FASTER

Forward Acquisition of Soil and Terrain for Exploration Rover

DATA FUSION OF SOIL MEASUREMENTS FOR TRAVERSABILITY ASSESSMENT OF MARTIAN SURFACE: ASSUMPTIONS AND CONCEPTS FOR NEW MISSIONS.

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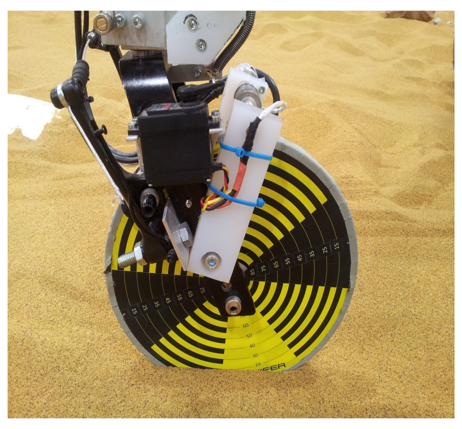
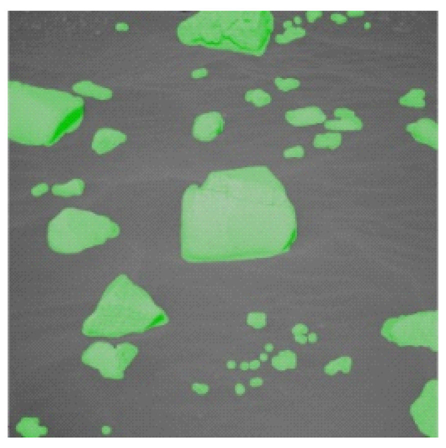
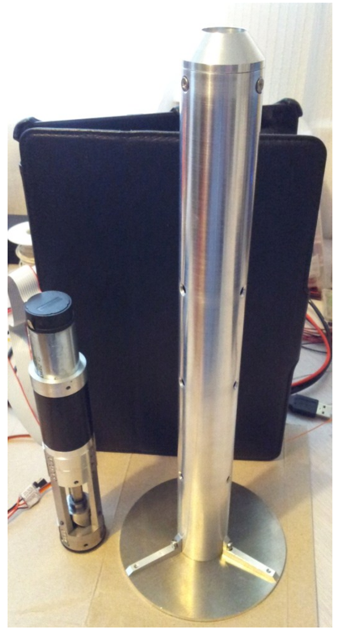
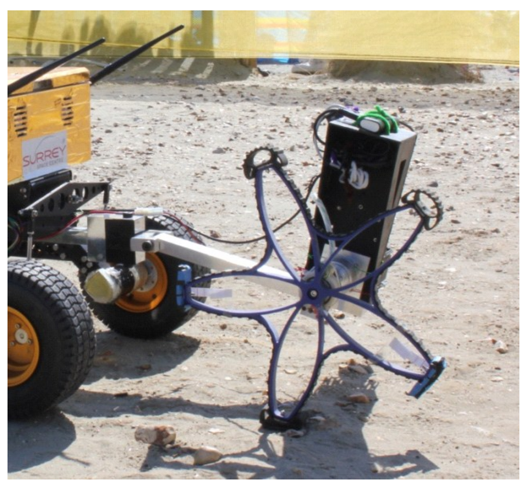
INTRODUCTION: Safe and effective traversability on the Martian surface is an important issue for recent robotic missions. As it was presented by MER Spirit, the safe movement on the planetary surface covered by various material and sediments can be tricky. The FASTER project is focused on on-board traversability assessment system designed as a potential support for ExoMars mission. Few aspects of development of FASTER project Data Fusion (DF) module is discussed here.







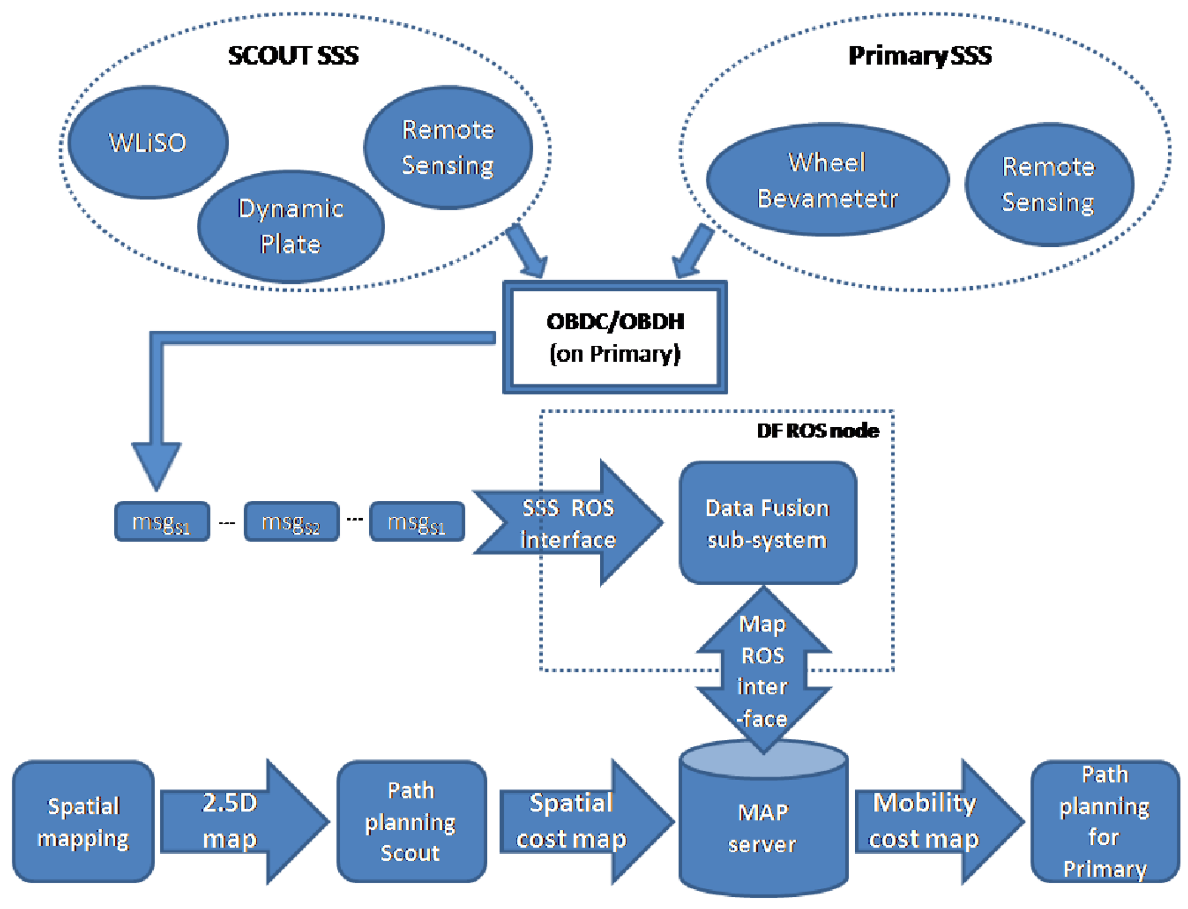


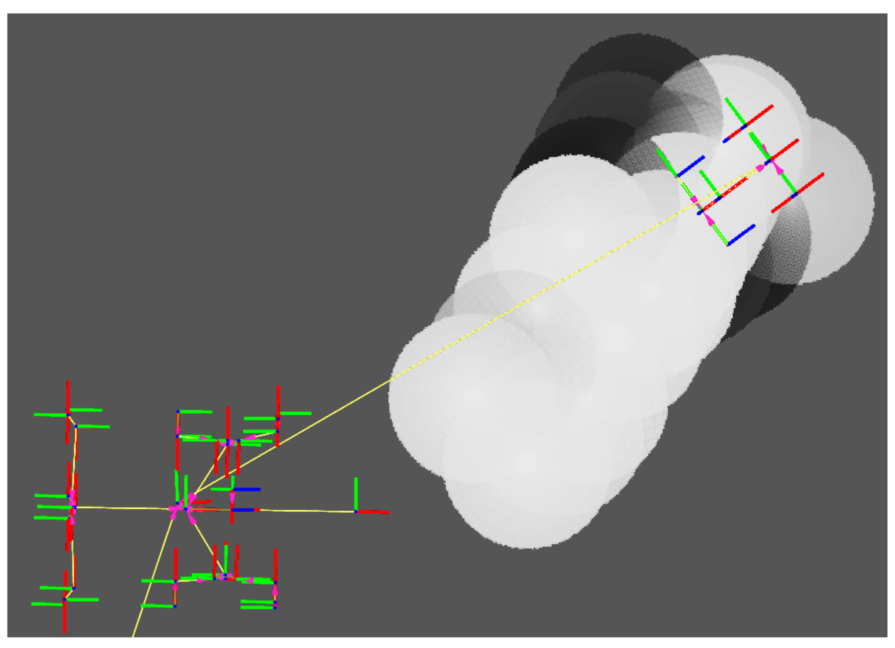
SOIL SENSORS – CASE OF FASTER PROJECT: In case of FASTER project, four different sensors, mounted on small, reconnaissance Scout rover and on base Bridget rover (mock-up of final ExoMars mission rover) were developed and common DF subsystem was prepared.

- *Wheel-Leg-Soil Interaction Observation system (WLSIO)* – two front wheels of Scout rover; Visual and IMU data are used for estimation of sinkage and slippage of wheels to predict the terrain 'softness' and final traversability properties. The wheel-legs offer both high terrain crossing capabilities, as well as the direct, semi-static leg-soil interaction analysis. Each wheel-leg is equipped with foot realising the same contact pressure as for base rover.
- *Dynamic Plate (DP)* – scout sensor uses the principle of measurement of reaction for hammer hit applied to the circular plate located on top of the soil; this sensor is deployed on request, when the WLSIO sensors give uncertain answer.
- *Wheel Bevameter (WB)* is mounted directly on base rover. It uses well known technique for terrain parameters estimation (called Bekker's parameters) widely applied in military devices for traversability assessment,
- Additional data source for terrain traversability assessment, *Remote Sensing (RS)* subsystem, returns localization and estimated size of rocks across camera Field Of View (FOV).

DATA FUSION CONCEPT: The aim of Data Fusion module is to integrate data from all sensors and put they on one grid map. The output map will be used by path planner for safe path estimation. Sources from all sensors are unified in the each sensor driver to trafficability percentage scale, where everything below 30% is not-traversable, between 30-65% is uncertain and above 65% should be traversable for Primary rover. The task for Data Fusion module is to return trafficability map built based on trafficability percent estimation from different sources, relative positions of this measurements and confidence parameters estimated for each sensor during a test trails.

Before fusion the measurements are inflated to specific radii of influence. This pre-processing step is necessary because sensors yield point measurements but output map should produce path useful for Primary rover, which is 2-3 times wider than Scout. Moreover, the measurement uncertainty, with the sensor confidence value in the measurement point, is increased with distance from measurement point. That approach allows to leave the same measurement value over whole circle with changing uncertainty, which take part during fusion process.





Fusion problem was divided to two steps: information fusion over each sensor separately, where Bayes rule is applied, and merging of that information to the output map. General idea for algorithm is presented. Following Thrun this information should not be fused by Bayes rule in one step because each sensor estimates trafficability based on different physical phenomena. In other words, there is no certainty, that two sensors returning the same trafficability estimation, producing results based on different methods, are detecting the same aspects of soil character. The Bayes fusion in first step takes under consideration current measurement, previous measurements intersected with recent one and confidence parameters in each point over measurement inflation radius. This step produces map for each sensor, which is merged to one output map in the second step. Merging step uses function that put on output map only the most certain and worst case value from all sensors' maps. That approach ensures safe and useful map generation.

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