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LIDAR-BASED TERRAIN SAFETY ASSESSMENT FOR SPACECRAFT LANDING

Abstract

In discussing the problem of planetary landing, it is important to detect and avoid hazardous areas with real time observations. In such a mission, a spacecraft will need to build a map detailing dangerous areas within a region of interest by performing a quantitative assessment. However, uncertainties due to limited data in field environments make this difficult. A new algorithm, based on trigonometric analysis and a graph cut algorithm, is proposed to select safe landing sites while piloting around candidate landing sites.

A combination of active sensors such as radar and Lidar operates by scanning the surface in order to measure the range from the spacecraft to the surface of the planet. These range measurements are used to calculate the relative geometry over the surfaces where laser beams are shot at by using trigonometric analysis. The analysis results provide a map of landing cost for terrain safety assessment.

Then, an additional step is required to infer the degree of safety of a given lidar-scanned area from the map of landing cost. To classify hazardous areas or safe areas, we employ a graph cut algorithm which has been applied to solve computer vision problems, such as image smoothing, stereo correspondence and energy minimization problems. In this framework, definite safe or hazardous areas, classified by likelihood ratio evaluation for the landing cost from a priori knowledge, are designated as hard constraints. The rest of areas are segmented by computing a global optimum by assigning weights on geometric data.

Hence, the proposed algorithm is robust to uncertainties of from both the data from sensors and control since the entire hazard map being built is evaluated in terms of the landing cost and constraints. This algorithm is well suited to planetary landing where landing environments are unknown since real-time measurements are significant when searching safe landing sites. Simulation in a virtual environment shows the effectiveness of the proposed algorithm when the computed safe areas are modeled into a 3D surface, then compared with the original surface being studied.