Probabilistic Path Planning of Montgolfier Balloons in Strong, Uncertain Wind Fields

This algorithm can be used for underwater unmanned vehicles for automated scientific data collection and for military uses.

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Lighter-than-air vehicles such as hot-air balloons have been proposed for exploring Saturn’s moon Titan, as well as other bodies with significant atmospheres. For these vehicles to navigate effectively, it is critical to incorporate the effects of surrounding wind fields, especially as these winds will likely be strong relative to the control authority of the vehicle. Predictive models of these wind fields are available, and previous research has considered problems of planning paths subject to these predicted forces. However, such previous work has considered the wind fields as known a priori, whereas in practical applications, the actual wind vector field is not known exactly and may deviate significantly from the wind velocities estimated by the model.

A probabilistic 3D path-planning algorithm was developed for balloons to use uncertain wind models to generate time-efficient paths. The nominal goal of the algorithm is to determine what altitude and what horizontal actuation, if any is available on the vehicle, to use to reach a specified EVA or other mission scenario can be made to guide alternative solutions for attaining determined objectives set by mission planners.

The ARRBOD GUI estimates the whole-body effective dose, organ doses, and acute radiation sickness symptoms for astronauts, by which operational strategies and capabilities can be made for the protection of astronauts from SPEs in the planning of future lunar surface scenarios, exploration of near-Earth objects, and missions to Mars.

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