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APPLICATION OF MODEL BASED SYSTEMS ENGINEERING FOR AN ASTEROID LANDER

Abstract

Surface exploration of asteroids are scientifically important for understanding of the origin and history of our solar system. Space agencies all over the world have started to launch exploration missions to asteroids. Low cost, small-sized landers with some capability to move on the surface of an asteroid would be highly suitable for in-situ observations.

This paper primarily proposes on Model Based Systems Engineering (MBSE) tool to handle the functional modelling of a class of small-scaled asteroid lander that would have requirements similar to the Mobile Asteroid Surface Scout (MASCOT) mission from the German Aerospace Centre (DLR). The latter aims at developing a landing package for the Hayabusa-2 mission. In this paper, System Modelling Language (SysML) is selected as the domain-specific language, and the lander system context is developed in the integrated development environmental (IDE) of IBM Rational Rhapsody.

The proposed unified functional modelling tool is platform independent. It covers a wide range of features for the lander system under consideration and proposes a clear decomposition of its functionalities. This MBSE approach can be easily adapted for other asteroid landers. Through this approach, systems engineers would make a rapid transformation from stakeholders' requirements to a functional model.

To this end, the proposed MBSE approach allows systems engineers and associated stakeholders at varying levels to define a number of common and basic lander scenarios derived from different levels of abstractions of the model system under test (i.e. the MASCOT lander). Furthermore, this proposed MBSE technique offers a structured and well-formed set of script templates for the lander model execution. Thus, allowing system engineers and stakeholders the privilege to verify, test and validate all functional, systems and interfacing requirements in a timely and efficient manner at varying stages in the project lifecycle. Further, the use of the animation feature of the Rational Rhapsody IDE to engineer the acquisition of visualised levels of detail for all SysML model elements and their respective executions will be presented.

Finally, to further show that the theoretical purity of the proposed MBSE approach does not mitigate against practical concerns, this approach is exemplified in a SysML model implementation of a shadow mission scenario the MASCOT lander.