Integrated Software and Sensor Health Management for Small Spacecraft

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***Abstract*—Despite their size, small spacecraft have highly complex architectures with many sensors and computer-controlled actuators. At the same time, size, weight, and budget constraints often dictate that small spacecraft are designed as single-string systems, which means that there are no or few redundant systems. Thus, all components, including software, must operate as reliably. Faults, if present, must be detected as early as possible to enable (usually limited) forms of mitigation. Telemetry bandwidth for such spacecraft is usually very limited. Therefore, fault detection and diagnosis must be performed on-board. Further restrictions include low computational power and small memory.**

In this paper, we discuss the use of Bayesian networks (BNs) to monitor the health of on-board software and sensor systems, and to perform advanced on-board diagnostic reasoning. Advanced compilation techniques are used to obtain a compact SSHM (Software and Sensor Health Management) system with a powerful reasoning engine, which can run in an embedded software environment and is amenable to V&V. We successfully demonstrate our approach using an OSEK-compliant operating system kernel, and discuss in detail several nominal and fault scenarios for a small satellite simulation with a simple bang-bang controller.

***Index Terms*—**Health Management, fault detection and diagnosis, Bayesian network