Prognostics Enhancemend Fault-Tolerant Control with an Application to a Hovercraft

Impact Technologies, LLC

Technical Abstract

Fault-Tolerant Control (FTC) is an emerging area of engineering and scientific research that integrates prognostics, health management concepts and intelligent control. Impact Technologies and the Georgia Institute of Technology, propose to build off of a strong foundation in fault-tolerant control (FTC) research performed with NASA in past years to mature the applicability of this technology and push the envelope on the capability and breadth of the technology itself. We are introducing for this purpose two novel concepts to expand the scope of fault tolerance and improve the safety and availability of such critical assets. Building upon the successes of Phase I, we will develop and apply to the hovercraft (a targeted testbed) a reconfigurable control strategy that relies on current prognostic information to maintain the platform's stable operation and complete its mission successfully. The second innovation to be introduced refers to a challenging problem encountered in complex systems such as aircraft platforms: A multitude of critical system components can not be monitored directly due to a lack of appropriate sensing modalities. We will introduce a Model Based Reasoning approach and frequency demodulation tools to resolve the ambiguity and "unmask" those fault variables that can not be observed directly.

Company Contact

George Vachtsevanos

(585) 424-1990

george.vachtsevanos@impact-tek.com

2009 Phase II
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Reliable Autonomous Surface Mobility (RASM) in Support of Human Exploration

ProtoInnovations, LLC

Technical Abstract

ProtoInnovations, LLC and Carnegie Mellon University have formed a partnership to commercially develop rover-autonomy technologies into Reliable Autonomous Surface Mobility (RASM). Our aim is to provide safe and reliable means for lunar rovers to travel at substantial speeds and operate in proximity to astronauts and other vehicles. Our unique partnership brings together state-of-art technologies for autonomous rover navigation with experience in delivering and supporting mobility systems for NASA. The RASM project will create an autonomy framework that is capable of supporting off-road vehicle speeds beyond 3 m/s with planetary-relevant constraints including a lack of infrastructure (such as GPS) and limited communication and computing resources. Our RASM framework is based on environment modeling, obstacle avoidance, path planning, and localization algorithms developed by Carnegie Mellon and proven by hundreds of kilometers of traverse in planetary analog landscapes on Earth. On the RASM project we will mature and package these algorithms in a reliable and portable software architecture that supports a variety of vehicle platforms, sensors, and middleware alternatives. Unique to RASM will be a failure-modes analysis of the autonomy system to model and mitigate hazards posed by operating alongside astronauts and lunar vehicles. Mission constraints and operating scenarios will vary broadly, so RASM will be adaptable. We will develop abstraction layers to enable portability across various vehicle chassis configurations, perception sensors, localization sensors, and communications protocols. In Phase 2 of the project, we will implement the portable architecture developed in Phase 1 and demonstrate its capability on KREX or LATUV vehicles developed by ProtoInnovations.

Company Contact

David Wettergreen

(412) 268-5421

dsw@ri.cmu.edu

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Proposal T1.02-9872