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FASTER project – data fusion for trafficability assessment

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Abstract

Martian surface missions since Sojourner mission typically use robotic rover platform for carrying the science instrumentation. Such concept, successfully demonstrated by twin MER rovers, is however risky due to low trafficability soil patches unrecognized. Idea of soil traversability assessment is the base for FASTER project activities. This article shortly presents topics of special interest for planetary rover safe path finding and decision making process. The data fusion aspect of such process is analyzed shortly.

1. FASTER project concept

FASTER project is the conceptual answer to preliminary ExoMars project operation scheme: separated of regolith sample collection task and sample recovery by rover and return-path sending task. It enhance the risk of the mission success related to sample recovery rover mission – unsuccessful rover operation will affect overall mission. The example of MER Spirit problems with sand ripple crossing and long rover recovery battle clearly showed the need for good travel path planning for overall mission success.

However, in FASTER project the suite of soil sensing (directly and on indirect way) instruments are prepared to obtain clear view of soil trafficability conditions on the realized movement path. Instruments located onboard two rovers, small, reconnaissance Scout rover and main Mother rover, measure the actual mechanical soil parameters along the rovers' path [1]. Final decision GO/NOGO will be prepared with the Data Fusion processing and analysis software at the main mission OBC.

1.1 Mechanical design and sensors

There are two main sensors carriers in the project. Small Scout rover carries compound Dynamic Cone Penetrometer / Dynamic Plate sensor for direct soil bearing capacity measurements and Ground Penetration Radar used for buried rocks and voids sensing. Additionally, the direct observation of front legwheels – soil interaction (sinkage) will be used as first estimation of soil trafficability [2]. Main Mother rover will carry one of two prepared instruments: Wheeled Bevameter or PathBeater for direct defence of the main rover. Additionally, the navigation system will be capable of preparing visual soil variability analyses used for remote terrain obstacles and sand traps avoidance [3].

1.2 System architecture

System is build on two main physical platforms (Scout and Mother) with direct communication link in WLAN standard, and two software platforms: Robot Operation System (ROS) for low-level operations and GenoM for high-level operations. OBC is located on Mother platform, so all collected data from sensors will be received and stored onboard Mother rover. Measurement data will be transferred in processed format to the data fusion subsystem. Results from data fusion subsystem will be input for navigation subsystem.

2. Data acquiring and fusion

The Data Fusion process will be based on inputs from Scout communication link and OBC navigation subsystem. The preliminary inputs and their reliability to Data Fusion process is presented below.

Table 1: soil sensors available

Data source	Speed rate	Reliability
Legwheel sinkage (S)	High (no stop)	limited
IMU sensors	High (no stop)	limited
GPR	Medium	limited
DCP	Low	high
DP	Low	high
Mother slippage	High (no stop)	Limited
Wheeled Bevameter	High (no stop)	High
PathBeater	High (no stop)	Limited

The data acquired by separate sensors will differ importantly, so there is no direct possibility to simply ‘vote’ to prepare the final decision (GO/NOGO). Thus, there will be one typical procedure of soil sensing system operation used: continuously the legwheel sinkage will be tested and IMU data collected and analyzed. GPR should be used in case of any possibility of voids or duricrusts. In case of high sinkage observed or GPR ‘alarm’ signal, Scout will be stopped and the DCP/DP instrument will be deployed for measurements. The results obtained can be influenced by type of soils measured and soil variability in the vicinity of the measurement point. Results will be sent to OBC.

Last defence point from accessing low trafficability terrain by Mother rover is soil sensing instrument located directly onboard rover. Data obtained from this sensor will be cross-checked with data from Scout to check the correlation of the results. There will be quite simple GO/NOGO decision making process in case of similar results obtained. In other case the decision making algorithm using full knowledge about all the sensors and measurement conditions will be crucial for reliable and safe decision made.

There is still no fully clear position of remote sensing data analyses in the data fusion procedure. These data, as a part of navigation system, should be stored in OBC memory and should be used when rover will arrive the remotely sensed point (or region). The use of RS assessment will be rather an element of decision of using GPR and DCP/DP sensors but not the direct input into decision making system. There is need for further studies of this part of the system.

3. Terrain and attitude influences

The simple scheme presented above will not be in fact such simple when other influences will be added to the decision making system. First of all, the actual geometrical correspondence between rovers should be taken into account: some maneuvers of Mother rover will not be permitted due to high risk or technical reasons. The attitude of both rovers can preserve from some measurements, in some cases the measurements made in specific attitude conditions will be unreliable or the results will not be directly fitting the measurements requirement conditions. Such conditions will be fully defined to prevent from erratic data collection and processing.

4. Final data fusion scheme

The modified data fusion scheme, with all above parameters implemented into decision making algorithm can still not be presented here. Because of the different type of parameters measured and assessed, the final version of soil traversability decision making system will be prepared in next months when all the development and test data describing the soil sensors’ operations will be known.

5. Summary and Conclusions

The FASTER acronym was primarily prepared to demonstrate both enhanced safety and FASTER movement of the rovers capabilities. In fact, after first definition and development activities we found, the safety will be crucial; in not all terrain types presented system will accelerate the rovers. The detailed studies show the high complicity of rover trafficability decision making process. Number of inputs and parameters affecting soil sensors measurements should be taken into account in the trafficability assessment process.

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References

[1] Lewinger W. at all: Multi-Level Soil Sensing System to Identify Safe Traficability Areas for Extra-Planetary Rovers, ASTRA 2013 conference, 2013.

[2] Sonsalla R. at all: Concept Study for the FASTER Micro Scout Rover, ASTRA 2013 conference, 2013.

[3] Nevatia Y. at all: Safe Long-Range Travel for Planetary Rovers through Forward Sensing, ASTRA 2013 conference, 2013.