Getting it Right the First Time: Predicted Performance Guarantees from the Analysis of Emergent Behavior in Autonomous and Semi-autonomous Systems

Ronald C. Arkin and Damian Lyons

Robots are currently deployed in Iraq and Afghanistan against conventional explosive threats, e.g., improvised explosive devices (IEDS) but without the use of any significant level of autonomy. WMDs, whether they by chemical, biological, or nuclear (CBN), obviously up the ante substantially and there is no tolerance for mistakes. Autonomy is increasingly demanded due to the large-scale hazard to human life and the need for a rapid response. However, to deploy autonomous systems effectively in such counter-WMD scenarios it is crucial to have a means of establishing performance guarantees for the systems.

The field of formal specification and verification of software systems has made impressive progress. However, leveraging these results to validate software for mobile robot systems has raised new challenges. In ongoing research for DTRA, we (1) introduce -a concurrent, communicating process-based formal model for describing behavior-based mobile robot programs, as well as the environments in which the programs operate, and (2) a robot program development toolkit for robot software validation and verification functionality.

The software development environment is embedded into the *Missionlab* software package, a comprehensive robot mission development, simulation and execution environment. Once the mission has been created, the designer can choose to validate the program's behavior in a range of standard environments. The designer selects from a library of sensor and motor models that include a range of noise and uncertainty characteristics and can request the validation of the combination of robot program and environment for specific properties of safeness, liveness or efficiency.