Now water used as propellant for tiny satellites

Bengaluru, Aug 10 (IANS) Engineers at Purdue University in the US have designed and tested a micropropulsion system that uses liquid water as the propellant for orbital maneuvering of tiny satellites called CubeSats.

With rapid developments in miniaturisation of technologies CubeSats -- which typically weigh about two kilograms -- are poised to take over the sky in the future to carry out tasks like imaging and remote-sensing currently performed by heavier satellites which are expensive to build and launch.

However, today's CubeSats cannot totally replace their larger counterparts as they are incapable of changing orbit or performing complex manoeuvres. For instance, none of the 101 nanosatellites that were launched aboard India's PSLV from the Sriharikota Space Centre in February 2017 had propulsion. A propulsion system would allow such tiny satellites to correct their orbit or maintain their altitude, thereby prolonging their operating life in space before becoming space debris.

A dedicated propulsion system that is also compact and not power hungry has been the aim of CubeSat builders in several laboratories to exploit their full potential.

The system developed at Purdue uses an innovative design of small thrusters that deliver bursts of water vapor to manoeuvre the spacecraft, its developers -- most of them undergraduate students -- reported at a recent "Conference on Small Satellites" held at Logan, Utah, in the US.

Pure water is chosen as the propellant since it is green, safe, easy to use and free from the risk of contaminating sensitive instruments by the backflow from plumes as in the case of thrusters using chemical propellants.

Called a "Film-Evaporation MEMS Tunable Array", or FEMTA thruster, it uses capillaries thinner than human hair through which the propellant water can flow. Small heaters located near the ends of the capillaries turn the water into vapor, which, on escape from these tiny tubes, provides the thrust. The minuscule capillaries act like valves that can be turned on and off by activating the heaters. The technology is said to be similar to the inkjet printer, which uses heaters that fire dots of ink at the paper.

CubeSats are usually made up of several units, each unit measuring 10 centimetres on a side. In the Purdue research, a single unit CubeSat prototype -- integrated with four FEMTA thrusters loaded with about a teaspoon of water -- was tested in a large vacuum chamber of the university's high vacuum facility.

The prototype contained electronics and an inertial measurement unit sensor to monitor the performance of the thruster system, which rotates the satellite using short-lived bursts of water vapor.

"We demonstrated that one 180-degree rotation can be performed in less than a minute and requires less than a quarter watt, showing that FEMTA is a viable method for attitude control of CubeSats," its developers reported in their paper.

Although the researchers used only four thrusters during the test, which allowed the satellite to rotate on a single axis, a fully functional satellite would require 12 thrusters for 3-axis rotation. The team is confident this device can be developed for a CubeSat. "What we really want to do next is to integrate our system into a satellite for an actual space mission," the researchers said.

The NASA-funded research involved collaboration with the space agency's Goddard Space Flight Center. A patent application for the concept has been filed.

(K.S. Jayaraman is a senior journalist who writes on scientific issues. He can be contacted at killugudi@hotmail.com)

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