Mars Lander User Guide

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Re-worked Code

The structure of the code was over-hauled to reduce repetitive calculations and make more advanced tasks more readable. As a result, a lander class was created to provide one location for drag components and reduce calculations for ground and climb speed. This was particularly helpful for the tuning function as a copy of the class can be made and methods applied in the same way without updating graphics. Similarly, header files for each file was added to make it clearer where function headers were.

Autopilot Modes

In all modes, the console will post updates on any changes and what it is doing.

Re-Entry/ Transfer

The lander will transfer from the current orbit to a different one. Upon activating the autopilot, the simulation will freeze awaiting an input radius as a multiple of Mars', into the console window. Upon arriving at the desired radius, the fuel will refill and not decay. The autopilot will correct the elliptical orbit to a circular one. The autopilot will then reset, allowing you to perform further maneuver. Should the lander come within the exosphere, it will switch to Descent and land. This mode is active in scenarios 0, 2 and 6.

Descent

The lander will attempt to land with the remaining fuel on the surface using a proportional gain controller. The autopilot may freeze for a moment as it tunes to the ideal value of K_h to be most fuel efficient or softest landing (version can be toggled using the 'm' key, the default is fuel efficiency). This mode is active in scenarios 1, 4, 5, 7 and 8.

Injection

Input radius into the console and the lander will inject into an orbit of that radius. There is no fuel decay, and the autopilot will switch to Orbital Re-entry once it has reached a stable orbit. Active in scenario 3. 'd' key will toggle between Orbital Injection and Orbit Descent.

Additional Mechanics

Wind

Toggling the 'w' (default is off), there will be wind of a given average speed over a normal distribution (providing minor gusts now and then). The autopilot may eject the parachute if it is being dragged by it, and the user will be notified if this happens on the console.

Engine Lag and Delay

An engine lag of 5s and delay of 2s can be toggled on or off using 'c' and 'v' key respectively. The autopilot will predict up to 5s ahead to try and counteract the effects of the delay, though it will not tune due to the time it takes to run through. Delay can cause inconsistent results in how successful a landing is, based on the timing of when in the simulation the autopilot is enabled.

Miscellaneous Controls

The direction of the lander can be modified using the 'x' and 'z' keys to manually rotate it. The mechanics of the planet's rotation is taken into account, so if the lander has 0 velocity it will still have a ground speed relative to Mars. Scenarios 7 and 8 were added to mimic 1 and 5, but give the lander 0 ground velocity at the start of the simulation.