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Integrated Motor Propulsor Magnet Design with Hybrid Halbach Array for Torque Ripple Reduction

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Recently, integrated motor propulsors (IMPs) have been under extensive research and development because of the numerous advantages of underwater propulsion for vehicles. IMPs require minimized torque ripple for smooth and quiet operation when used in undersea vehicles or unmanned submarines. Thus, torque ripple reduction should be considered in the design stage. In the IMP case, a permanent magnet (PM) design with a Halbach array should be developed. PMs with radial array are not available because of the minimized flux leakage. With regard to torque ripple reduction researchers have proposed various designs for IMPs. However, these research activities didn't consider the influence of the width ratio and material of PM in IMPs with a Halbach array. Therefore, this paper presents a magnet design with a Halbach array for torque ripple reduction according to the width ratio, and deals with influence of material of radial array permanent magnet. We believe that the proposed method is useful and effective in designing other models. This paper is divided into two main parts. The first part focuses on the PM width ratio, which use a downscaled PM to compensate for the torque pulsation. Because the magnetization of a magnet in the x-axis direction is the same as that in the air gap, the torque ripple varies. The second part is based on the PM material. Generally, the same arrangement is used in the Halbach array, but the back-emf is affected by the magnet width in the y-axis direction. The material of radial array PM does not matter if the material cahges because x-axis does not significantly affect the magnetic flux. The results are calculated by a two-dimensional finite element method (FEM). A more specific comparison with an accurate initial design method in consideration of the mechanical structure will be investigated for its contribution to related researches.

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