HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Joint Session on Human and Robotic Partnerships to Realise Space Exploration Goals (3-B3.6)

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DEVELOPMENT AND IMPLEMENTATION OF ALGORITHMS FOR ADVANCED ROVER GUIDANCE NAVIGATION AND CONTROL

Abstract

Robotics plays a key role in space exploration activities, as autonomous mobile manipulators can relieve humans from dangerous tasks and accomplish difficult operations. Many capabilities are needed by such systems: from navigation and localization issues, to data fusion for robust motion estimation and environment perception. To this aim, techniques such as effective visual odometry and Kalman-like filters for data fusion are exploited and real-time implemented within such rover architectures. Moreover artificial vision is exploited for working area reconstruction and mapping, in such a way to obtain a more robust interaction with the external environment and thus a more effective robot behavior. Work done about these three aspects (even within different projects) will be described in the paper, together with a preliminary methodology to intrinsically improve visual odometry via the exploitation of state and sequence estimators. The essential role played by both autonomy and capability to cooperate with human beings (e.g. astronauts) is presented as a lesson learnt in a project such as Eurobot Ground Prototype, by ESA and Thales Alenia Space, about a crew assistant able to effectively support man in different scenarios. Once that such robotic skills have been addressed, investigated and implemented, a strong need arises: all robot capabilities must interact among them (e.g. exchanging data) and, above all, high level robot behaviors must be integrated with lower level issues (of different nature, such as communication problems or actuator piloting,...). To this aim, a framework that offers higher level services to the programmer (thus easing the programming process and making it less error prone) has been developed at Graal Lab. Such a framework has been implemented on RTAI, QNX Neutrino and RTEMS and will be described in the paper, in relation to the development of some of the rover functionalities, needed for space exploration missions. Conclusions about the experiences at Graal Lab in Genoa about control algorithms and robotics for space exploration are drawn and some simulations and experimental results are presented about visual odometry, data fusion and rover perception capabilities and also about coordination within the same robot (e.g. between a vehicle and an arm) or among different robotic agents. Moreover, directions for future works will be finally given, considering also the possibility to exploit a multi-robot system composed by different agents with different capabilities, having to share such skills to achieve some global objectives concerning exploration.