Proposal for Master Thesis at Space Robotics Division, DFKI

3D-Terrain Map Generation & Surface Classification for SpaceClimber Robot

Motivation

The project SpaceClimber is currently under development. It deals with developing a six legged robot with specially made joint motors and a sophisticated behaviour based control approach. The robot will be able to plan its foot placement using trajectory planning for optimal locomotion. It is important to obtain a three dimensional map of the terrain on which the robot walks. Since the intended purpose of the robot is its subsequent deployment in extraterrestrial crater and rocky surface exploration activities, a 3D terrain map is useful in navigational guidance planning and execution. The different surfaces viz. rocky surface, sand etc encountered during navigation would provide additional information which assist in route planning. This surface information plays an important role in the decision to steer away from an obstacle or climb up over it. Slip phenomenon is dependent on the surface on which the Robot walks, so this information plays a significant role in locomotion control and drive. The different surfaces may be distinguished for example, from the varying degrees of reaction force offered to the robot legs, which is dependent on the extent of deformability.

Further, the knowledge about the temperature of the surface provides an additional insight about the thermal stress inducible, thereby facilitating real time navigation course correction.

Goals

The scope of the thesis incorporates the following salient objectives:

- Surface Classification on which the SpaceClimber Robot is subjected to.
  The SpaceClimber Robot encounters different surfaces while walking. These surfaces are to be classified as soft ground and hard ground respectively. Identification of the surfaces as rocky, sandy etc is the next task.
- Map Generation and Visualization
  - Development of 3D-Terrain Map from exteroceptive and proprioceptive sensor information from the foot and leg sensors.
    A set of 3D data cloud points is calculated using the raw data obtained from the foot-leg sensors, under the assumption of known robot position coordinates and orientation of robot. A terrain map is then generated using the 3D data set, which serves to correct and aid in the locomotion planning.

- Development of Temperature Map of the Terrain.
  The surface temperature is obtained from temperature sensors attached to the foot. This temperature data is used to generate a temperature map.
- Integration of the 3D-Terrain Map and Temperature Map within the existing simulation environment.

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