Platform for Lunar Follow-Me Camera Drone

NASA TSGC Design Challenge

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Executive Summary

To design a lunar camera drone, the team explored various propellant methods. Based on our research, silane met the requirements of viability and abundance on the moon. The drone was designed to minimize cost and maximize weight savings by using a single bipropellant tank. To allow for six degrees of freedom, a four thruster system was utilized.

Background

Inspired by the documented challenges faced during missions like Apollo 17, this project addresses the current barriers of high costs and the technical difficulty of capturing quality footage on the Moon by proposing an autonomous lunar "follow me" camera drone. The central idea is to adapt existing Earth-based drone technology to the lunar environment, providing a novel, reliable, and cost-effective solution for high-quality video capture, thereby significantly improving mission documentation and public outreach.

Design Procedure

We first considered various propulsion systems, then environmental factors and finally various system configurations. We ultimately converged on a design that utilized silane, a hypergolic fuel which could be synthesized using local materials. For flight, our design uses a 4 thruster design because it was proved to be overall the simplest system striking the optimal balance of physical complexity, kinematic complexity, and reliability. For the tank configuration we went for a single spherical tank with a dual diaphragm to hold both propellants which reduced mass by nearly 40% compared to a more conventional tank configuration. All other aspects of the drone from camera configuration to thermal coatings were done systematically in order to produce the best design possible.

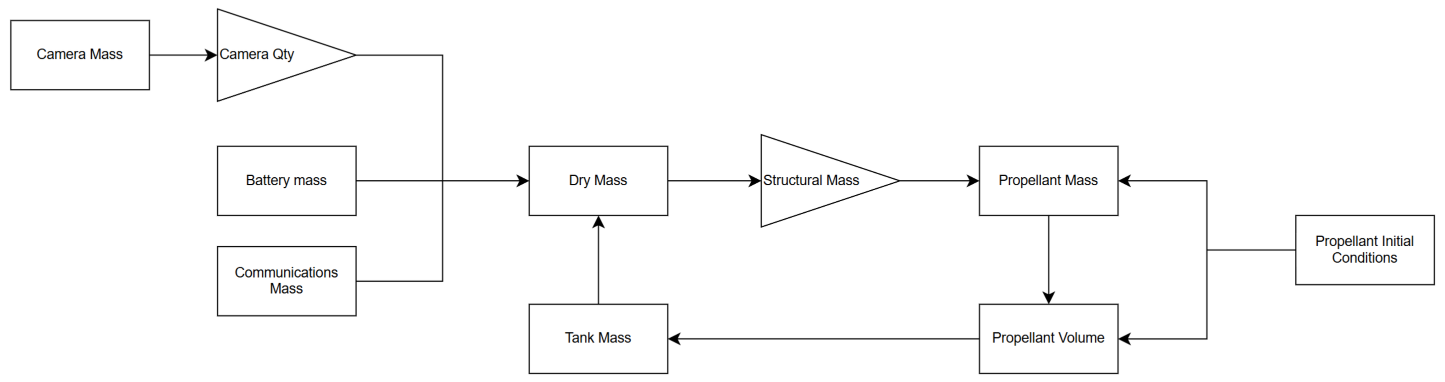

Figure: Drone Design Procedure

Control Systems

Without an atmosphere that would naturally help dampen various random deviations, we needed to make sure that our configuration could adequately compensate by designing a control system for the drone. This also allowed us to simulate the drone in various situations to ensure that our system had acceptable dynamic response.

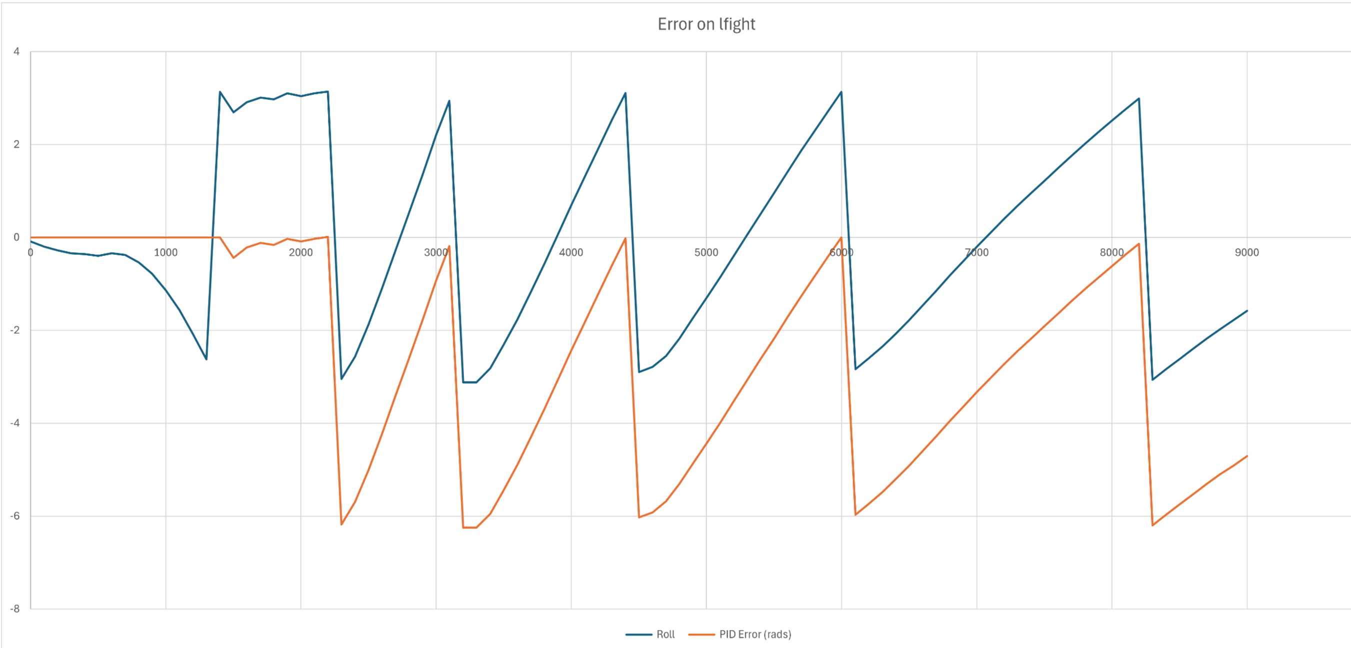

Figure: System Response to indeterminate Euler-Angle

Thruster Model

The thruster model that we used was based off of theoretical models we found in literature as well as thrust curves we found online. This model was the backbone of our dynamic system and allowed us to test the drone with realistic thruster expectations.

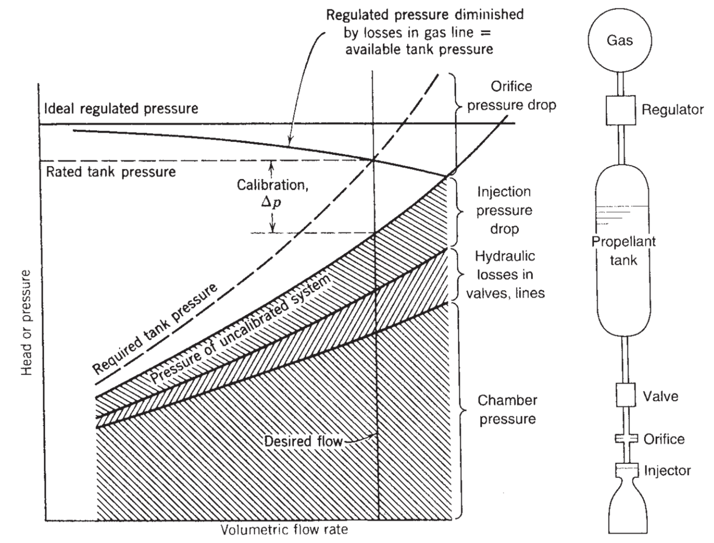

FIGURE 11–5. Simplified flow diagram and balance curves for the fuel or the oxidizer of a typical gas-pressurized bipropellant feed system. This diagram is also the same for a monopropellant feed system, except that here there may not be a calibration orifice; calibration is done by setting the proper regulated pressure. Hydraulic losses include friction in both the liquid piping and the cooling jacket.

Flight Model

We modeled the drone's equation's of motion to update its position in space based on user input and the thrust model.

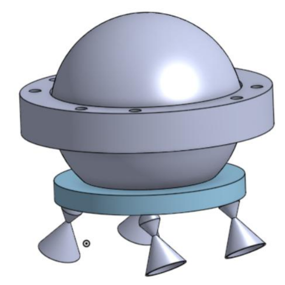

Figure: CAD Model of Follow me Drone

Conclusions

The drone's capability of six degrees of motion, ability to sustain flight for the required twenty minutes, and utilization of processed fuel from the lunar surface makes it an ideal candidate to record human missions. The design's reusability makes it an economic choice to reduce the reliance on Earth for resources. In the future, this drone concept could be equipped with scientific experiments, assist with transportation, and aid search and rescue operations.

References

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