Lunar Rover Motion Planning and Control Based on Autonomous Behavior Agent

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This paper addresses lunar rover motion planning and control method based on autonomous behavior agent. It deals with an architecture of Lunar rover autonomous control system, constraint conditions of driving system, basic behavior design, autonomous behavior path planning, autonomous behavior motion planning and control, and motion learning based on GA & VR (virtual running). The main contents are as follows:

Firstly, A control system architecture based on autonomous behavior agent is presented, which composed of lunar rover agent, description of rover and terrain traversability, obstacle extraction , semi-structured terrain representation map, and information sensing from semi-structured terrain representation map. It helps the motion planning and control system constructed implementing behavior control with real time performance , and improves the behavior based motion control system with more autonomy using environment information like terrain features. The control system architecture is prepared for the lunar rover motion planning and control based on autonomous behavior agent.

Secondly, based on semi-structured terrain representation map, basic behaviors in response to different context, situation and states perceived by the rover agent, are designed using hierarchical fuzzy control method to guarantee their real time performance. They include goal-oriented behavior, obstacle-avoidance behavior, obstacle following behavior, and goal-oriented obstacle-avoidance behavior. Also, those behaviors satisfy the constraint conditions of driving system, and they include terrain features and prior knowledge of motion control without the modeling of the obstacles to enhance their reactivity. Thus, lunar rover can safely run in the real world on condition that its driving constraint conditions are provided. Those behaviors are used for the motion planning and control approach based on autonomous behavior agent.

Then, three approaches of autonomous behavior motion planning and control are presented. They are Autovior for known environment, Situated-Bug for unknown environment, Smart-Bug for partly known environment. Also, an autonomous behavior path planning method is presented, which is based on the semi-structured terrain representation map, it can

distinguish relative obstacles with path planning task, and find rapidly its optimal way for the computation complexity of just simple obstacle number for path finding and optimization. The rover's motions are planned and controlled from its starting point to its goal in real world through its agent running in the semi-structured terrain representation map. Also, the three approached are convergent theoretically and robust to measure noise and path planning errors practically.

Lastly, the motion learning method based on GA & VR (virtual running) is presented to enhance lunar rover's adaptivity. More complex motion with more strictly limiting conditions can be planned and controlled by the motion learning in the semi-structured terrain representation map to coordinate behavior parameters. Simulation results show Lunar rover motion planning and control method based on autonomous behavior agent can adapt the terrain with extensive mechanical property and traversability.