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To the Moon on a Shoestring

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Abstract

The Euroluna Team is one of the around 30 teams competing in the Google Lunar X PRIZE Competition. The goal of the competition is to be the first team to successfully land a vehicle on the Moon, drive 500 m, and send video of the drive back to Earth.

The Euroluna Team was formed in 2007, and the first flight hardware was acquired in 2010.

Euroluna is financed privately with small funds. We have not received any external financial support. Therefore we have made an effort to keep all investments low. This has resulted in a design that uses new technologies and old technologies in a new way.

Components are largely based on the Cubesat family and an ion thruster is being used for propulsion. A special strategy for landing on the Moon is under development.

Special software **of own design** is being used for simulation of trajectories and energy consumption.

1. Introduction

The special considerations relating to the design of the trajectory and landing procedure are discussed. Since the cost of launching the spacecraft is largely proportional to the amount of mass of the spacecraft, the spacecraft is light and small. We have aimed for a mass of less than 5 kg. Our current weight budget is at 3.1 kg including the Google X-prize payload.

2. Propulsion

This puts some constraints on the technology that can be used for propulsion. Chemical thrust was considered but discarded because of the high fuel consumption. Instead electrical propulsion using ion thrust has been chosen.

However, ion thrusters have low thrust. Presently the thrust is in the order of 1 mNewton which means that obtaining the required 4-5 km/s deltaV to get to the Moon takes time. In the simulated example shown below, 439 days.

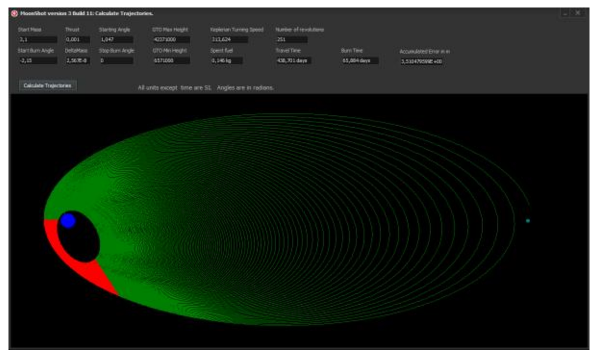

Figure 1: Simulated mission from GTO to the Moon.

2. Navigation

The low weight and cost budgets also dictate that we use as simple means of orientation as possible. We have restricted ourselves to three types of observations.

1. The Earth's magnetic field.
2. Sight (analysis of pictures).
3. The angle to the Sun.

We also have a clock and a number of Moon and Earth ephemerides aboard.

All the observation types have limitations. The current dipole model of the Earth's magnetic field is only good within 3 Earth radii, and the analysis of pictures and the angle to the Sun can only deliver a couple of degrees accuracy.

The best measuring device is the clock, by which we can measure the times when the spacecraft enters and leaves the shade of the Earth and the Moon, and correlate them with the planned trajectory. It is also used extensively to measure lap times, giving the sizes of ellipse major axes and other particulars through well-known formulas by Kepler and Newton.

2. Landing Procedure

The landing procedure presents the real challenge since low thrust cannot be used for braking from at least 1.6 km/s to zero in a few minutes.

We intend to split the spacecraft in two connected with a tether. The tether will transfer all the kinetic energy relative to the Moon to the propulsion module, which will be sacrified during the landing. As far as we know, this has not been tried before.

The elevation of the Moon's surface will be tabulated or similarly described in order to facilitate an orderly landing.

3. Command and Control

Because of the time lag, the fact that the spacecraft may not be reachable from our homes (Europe) all the time, and the size of our team (just three to five active members) we need to emphasize control in the form of programming of the action to the events that the spacecraft might encounter, rather than commands sent from Earth.

The onboard computer is the heart of the spacecraft and has software for all the measurements, ephemerides calculations, the tethering and the landing procedure.

A simulator for the flight and the onboard software is being built to check and correct programming bugs.

Great effort has gone into the design of the trajectory using ground based computers and our own software. Some of that software can be reused on board.

4. Summary and Conclusions

The undertaking of sending a spaceship to the Moon is huge, but with modern technology it is still feasible for even a small organisation such as ours. Time will tell whether we are successful.

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