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Abstract #
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Title

Compliant high support stiffness rocket gimbal for Thrust Vector Control on liquid engine

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Abstract

In recent years, there has been increasing interest in the development of compliant mechanisms for use in aerospace applications. This paper presents the design and performance evaluation of a compliant, high support stiffness 2 Degrees Of Freedom (DOF) gimbal used for thrust vector control (TVC) of a rocket engine, which offers multiple advantages over traditional rigid gimbal designs. Indeed, compliant mechanisms are simpler as the part count is reduced and the motion is more precise as there isn't any backslash or friction. No lubricant is therefore necessary which make the mechanism more reliable over a long period of time unattended. This is especially useful in extended space missions where human interaction is limited. Compliant mechanisms can also be easily adapted to different sizes from microstructures to larger devices. As the part count decreases to a single or few pieces, the weight is reduced and the simplicity improved, which is a key point in outer space and on rockets.

The compliant mechanism allows the control of two rotations of the rocket motor which creates thrust; the gimbal thus guides the rocket body. This is called Thrust Vector Control (TVC) and its purpose is to land back on the ground without the use of traditional recovery system such as parachutes. Another advantage of TVC is the ability to stay stable on ascent despite the lack of fins. Removing the later greatly reduces the drag of the rocket thus lowering consumption and being able to go higher up with less fuel.
This project is one of projects from the EPFL rocket team association, whose goal is to reach an altitude of 100 [km] surpassing the Karman limit, and to be the world's first students' group to land a rocket with a TVC system.

One of the main characteristics of our design is the ability to withstand a liquid engine force of around 1.2 [kN] while maintaining a high speed and precise control on a large range of motion. In this paper, we look at the different designs we went through and discarded until we found the most suited in our case.