Bereshit's Lunar Lander Summary Report

Landing Method Overview

Roni Michaeli 209233873
Neta Cohen 325195774

The spacecraft was landed on the Moon using a controlled descent strategy managed by a PID control system. The main goals were to reduce both vertical and horizontal velocities to safe landing values and maintain the optimal angle for stability and control, all while efficiently managing fuel consumption.

PID Control Mechanism

A PID controller was employed to regulate two main aspects:

- **Throttle (engine power)**: Controlled mainly by a PID for vertical speed (dvs).
- **Angle (tilt of the spacecraft)**: Controlled by a PID for horizontal speed (dhs).

Each PID controller adjusts its output based on:

- **Proportional term (P)**: How far the current value is from the desired value.
- **Integral term (I)**: The sum of past errors to eliminate residual steady-state errors.
- **Derivative term (D)**: Predicts future error based on the rate of change.

These controllers allow smooth correction of the lander's motion in real-time, ensuring a stable and safe descent.

Graph Interpretation

1. Horizontal Speed (Blue)

- **Behavior**: The horizontal speed starts high (~930 m/s) and decreases steadily over time.
- **Influence**: Controlled mainly by adjusting the lander's tilt (angle), which redirects some of the engine thrust to counteract horizontal motion.
- **Observation**: As the angle reduces, more thrust is directed horizontally, slowing the lander’s lateral drift effectively.

2. Vertical Speed (Green)

- **Behavior**: Starts at a moderate descent speed (~25 m/s) and gradually increases due to gravity, but is later slowed and stabilized by increased throttle.
- **Influence**: Managed directly by the engine's throttle using the vertical PID controller.
- **Observation**: The descent rate is controlled to ensure a soft landing. Throttle spikes indicate periods where the PID compensates for increased descent velocity.

3. Angle (Orange)

- **Behavior**: Starts at a steep angle (~57°) and steadily decreases to 0° as the lander approaches touchdown.
- **Influence**: Managed by the PID controlling horizontal speed (dhs). As horizontal speed decreases, the angle is gradually corrected to vertical (0°).
- **Observation**: Smooth transition in angle shows stable PID tuning, crucial for ensuring the lander is upright upon landing.

Code Summary

The simulation code included:

- State variables tracking position, velocity, angle, fuel, etc.
- PID controllers that compute throttle and angle adjustments.
- Physics update step that computes the lander's new state based on thrust, gravity, and orientation.
- A data logger saving time-step results for later analysis.