors that are available for the vehicle and other traffic participants; and ensures the safety of the path planned for the ego vehicle. The development of the algorithms required to monitor the roadway and the other vehicles requires rigorous testing to ensure the accuracy and precision of the data. The students on the Bosch team will create a set of tools using AI/machine vision to evaluate multiple facets of automated driving performance including lane keeping of the ego vehicle and identification of the location of other vehicles on the road ahead.

Impact:
Automated evaluation of the performance characteristics of automated driving systems will improve the reliability of the analysis while simultaneously reducing the labor required to perform the analysis. Currently this is all done manually, or not performed at all. These tools will allow efficient and uniform benchmarking to occur, and will therefore support development and evaluation of new algorithms.

Scope:

Minimum Viable Product Deliverable (Minimum level of success)

- Prototype data collection system, including camera positioning and calibration.
- Develop an algorithm (tool) on a training data set to provide the relative position of a test vehicle to the lane lines.
- Identify when a vehicle ahead of the test vehicle abruptly moves in or out of the lane the test vehicle is in (called cut-in and cut-out).

Expected Final Deliverable (Expected level of success)

- Validate algorithm performance on the lane position and cut-in/cut-out on sample data (Bosch to provide).
- Deliver polished toolchain that can handle common input video types.
- Thorough documentation.
- Reasonable regression test suite for tools to verify basic functionality.

Stretch Goal Opportunities (High level of success - May include one or more of the following)

- Develop and validate an algorithm for one or more of the additional key performance indicators noted below:
    - Tool runs real-time on a smartphone, using smartphone video camera (without loss of performance).
    - Tool is multiplatform (Windows, Linux)
        - For Lane Position: Extraction of: Vehicle Speed (longitudinal), Lateral Speed (relative to lane marking), Lateral Acceleration (relative to lane marking), Detection of lateral oscillations (relative to lane markings), Quantification of lateral oscillations (relative to lane markings), and/or Analysis of necessary image resolution and mounting relationship, For Cut-in/Cut-out: Estimate target vehicle distance at event, Estimate target vehicle lane entry/exit lateral velocity, Estimate target vehicle longitudinal speed, Accuracy > 99% on test data, timing accurate to +/- 33ms.
    - Additional, appropriate output file formats (matlab, .mf4).
    - Logging standard vehicle signals from CAN (speed, etc.), synchronized to other data.

Student Skills:

MDP Sponsored Projects are both a professional and academic learning experience for students. By participating in this program, students are actively preparing for graduate school and a professional career. As part of the experience, MDP expects professional behavior. To best prepare you for future professional opportunities, your experiences on this MDP team will be very broad. In addition to key technical skills that you will bring to the team, you will engage deeply in the self-directed learning of new and important concepts, demonstrate flexibility, collaboration, and cooperation, and develop strong professional communication skills. This also means that you will need to be able to work outside of your traditional area of study in the true multidisciplinary nature of our projects. You won't always be able to anticipate how your skills and expertise will be used, so the MDP Sponsored Project will challenge you to grow and develop as a professional.

Project Area	**Specific Skills**	**Likely Majors**
General Programming (3 – 4 students)	Strong interest in developing machine vision skills. General skills in programming. Must have completed EECS 281 or equivalent and highly motivated to develop AI/Machine Vision skills.	CS (BS-E/BS-LSA)
Machine Vision Algorithms (1 – 3 students)	Prior or co-current coursework and/or practical experience in Machine Vision. Ideally EECS 452.	ROB (MS/MSE) EE (MS/MSE) Other students with prior experience/coursework in MV.
Systems Engineering (1 – 2 students)	Systems integration	ISD-System (MEng) MECHENG (MS/MSE)

	Highly motivated to develop AI/Machine Vision skills.	EE (MS/MSE)

Additional Desired Skills/Knowledge/Experience

Any of the following Skills, Knowledge, Experience, Interest or Outlook, would be valuable to the 2020 team. We don't expect students to be familiar all or even most of the technical items, but strong candidates will have familiarity or experience with *some* of them and a positive attitude to learn what is necessary as the project gets underway. Please highlight your experience with any of the items on this list in your personal statement on the application.

- Exposure to machine vision and Artificial Intelligence
- Interest in automated driving
- Valid US Driver's license with no points
- Experienced highway driver
- Interest in vehicle performance driving/vehicle dynamics
- Effective in communication – written/oral, technical and business format
- Awareness of agile development methods

Location:

Most of the work will take place on campus in Ann Arbor with the possibility of travel to Bosch in Plymouth, MI for visiting facilities and periodic touch points (MDP will provide travel to Plymouth location).

Sponsor Mentor:

Scott Fohey

Scott has been working for Bosch since 2006. He has his BSE EE from the University of Michigan in1996. He has experience in many software domains and languages, automotive powertrain control software and electronics, machine controls, and manufacturing.

Executive Mentor

Dushyant Wadivkar
Engineering Director

Dushyant Wadivkar leads multiple system software teams focused on making highly automated driving a production reality as quickly and safely as possible. His teams concentrate on highway applications for passenger cars and specialize in system safety engineering, feature and core algorithm development and vehicle motion control service needs for Bosch customer projects. His specialties includes vehicle dynamics, control theory, automated driving, functional and non-functional design of safety critical software. He graduated with a Master of Science degree in Mechanical engineering from the University of Michigan, Ann Arbor in 2004 and has been with Bosch since 2006.

Faculty Mentor

Kerby Shedden, Ph.D.

Kerby Shedden is an Associate Professor of Biostatistics and an Associate Professor of Statistics in the College of Literature, Science and the Arts (LSA). He received a Ph.D. in Statistics from UCLA in 1999. His research focuses on developing and evaluating methods for analyzing high dimensional and complex data including dimension reduction, feature extraction, modeling, and inference. In addition to basic research he also collaborates on a number of life science projects in which complex data sets arise. This includes collaborations with members of the UM Cancer Center Cancer Genetics Program and Biostatistics Core, the UM College of Pharmacy, and the UM Addiction Research and Depression centers.

Legal Requirements:

Citizenship Requirements.

- □ ***This project is open to US Citizens or Permanent Residents only***

Intellectual Property Agreements / Non-Disclosure Agreement

- □ Students will sign IP/NDA document(s) that are unique to Robert Bosch LLC.

Summer Project Activities

- □ **Summer 2020 Internships are guaranteed *and required* for all students who match to this project team.** Every student who accepts an offer to join this project team must also accept a summer internship from Bosch.
    - Start date; end date and location and any pre-employment (background checks, drug screening) checks will be included in the public call. The compensation will be provided in the offer letter which is sent in early November.

Company Information:

Bosch is a German multinational engineering and electronics company headquartered in Gerlingen, near Stuttgart, Germany. Bosch's core operating areas are spread across four business sectors; mobility solutions, consumer goods (including household appliances and power tools), industrial technology (including drive and control) and energy and building technology. See link for more details.

https://www.bosch-mobility-solutions.us/us/highlights/automated-mobility/