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An autonomous science capability for Mars exploration rovers

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The Mars Exploration Rovers (MER) [Squyres 04] have achieved a 10 fold increase in traverse distance travelled per Sol when compared with the first rover to land on Mars [Stone 96], and are now in a further extended mission phase. This success is not without cost as primary mission operations can often cost as much as 40% of the total primary mission. The fundamental problem is that large teams of scientists and engineers are involved in the tasks of defining, rehearsing, planning, scheduling and uploading every single activity associated with surface operations, no matter how small or large that activity might be. The ESA ExoMars rover is planned to traverse further and for longer than the MER rovers, and therefore these operations problems will arise. If they are not solved, then potential science data will be lost and operations costs will soar. The ability for a rover to operate autonomously is advantageous as this could potentially increase science data return whilst reducing operations costs. Current work in the area of autonomous science data gathering for Earth observation satellite operations is showing how successful an autonomous approach can be [Chien 05]. However to apply such an approach to planetary surface rovers is not trivial, and JPL is beginning to invest in this area [Estlin 05].

Surface science sample acquisition is a critical activity within any planetary exploration mission, and our research is focused upon the design, implementation, experimentation and demonstration of an autonomous 'Surface Sample Acquisition Agent' (SSAA). In addition to simulation work, our experimentation and demonstration will utilise the UWA Mars Yard and our new Concept-E rover chassis and mounted manipulator ARM. We are adopting Qualitative Modelling methods to endow the rover and ARM system with an autonomous surface science sample acquisition capability. Recent results in the area of Fuzzy arithmetic, kinematics and control [Hanss 05], [Liu

05], now provide new techniques that have the potential to solve not only the problem of how to traverse a rover with manipulator to a science site (e.g. a rock), but how to interact with that science site autonomously. This paper presents our recent work in this area.

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