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Author: Mr. Peter Batenburg
Delft University of Technology (TU Delft), The Netherlands, pawbatenburg@gmail.com

Prof. Eberhard Gill
Delft University of Technology, The Netherlands, E.K.A.Gill@tudelft.nl
Dr. Guy Drijkoningen
Delft University of Technology (TU Delft), The Netherlands, G.G.Drijkoningen@tudelft.nl

CONCEPT SELECTION FOR A PLANETARY REFLECTION-SEISMOLOGY SYSTEM WITH MULTIPLE END-USER REQUIREMENTS AND MISSION CONSTRAINTS.

Abstract

A study was performed to determine the feasibility of reflection seismology for planetary geology taking into account present-day technology advances. An end-user requirements approach was applied to assure the scientific usefulness of the results. Thirty applications of a seismic-reflection system for space applications were determined in cooperation with geologists. The requirements on the seismic system were derived from the end-user requirements, the geologists' requirements, on the product; the seismic image of the subsurface structure. This derivation or seismic system design is a task performed by geophysicists. This process is extremely complex and several aspects and expectations of the to-be-investigated area are required to design the system such that it can perform its task.

The process to design the seismic-reflection system for the thirty applications was challenging because of the very limited amount of existing data. Furthermore, an individual design for each application was too time consuming and would result in a different treatment of each application. Instead, this problem was solved by a novel method to systematically and consistently transform the end-user requirements into the reflection-seismology-system requirements for all the thirty applications. Theoretical and empirical relations were used to determine the required system requirements from the input of the geologists.

Furthermore the study assumed an open setting for mission conditions to allow all possibilities for the use of a reflection-seismology system. The result of this approach was sixty sets of system requirements and nine sets of (basic) mission constraints. On top of these multiple sets of requirements and constraints, the concepts for the reflection-seismology system consisted of three separate concept groups: seismic-wave sources, seismic-wave detectors and deployment methods. These three groups contained seven, five and five concepts respectively which, combined, are 175 concepts for the entire system. Combined, these resulted in 94,500 combinations to evaluate.

Assessing all these combinations separately was considered too time consuming and error sensitive. The process of concept selection was therefore performed in a stepwise systematic fashion. Prior to concept selection, combination assessment matrices were created as guideline tools for the actual concept selection. This selection was split up into four levels, levels that simulate the mission design, systems and subsystems selection.

The methods created for requirement transformation and the concept selection proved to be robust. It could be shown that the applied process protected the end-user requirements.