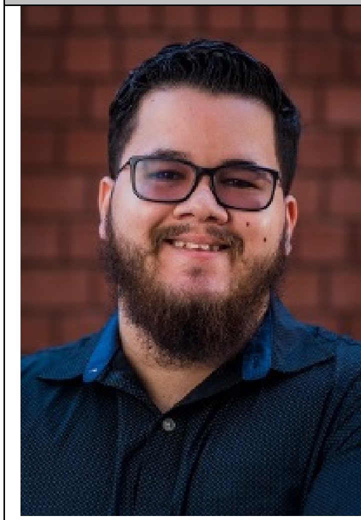
CAT VEHICLE PROGRAM/ Electrical and Computer Engineering REU

PI: K. Larry Head, PhD and Tamal Bose, PhD
Coordinator: Nancy Emptage
Sponsor: The University of Arizona; National Science Foundation REU

CAT VEHICLE PROGRAM ABSTRACTS



CHRISTOPHER ALICEA-NIEVES

A Domain Specific Modeling Language for Safe Autonomous Vehicle Behaviors with Dynamic Constraint Verification

Interamerican University of Puerto Rico, Bayamon Campus, Computer Engineering
Mentors: K. Larry Head and Matt Bunting

Abstract

Safety is one of the most important aspects of cyber -physical systems due that many interfaces have already been made available for experts and non -experts of the fields involved in these systems, allowing them to develop behaviors for these automated systems such as automated cars. These behaviors can constitute primitive movements, as well as complex ones. Experts in the field have been developing tools for the verification of dynamic behavioral constraints of a system that allow us to determine whether the behavior will be correct or not, and the generation of lower-level artifacts for said systems. With these tools, individuals and groups of both experts and non -experts in the field can program behaviors for these systems and ensure that their behaviors are correct and safe. In order to achieve this, a high -level domain -specific modeling language was created so that non-experts could design behaviors and run them on an automated vehicle. The operations that the vehicle can perform are limited, but it still allows for the vehicle to perform unsafely. The modeling language is compiled into code that can be run on a virtual machine that interprets the model's code and sends safe commands to the vehicle. Verification for the system was performed at a design-level which includes the constraints imposed in our modeling language and verification of the state machine of said behavior.

KHALIL ANDERSON

Validation of a CRV Model Using TVWS Measurements

University of Maryland, Baltimore County, Computer Science
Mentors: Tamal Bose and Garrett Vanhoy / Adam Nighswander

Abstract

Autonomous cars are growing in commercial popularity. This growth will cause the need for wireless transmission of data to these cars to not only aid the software to drive more efficiently, but to also entertain the driver. Currently, aut onomous vehicles are allowed to transmit using the band specified by the IEEE protocol 802.11p. While vehicles can transmit data using the 5.9 GHz band (5.850 - 5.925 GHz), the band may not support wireless transmission of media to vehicles' infotainment systems. As people are freed from the task of driving, the demand for in-car internet connect applications, such as Netflix or Skype, will grow. This requires an alternative. With the switch from analog to digital television, the

government has vacated the analog TV bands. This bandwidth provides a possible solution to the limitations of 802.11p transmissions. The vacated space is called TV white space. One proposed use of this white space is to provide Wi -Fi. This idea has been called White-Fi. According to our research, researchers have measured whether the specific frequencies are occupied but do not provide the unprocessed data. With this in mind, we measure the occupancy of the TV white space and we simulate how a network using this band would perform under the multiple scenarios of everyday driving.

NIAMKE GIRAUD

Real-Time Position Tracking and Velocity Estimation of Moving Vehicles Using Lidar Data

University of Massachusetts Dartmouh, Computer Science
Mentors: K. Larry Head and Rahul Kumar Bhadani

Abstract

In the work performed by *Stern et al.* (2017), it was shown that a low penetration of autonomous vehicles (AVs) into traffic flow is able to dampen phantom traffic waves by means of the AV maintaining a control velocity dictated by distance from the lead vehicle. Detection of the lead vehicle was performed only through finding the closest point in 2D LIDAR data from the AV. This form of detection may not provide an accurate estimate of the location of other vehicles in the road environment, which is required for maintaining a correct control velocity to dampen the traffic flow shock waves. In this work, we implement an algorithm that performs vehicle recognition and position estimation on 3D LIDAR data, followed by tracking and relative velocity estimation on the acquired position data. Vehicle recognition is performed on the 3D data by means of blob detection and classification into vehicle and non-vehicle objects. A linear Kalman Filter is used with the centroid information extracted from the 3D data in order to account for uncertainties in position measurements and to perform state estimation of other vehicles by means of a constant acceleration dynamical model. The Hungarian algorithm for assignment performs matching between vehicle detections and previous state estimations. This method allows us to detect and track other vehicles with increased precision and create a better model of traffic flow.

GEORGE GUNTER
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University of Illinois at Urbana-Champaign, Civil and Environmental Engineering
Mentors: K. Larry Head and Rahul Kumar Bhadani

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MARTI HANDS
Validation of a CRV Model Using TVWS Measurements
Texas Tech University, Electrical Engineering
Mentors: Tamal Bose and Garrett Vanhoy / Adam Nighswander

Abstract

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	**LAUREN LUSK** *Validation of a CRV Model Using TVWS Measurements* University of Oklahoma, Electrical Engineering Mentors: Tamal Bose and Garrett Vanhoy / Adam Nighswander **Abstract** Autonomous cars are growing in commercial popularity. This growth will cause the need for wireless transmission of data to these cars to not only aid the software to drive more efficiently, but to also entertain the driver. Currently, aut onomous vehicles are allowed to transmit using the band specified by the IEEE protocol 802.11p. While vehicles can transmit data using the 5.9 GHz band (5.850 - 5.925 GHz), the band may not support wireless transmission of media to vehicles' infotainment systems. As people are freed from the task of driving, the demand for in-car internet connect applications, such as Netflix or Skype, will grow. This requires an alternative. With the switch from analog to digital television, the government has vacated the analog TV bands. This bandwidth provides a possible solution to the limitations of 802.11p transmissions. The vacated space is called TV white space. One proposed use of this white space is to provide Wi -Fi. This idea has been called White-Fi. According to our research, researchers have measured whether the specific frequencies are occupied but do not provide the unprocessed data. With this in mind, we measure the occupancy of the TV white space and we simulate how a network using this band would perform under the multiple scenarios of everyday driving.
	**KAITLYN OURA** *A Domain Specific Modeling Language for Safe Autonomous Vehicle Behaviors with Dynamic Constraint Verification* University of Arizona, Electrical & Computer Engineering; Aerospace Engineering Mentors: K. Larry Head and Matt Bunting **Abstract** Safety is one of the most important aspects of cyber -physical systems due that many interfaces have already been made available for experts and non -experts of the fields involved in these systems, allowing them to develop behaviors for these automated systems such as automated cars. These behaviors can constitute primitive movements, as well as complex ones. Experts in the field have been developing tools for the verification of dynamic behavioral constraints of a system that allow us to determine whether the behavior will be correct or not, and the generation of lower-level artifacts for said systems. With these tools, individuals and groups of both experts and non

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WILLIAM SILLOWAY

A Domain Specific Modeling Language for Safe Autonomous Vehicle Behaviors with Dynamic Constraint Verification

Kennesaw State University, Software Engineering
Mentors: K. Larry Head and Matt Bunting

Abstract

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YURIY SLASHCHEV

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Stony Brook University, Electrical Engineering

Mentors: K. Larry Head and Rahul Kumar Bhadani

Abstract

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