

Modeling and real-time simulation architectures for virtual prototyping of off-road vehicles

Virtual Reality

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- Manoj Karkee (1)
- Brian L. Steward (1) Email author (bsteward@iastate.edu)
- Atul G. Kelkar (2)
- Zachary T. KempII (2)

1. Agricultural and Biosystems Engineering Department, Iowa State University, Ames, USA
2. Mechanical Engineering Department, Iowa State University, Ames, USA

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Abstract

Virtual Reality-based simulation technology has evolved as a useful design and analysis tool at an early stage in the design for evaluating performance of human-operated agricultural and construction machinery. Detecting anomalies in the design prior to building physical prototypes and expensive testing leads to significant cost savings. The efficacy of such simulation technology depends on how realistically the simulation mimics the real-life operation of the machinery. It is therefore necessary to achieve ‘real-time’ dynamic simulation of such machines with operator-in-the-loop functionality. Such simulation often leads to intensive computational burdens. A distributed architecture was developed for off-road vehicle dynamic models and 3D graphics visualization to distribute the overall computational load of the system across multiple computational platforms. Multi-rate model simulation was also used to simulate various system dynamics with different integration time steps, so that the computational power can be distributed more intelligently. This architecture consisted of three major components: a dynamic model simulator, a virtual reality simulator for 3D graphics, and an interface to the controller and input hardware devices. Several off-road vehicle dynamics models were developed with varying degrees of fidelity, as well as automatic guidance controller models and a controller area network interface to embedded controllers and user input devices. The simulation architecture reduced the computational load to an individual machine and increased the real-time simulation capability with complex off-road vehicle system models and controllers. This architecture provides an environment to test virtual prototypes of the vehicle systems in real-time and the opportunity to test the functionality of newly developed controller software and hardware.

Keywords

Real-time simulation Distributed architecture Virtual reality Vehicle dynamics models
Multi-rate simulation

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Notes

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