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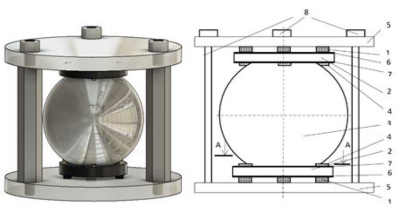
Spherical magnetic drive for attitude control on nano satellites

Grazvydas Kazokaitis and **Vytautas Jurenas**
Kaunas University of Technology, Lithuania

Small satellites are great tools for various research and analysis tasks. They can work like standalone units or to be modular and combined together to the clusters. Depending on their missions and provided exercises, various orientation and positioning systems are needed. Attitude control systems can be with active or passive elements. Typically, these systems are driven by: gravitational forces, permanent or electromagnets, reactions wheels or thrusters. Small satellites have limited capabilities and many restrictions for size, composition, energy consumptions. Nowadays most popular systems consume significant amounts of energy, takes a lot of volume. As a possible option for alternative attitude control mechanism spherical magnetic drive was submitted. Spherical permanent magnet has stable dipole and when it orientates with the Earth's magnetic field, attitude control can be achieved. This developed drive combines advantages of active and passive systems. The drive is fairly simple: permanent magnetic sphere is inserted between two ring-shaped piezoelectric actuators. Electrodes of the piezoelectric rings are divided into three equal sectors and are excited by separate harmonic signal. The out-of-plane bending and radial vibration modes of the piezoelectric rings are excited to obtain elliptical motion of the contacting points and rotate magnetic sphere about three axes. Amplitude and duration of the applied signal depends on rotation or motion trajectory of the sphere. In addition, it must be mentioned that actuator can be driven by burst type signal in order to achieve very high resolution. Using this technique, controlled movement of magnetic sphere is achieved. Numerical and experimental studies were performed to verify operating principle and output characteristics of the actuator. The aim of study was to investigate vibration modes of the piezoelectric actuators and identify resonance frequencies at which these piezoelectric actuators generate 3-DOF rotational motion of a spherical rotor with high resolution, determinate further development steps.



1 - Elastic supports; 2 - Piezoelectric transducers; 3 - Magnetic sphere; 4 - Contact points; 5 - Flanges; 6 - Sides of continuous electrodes of piezoelectric rings; 7 - Sides of divided electrodes of piezoelectric rings; 8 - Bolts.

Recent Publications

1. Kazokaitis Gražvydas, Jurėnas Vytautas and Eidukynas Darius (2017) Research and analysis of spherical magnetic drive for attitude control on nano satellites. Vibroengineering Procedia 15:50-55.
2. Bansevičius Ramutis Petras, Mažeika Dalius, Jūrėnas Vytautas, Kulvietis Genadijus and Bakanauskas Vytautas (2016) Development of traveling wave actuators using waveguides of different geometrical forms. Shock and Vibration DOI: 10.1155/2016/4101062.
3. Grybas Ignas, Bansevičius Ramutis Petras, Jūrėnas Vytautas, Bubulis Algimantas, Janutėnaitė Jūratė and Kulvietis Genadijus (2016) Ultrasonic standing waves-driven high resolution rotary table. Precision Engineering 45:396-402.
4. Ostaševičius Vytautas, Markevičius Vytautas, Jūrėnas Vytautas, Žilys Mindaugas, Čepėnas Mindaugas, Kižauskienė Laura and Gylienė Virginija (2015) Cutting tool vibration energy harvesting for wireless sensors applications. Sensors and Actuators A: Physical 233:310-318.
5. Šakalys Rokas, Janušas Giedrius, Palevičius Arvydas, Čekas Elingas, Jūrėnas Vytautas and Sodah Amer (2016) Microstructures replication using high frequency excitation. Microsystem Technologies 22(7):1831-1843.

Biography

Grazvydas Kazokaitis has experience in design and R&D fields developing small and precise mechanisms for ultra-fast laser beam control and machining apparatus. This experience allows providing solid foundation and knowledge creating possible solutions for laser beam orientation mechanisms between small units in space, attitude control and other control tasks.

grazvydas.kazokaitis@ktu.edu

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