A Spherical Induction Motor with Hexahedron Stator for Attitude Control

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This study aims to design and fabricate a Spherical Induction Motor (SIM), which can provide a 3 degree-of-freedom angular momentum with only one motor and serve as the customized reaction sphere of Attitude Control System (ACS) in robots. Nevertheless, the efficiency of a conventional SIM is not only less than 20% but is also too complicated to be manufactured. To improve the efficiency and simplify the fabrication of a SIM, we design a hexahedron type stator, which requires only one molding die for fabrication and 3 pairs of power transistors for driving. The magnetic circuit analysis, equivalent circuit theory, Finite Element Analysis (FEA), prototype and the measurement of steady state speed and friction torque are implemented to assess the ratio of mechanical energy output under different input voltage and frequency. The FEA indicates that the efficiency of SIM can reach 89% and experiment reach 66% under ideal condition. Additionally, the steady state speed of prototype verifies the accuracy of design procedure. Finally, the mathematical model for SIM is constructed, which allows us to optimize its efficiency by setting the expected maximum angular momentum, input voltage and dimension. In conclusion, the manufacturing procedure of SIM with hexahedron stator is simplified, while the efficiency of SIM for attitude control can be increased. The mathematical model is effective and accurate for researcher to customize a SIM.

Awards Won:
Second Award of $2,000