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HYBRID ROUTING ALGORITHMS FOR NAVIGATION CONTROL OF A SEMI-AUTONOMOUS ROBOTIC PLATFORM

Abstract

Past and current advances in planetary exploration are crucial milestones that will potentially lead to human interplanetary travel, construction of interplanetary outposts, with possibility of a gradual interplanetary colonization. Before proceeding with creation of bases for humans on Moon, there is a serious need in the continuous scientific study of its surfaces and atmosphere. The robotic monitoring approach is currently undertaken by NASA, European Space Agency, and other space-exploration capable countries in order to collect, analyze and continuously monitor the environmental data from the Moon's surface and atmosphere utilizing a network of geophysical stationary nodes under the International Lunar Network project. Based on the long-term studies of the Moon's surface and atmosphere, the Structures Pointing and Control Engineering (SPACE) University Research Center (URC) at California State University of Los Angeles (CSULA) proposes a design of the semi-autonomous robotic platform, which can serve as a stepping stone to the mobile lunar robotic network. The semi-autonomous control incorporates a mixed-control mode, which assigns certain tasks to run in automated execution mode, while reserving critical or complex tasks for remote user-controlled execution. The platform will be using three-level Hybrid Routing Algorithms to accurately navigate through assigned lunar terrains and provide scientists with collected environmental data. The data will be relayed to a Host Computing Station and tagged on the OpenGL-generated map co-ordinates for further back-end processing. The Hybrid Routing Algorithm Model provides navigation for the Robotic Platform by accessing multi-source map data for information, making the platform aware of its distant surroundings as well as the adjacent obstacles. There are three encapsulated levels of maps: with Layer-1 covering area of a square kilometer. It is divided into a hundred

Layer-2 maps, each covering an area of 100 square meters. Each Layer-2 is further divided into hundred Layer-3 maps, each covering 10 square meters. The navigational process for this platform involves a hybrid model of routing algorithms, which will rely on the aerial obstacle information(e.g. obtained from Lunar Reconnaissance Orbiter) for the outer A* algorithm path-finding navigation in Layer-1 and Layer-2, while dynamically identifying obstacles using on-board depth sensor equipment and calculating target routes with the D* algorithm (Dynamic A*) for the Layer-3 navigation. The robot travels to its destination in the three encapsulated coordinate levels: with respect to Layer-1 Map, with respect to Layer-2 Map, and while dynamically determining the Layer-3 path based on real-time encountered obstacles.