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DEVELOPMENT STATUS OF A NON-MECHANICAL THRUST VECTORING SYSTEM USING INDEPENDENT CONTROLLED MULTIPLE COILS FOR A PLASMA PROPULSION

Abstract

Magnetic nozzle for plasma propulsion systems has been studied to improve thrust performance. A magnetic nozzle is a contactless plasma control system, and it does not have any mechanical actuator. There is no time-related deterioration theoretically for these reasons. In other words, the system is available for long-time missions such as deep space exploration due to its long lifetime.

A thrust vectoring system is also essential for a propulsion system for almost all missions to keep the alignment between the center-of-mass and thrust axis. The center-of-mass of spacecraft changes during a mission due to fuel consumption, solar array deployment, and probe deployment. When the center-of-mass shifts away from the thrust-axis, unexpected torque is generated. Mechanical gimbal adjusts the thrust axis and avoids the torque generating in previous spacecrafts. It might limit a lifetime of a spacecraft due to degradations of a lubricating material and wear accompanying it.

We developed a non-mechanical thrust vectoring system for plasma propulsion that consists of independently controlled multiple-coils, having functions of both existing magnetic nozzle and mechanical gimbal. Numerical analyses and experiments using an unsteady plasma flow from laser ablation were performed, and it proved the feasibility of the system.

The demonstration experiment is ongoing, and we are evaluating the performance of the multiple-coil magnetic nozzle for unsteady plasma flow. A demonstration experiment for a steady plasma flow is also ongoing to evaluate the continuous control performance of the thrust vectoring. As evaluation parameters, we focus on vectoring angle, plasma divergence angle, and thrust. The time response characteristics of them are also crucial to control a steady plasma flow.

In this conference, we will share the current status of the multiple-coil thrust vectoring system and the future experiment plans on the ground and in orbit.