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Simulation of Motion Performance for a Cobalt Crust Miner on Seamounts

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ABSTRACT

It is necessary that the cobalt crust miner has better motion performance on seamounts in the cobalt crust mining system. The tracked vehicle with articulated steering is chosen as a type of cobalt crust miner. Based on multi-rigid body theory, the three-dimensional kinetic and dynamical models and virtual prototype of the tracked vehicle with articulated steering are built and designed by using the ADAMS Tracked Vehicle Toolkit. The simulations of virtual prototype moving on different terrains are carried out, with the digging force of the head and the resistance of the flexible pipe acting on the prototype. A great number of kinetic and dynamic characteristics of the virtual prototype on bumpiness terrain are analyzed in detail. The motion performances for the virtual prototype are predicted. The designed virtual prototype of a cobalt crust miner can climb the obstacle 1m high, the trench 1.2m wide, the slope 35º and bumpy terrain steadily.

KEYWORDS: Cobalt crust, Simulation, Tracked vehicle, Articulated steering, Terrain, Motion performance, Dynamics

INTRODUCTION

There is one abundant ocean mineral resource – cobalt crust locating on the surface of seamounts. The cobalt crust miner is the key device of a cobalt crust mining system. The mining system consists of a digging head, an ore separating device, a power unit, an electrical box and a long flexible pipe to move stably on seamounts with difficult terrain in the cobalt crust mining system (Li, L, Zhong, J, 2005). The cobalt crust miner is simultaneously exposed to digging forces of the digging head, vibrations of electrical motors, three-dimensional resistances of the flexible pipe, seawater resistance and ocean current adjacent seafloor etc., while the cobalt crust miner is moving to mine cobalt crust ore cohering to seamount bedrock. This indicates that the moving cobalt crust miner is on a complicated operating situation. So, the cobalt crust miner should have perfect motion performance such as an ability to pass effectively through obstacles, trenches and sloping terrain, good mobility and bearing heavy load. And these performance requirements are considered as main factors in the design of a cobalt crust miner.

Due to extremely bumpy terrain of seamounts and combination of many kinds of forces acting on the cobalt crust miner, it is significant to use a virtual method to built up three-dimension dynamical model of a cobalt crust miner, design its virtual prototype, simulate sufficiently the motions on a difficult terrain and predict the motion performance on seamounts. This will supply good technical guidance for the design of a cobalt crust miner.

THE TYPE OF COBALT CRUST MINER

The type of cobalt crust miner is an important factor to determine motion performance on a difficult terrain. Broadly speaking, there are currently two basic types of ground vehicle capable of operating over a specific range of unprepared terrain: wheel vehicles and tracked vehicles. The sinkage and external motion resistance of a tracked vehicle would generally be lower than that of an equivalent wheeled vehicle (Wong, JY, 2001). Furthermore the slip of a tracked vehicle is usually lower than that of an equivalent wheeled vehicle for the same thrust. As a result, the mobility of the tracked vehicle is superior to that