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# INVESTIGATION OF INNOVATIVE THRUST-VECTOR CONTROL TECHNIQUES FOR MICRO PROPULSION SYSTEMS

**Abstract**

The use of propulsion systems in micro and nano satellites has gained increasing attention due to its potential to improve the performance related to mission lifetime and mission capabilities. However, the size, mass, and power constraints of these types of satellites set a great challenge for developing micro propulsion systems and there are still some developments do be done in order to give them other functionalities present in a full scale system, such as thrust-vector control, which may significantly improve the functionality of the satellite by allowing the execution of attitude manoeuvres for applications such as reaction wheels desaturation, or compensation of small perturbations, and also orbital manoeuvres for applications such as station keeping, orbit transfers or even deep space missions; these capacities are required in a wide range of missions such as formation flying, removal of space debris, or de-orbiting. In this paper, a new design concept is investigated for a micro resistojet that includes the ability of controlling the thrust-vector direction. The innovative technique involves the use of only one thruster and no moving parts that are two important key features to be considered for keeping a good reliability and low complexity. Generally, the thrust-vector is controlled using an array of thrusters, that may increase complexity, or a gimbal assembly, which may decrease reliability for involving moving parts. For a micro propulsion system these aspects also represent a possible increase in size that may affect the feasibility of such system. The proposed concept consists of actively using an electrical field to steer the propellant flow in the nozzle exit making it able to control its thrust-vector direction. A controlled electric potential is applied to two plates placed in the nozzle exit such that it maintains a constant distance to the propellant beam. This will create a controlled electrical field, by which the propellant will pass through, that will accelerate the molecules in a direction perpendicular to the beam steering them in the desired direction. Numerical simulations are performed to assess and validate the concept in terms of thrust, specific impulse, power, and propellant consumption and also to characterize its relation between applied potential and angular deviation in the thrust-vector.