Compiling CPS Model Repositories through Student Competitions

Extended Abstract

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ABSTRACT

This talk describes how the Cyber-Physical Systems Virtual Organization (CPS-VO) is hosting competitions for the purpose of improving CPS verification tools. We describe the 2016 Challenge, which focused on quadrotor control and codesign of payload, and the 2017 Challenge which focuses on populating a ground vehicle simulator with realistic obstacles. In addition, the interfaces by which participants compete are described, in order to articulate the means by which models can be decoupled from the system for the purposes of evaluation by external tools.

CCS CONCEPTS

• **Computer systems organization → Embedded and cyber-physical systems**; **Robotic control**;

KEYWORDS

Quadrotor, Autonomous car, simulation, ROS

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OVERVIEW

The Cyber-Physical Systems Virtual Organization (CPS-VO) began as an online community for researchers in CPS, and its growth has enabled it to serve as a resource for the community to browse research artifacts. Beginning in 2016, the CPS-VO began to host *active resources*, such as online simulators, to broaden the accessibility of CPS tools.

Wider access to these simulation resources can only take place through well-defined interfaces, which is enabled through adoption of the Robot Operating System (ROS) and its industry-standard set of messages by which distributed robotic experiments can be carried out. Through this interface an additional benefit can be achieved: software-in-the-loop (SWIL) and hardware-in-the-loop (HWIL) system execution as part of the traditional validation and verification design workflow. Two student competitions are presented to demonstrate the active resources and how they enable the compilation of model repositories, since as a part of these competitions it is possible to put students in contact with the physical platforms at some point.

In the first example, a UAV competition was staged over the period of 12 months. Students were challenged to design a mechanism for a quadrotor aircraft to pick up a payload, as well as the control algorithms for the payload. Models developed for this competition include physics-based models through Simulink, as well as ROS models that support online simulation. During the final demonstration in an outdoor area, vehicles were flown with various payloads attached, and data traces recorded in order to validate these models against simulation.

In the second example, a ground vehicle competition was staged over a period of 4 months. Students were challenged to develop plugin components in Simulink to control a self-driving car through ROS, and synthesize at the conclusion of their simulation a 3D model of the world in which they just drove. Checkpoints of the challenge are passed by using the simulators hosted at the CPS-VO website. This challenge will be concluding at the time of the workshop, and various models will be shown as part of the talk.

SUMMARY

This work shows the potential for using simulation-based and experiment-based work to build up repositories of models that can then be verified across new tools. The approach is meant to inspire the participants to consider verification problems, and to acquire a wide variety of models from different users as part of the process. At the conclusion of each challenge, these models are archived in order to make them available to researchers in the future.

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