Model-based development (MBD) is a popular technique for performing embedded control system design for cyber-physical systems, such as automotive control systems. MBD designs are used to generate critical software, so it is vital to ensure correctness of these designs, but verification and validation (V&V) for MBD designs is a difficult and expensive process. This talk presents some perspective on the types of verification techniques currently available for MBD designs. We argue that new simulation-based techniques to increase confidence in system designs should be investigated, and we present one such technology that we are developing.

Our new analysis technique uses numerical simulations to discover Lyapunov functions. Lyapunov functions for continuous dynamical systems are analogous to ranking functions for software systems; they can be used to certify convergence and also to obtain performance bounds on behaviors, but they are difficult to discover. Our technique uses simulation traces to discover Lyapunov functions for nonlinear and hybrid dynamical systems. We compute candidate Lyapunov functions, which we iteratively improve using a search-based approach until we arrive at a sound result. We certify the resulting Lyapunov function using a satisfiability modulo theories (SMT) solver. The technique can be used to verify stability and to obtain performance bounds for MBD designs of cyber-physical systems.

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