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ACTUATOR BLOCKAGE DETECTION IN MILLIGRAVITY

Abstract

Exploration rover like IDEFIX, the rover of the Martian Moons Exploration Mission (MMX), even when designed with extraordinary diligence, can get stuck in their environment or affected by other faults. Ground loops for fault isolation and detection are time consuming, especially in a time-limited mission like that of the MMX rover. Thus, on-board fault detection, isolation and recovery (FDIR) in case a rover gets blocked with their actuators is very advantageous. The MMX rover is provided with four identical shoulder modules including a leg and a wheel with one motor each. The relative angular position and the motor current can be measured at every joint. Additionally, the legs have absolute angular position sensors and torque sensors. All of them shall be used to detect a blockage and classify if it is positioned at a leg or a wheel to induce the corresponding recovery strategy. To analyze this problem, tests on flight-similar hardware were conducted, whereby blockages were induced at different locations at the hardware. Further, the tests were executed with different actuator speeds. The main issue that was noticed is that a blockage at the wheel can induce a higher current even in the leg motors, as well as a high torque in the torque sensor, which also happens during a leg blockage. Thus, the location of a blockage cannot be deducted by simply setting an alarm threshold for any value, but the data have to be interpreted in combination. With the collected data, logistic regression was used to find thresholds for the sensor values that map the sensor data to the correct blockage location. By that method, the fault location could be identified correctly in almost all cases. With this result, blockages can be detected on-board and recovered in a further step, which increases the autonomy and hence the reliability of the MMX rover locomotion.