Simulation and Verification of Fault Tolerant Control for a Mobile Robot

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Abstract: *Fault-tolerant control* systems, i.e., systems that can continue operation even in case of faults, are attracting significant attention in academia and industry alike. Fault-tolerant control systems are inherently *hybrid*, i.e., contain both continuous and discrete dynamics, and thus present problems in terms of both simulation and control synthesis.

This paper presents an advanced application of a new simulation tool for hybrid systems, along with verification results. SOPHY (Simulation, Observation and Planning in Hybrid systems) is an open-source, distributed, object-oriented hybrid systems simulation tool written in pure Java. In this paper, we demonstrate how this tool can be used to investigate the mode shifts in a fault-tolerant supervisory controller developed for a four-wheel driven, four-wheel steered autonomous mobile robot, along with the continuous-time dynamics of the robot itself.

Through practical experiments with the robot, the fault-tolerant control system is demonstrated to improve the reliability of the robot significantly, and the simulation is found to show surprisingly good agreement with the practical experiments. Furthermore, evaluations show that the numerical accuracy and calculation speed is comparable with commercially available software.

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