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Robotics Vision for a Scouting Rover - PRoViScout

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Abstract

The FP7-SPACE Project ProViScout (*Planetary Robotics Vision Scout*, scheduled from April 2010 to September 2012) aims to demonstrate the feasibility of vision-based autonomous sample identification & selection in combination with vision-based navigation for a long range scouting/exploration mission on a terrestrial planet along with the robotic elements required. The paper gives an overview of the PRoViScout technical and scientific objectives, envisaged solutions and achievements so far.

1. Introduction & Objectives

Mobile systems will require more autonomy than is feasible today [1], particularly in the **autonomous on-site selection of and access to scientific and mission-strategic targets**. The combination between science-driven and operations-driven decisions taken on-board is a key component of this autonomy.
PRoViScout [7] establishes the building blocks of such a system in terms of robotics vision by a decision – based **combination of navigation and scientific target selection,** and integrating them into a **framework ready for and exposed to field demonstration** with following **objectives**:

1) Include the **search for scientifically interesting targets** into the navigation chain
2) Perform **Autonomous Tasking** (Goal based **planning and re-planning**).
3) Populate a robotic **vision on-board processing chain (PRoViSC)**
4) Address and merge a **representative set of sensors** (including a novel zoom 3D-Time-of-flight camera) to fulfil important scientific objectives and prove the general applicability to the approach in different mission scenarios.
5) Compile a **PRoViScout Demonstrator on a mobile platform** that combines sensors, processing and locomotion on-board ready for an integrated outdoor demonstration.
6) Integrate a **monitoring function (PRoViM)** to understand the behaviour of the system in operation.
7) Demonstrate the **feasibility of long-term vision-based scouting** making use of a representative outdoor test bed and the PRoViScout Demonstrator platform.

2. System Outline

The **Software part ("PRoViSC")** consists of Mission Management components such as an Executive, a Planner (MMOPS [8]), a science assessment module, and the navigation & vision processing modules. The Hardware Platform consists of the Rover together with the sensors and sensor pointing devices. For a more detailed description of the hard-and software architecture see [5].
The **Rover Platform** component, in its simplest form, provides an abstraction to the low level functionality specific to the platform. This includes a Pan/Tilt unit mounted on the mast, a Wide Angle Camera system, a zoomable 3D Time of Flight (TOF) camera with RGB capabilities, a Wide Angle Laser Imager (WALI), the Locomotion subsystem and (potentially) a hyper spectral imager.

3. PRoViScout System Status

By paper submission PRoViScout has been running for 14 Months. Its main results achieved so far are as follows:

- All requirements from science and operations have been collected and reported. This includes the definition of the target scenario planned for the field test during the final Project phase.
- System design has been finished.
- A new 3D-TOF camera has been designed and prototyped, able to zoom, and integrates RGB high-resolution images.
- Preliminary tests to extract scientifically interesting image parts from training &

classification indicate that an automatic system is able to detect meaningful targets.

- Candidate field test sites in Morocco, Tenerife, Wales and Iceland were investigated, assessed and discussed. The major result is a strong preference towards Tenerife, due to accessibility, logistics, locomotion, climate & science aspects.

In 2010 the assessment of scientifically interesting areas at Clarach Bay (Aberystwyth, UK) took place (Figure 1, a report is publicly available via download [3]). In January 2011 an aerobot test [6] verified the concept of a tethered aerobot for Rover mapping & science target selection support. The definition of training samples to test pattern recognition methodologies for the identification of scientifically interesting targets is ongoing. Key parameters for the operational scenario of the final field test have been assessed, and some recently implemented components have already been verified [2], [4].

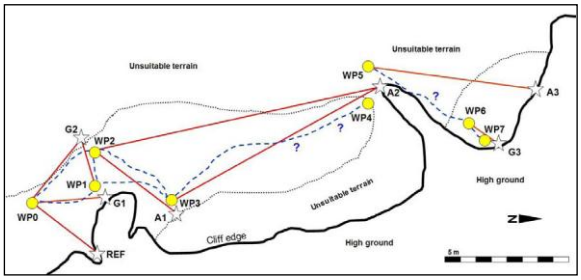

Figure 1: Example for waypoints and a globally planned rover trajectory in the area of Clarach Bay (Aberystwyth, UK). © Univ. Leicester

4. Summary and Conclusions

ProViScout supports the development of **more autonomous space vehicles**. Vision based sample identification enables such rovers to act more independently, which is needed for more efficient scientific mission outcomes. The PRoViScout project objective is to **increase the amount of quality science data** that remote planetary rovers can deliver on behalf of Earth based science teams. This is obtained by prototyping intelligent technologies which increase their autonomy and therefore exploration efficiency.

The major project goal is a **field test** that demonstrates the ability to autonomously traverse terrain whilst "keeping an eye open" on potential scientifically interesting targets passed on its way – and change the global plan in favour of additional observations.

The first year of the Project has paved the way to such a system by identifying the key parameters of a scenario, specifying the system components and their interfaces, and already detailed designing and implementing major components such as a novel 3D-TOF sensor, and aerobot mapping strategies.

Acknowledgements

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