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Collaborative Virtual Environments for Mars Science Analysis and Rover Target Planning

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Abstract

The CROSS DRIVE project aims to develop an innovative collaborative workspace infrastructure for space missions that will allow distributed scientific and engineering teams to collectively analyse and interpret scientific data as well as execute operations of planetary spacecraft. It aims to mobilise a team of best European expertise in the field of Mars science data collection and analysis to propose and study synergic combinations of data sets and their benchmarking.

1. Introduction

CROSS DRIVE stands for "Collaborative Rover Operations and Planetary Science Analysis System based on Distributed Remote and Interactive Virtual Environments" and aims at creating the foundations for collaborative distributed virtual workspaces for European space science. Space exploration missions have produced huge data sets of potentially immense value for research as well as planning and operating future missions. However, currently expert teams, data and tools are fragmented, leaving little scope for unlocking this value through collaborative activities.

The question of how to improve data analysis and exploitation of space-based observations can be answered by providing and standardising new methods and systems for collaborative scientific visualization and data analysis, and space mission planning and operation. This will not only allow scientists to work together, with each other's data and tools, but importantly to do so between missions. The proposed collaborative workspace encompasses various advanced technological solutions to coordinate central storage, processing and 3D visualization strategies in collaborative immersive virtual environments (cf. Fig. 1), to support space data analysis.

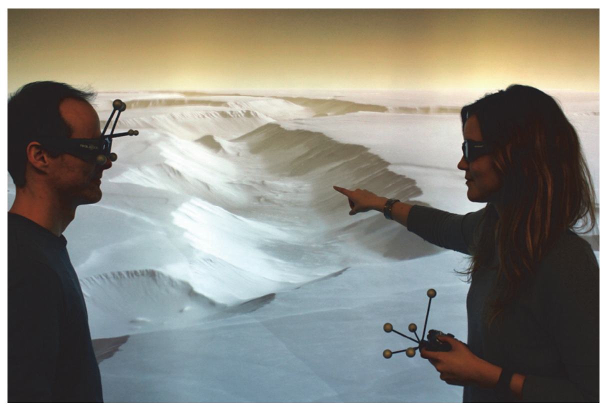

Figure 1: Interactive Mars Science Data Analysis in an immersive Virtual Environment.

Three case studies will demonstrate the utility of the workspaces for European space science: Mars atmospheric data analysis, rovers landing site characterization and rover target selection during its real-time operations. The use cases will exploit state-of-the-art science data sets and they will be constructed in view of the ESA ExoMars 2016 TGO and 2018 rover missions' scenarios.

Impact on beneficiaries will be maximised both through providing an expandable backbone infrastructure and three levels of workspace for: scientists directly engaged, other external scientists, and the public.

2. The Workspaces

The collaborative workspace platform is focused on the data analysis and operations of planetary missions (cf. [1]). Its purpose is to allow scientific and engineering teams, distributed across the world, to work together in a shared 3D space using data from past and ongoing missions, visualise scientific data and the spacecraft and rover as well as their trajectories and status information, and allow the users to freely navigate and collaboratively interact with the displayed data.

In order to allow different forms of collaboration in different contexts, three workspaces will be investigated in the CROSS DRIVE project: Core Collaboration Workspace for the core mission team, External Public Workspace for engaging selected scientists and Web Portal for broader dissemination and engagement of scientific community.

3. The Use Cases

The main target mission will be the ExoMars scenario when a Mars satellite and rover will be jointly operated. Intensive real-time science analysis processes are expected during the rover operations and in order to reduce costs, part of the science team would have to be remotely connected to the Mission Control Centre at ALTEC. To evaluate the efficiency of CROSS DRIVE's architecture as well as the foreseen data processing and analysis methods, we will perform three test use cases:

1. **Landing sites characterisation**: This use case will visualise, analyse and present relevant aspects of research in landing site selection for Mars robotic missions. Science users will be able to analyse geologic features of selected areas of Mars, apply basic GIS functionality and a selection of real-time analysis tools, and analyse the surface and subsurface structure of the terrain. Relevant sample datasets will be visualised as 3D terrain model using the Mars Cartography Virtual Reality System.

2. **Mars atmospheric data analysis and benchmarking**: Global views of Mars in order to analyse concepts related to the global circulation like geo-potential maps and time/spatial variations of selected variables will be considered. Tests will include comparisons among measured data and output of off-line complex models, among data from different payloads, and among data collected from different locations or time. Correlation and benchmarking between satellite and ground based measurements are also foreseen.

3. **Rover target selection**: This test addresses operation planning of planetary rovers and satellites by using the Collaborative Workspace. In particular the system will allow analysis of geologic features of terrain as viewed by the on-board cameras of the rover, comparison among rover images/DTM and satellites' images/DTM, analysis of the morphology of the terrain in correlation with the expected landing trajectories, provision of commands to the satellite and rover, and review of the data coming from the rover after commands execution.

4. Conclusion and Future Work

The CROSS DRIVE project will last until December 2016. During the remaining project timeframe, the three use cases will be developed and the architecture of the collaborative workspace infrastructure will be finalized and tested. The final goals of CROSS DRIVE are to deliver a virtual, collaborative and distributed workspace for space missions, in which scientific and engineering data will be visualized, analysed, interpreted and spread across scientists, engineers and the common public. A final workshop will present the results and discuss future steps with virtual reality experts and the space science community. We believe that eventually the outcome of CROSS DRIVE will advance the ExoMars planning and operation support as well as space mission data exploitation considerably.

Acknowledgements

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References

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