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HIGH PRECISION ATTITUDE AND ORBIT CONTROL SYSTEM BASED ON THE EMISSION OF ELECTROMAGNETIC RADIATION

Abstract

This paper deals with a propellant-less, high-accuracy attitude control system based on the emission of electromagnetic waves, called PACER. From basic physics it is known that the emission of 1 W of electromagnetic power is associated with a generated force of 3.3 nN. To our knowledge, this physical principle has only been suggested as a main propulsion system for deep space interstellar missions, but never been exploited for attitude control purposes.

The motivation for the investigation of such a system bases on upcoming and planned satellite missions within the commercial and scientific sector. An ever increasing demand on precision and accuracy can be observed.

The advantages of a system like this are easy to see:

- very low forces (Nano Newton) can be generated precisely
- no fuel is required, hence, life expectancy is only proportional to the degradation of the radiation source
- The system is well scalable

This paper will discuss the underlying physical principle of the thruster technology, present our current design plans and lay out first results of our characterization process. The current plan is, to build a technology demonstrator and the tools to characterize a system like Pacer. To achieve this, a high precision thrust stand and the essential system sub-components required for the spacecraft power system including power generation, distribution, allocation and storage are under development and part of our discussion. This platform shall be used to evaluate radiation source concepts, different system setups and system efficiency. The currently favored radiation source are LEDs because of the low thermal radiation component, and because of the capability of using glass fibers. Different setups include the discussion if the radiation source shall be centralized and an optical system is in charge of distribution, or if the radiation source is placed within the "nozzle". Another topic will be the management of thermal radiation under the aspect of an estimation of performance capabilities. An estimation of system mass, power consumption, regulated thrust generated and disturbances generated shall be given. The design of the high precision thrust stand will be another focus of the paper. To reach the precision needed, a pendulum thrust stand with electrostatic displacement measurement is planned. To increase precision and decrease the effect of disturbances, a resonant operation at Eigen frequency is considered. A more detailed mass estimation and list of components will be given.