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Sat-Mo-Po.02-01: Research on magnetic driving model and control strategy of magnetic guidewire based on nonlinear magnetic field

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The magnetic field distribution of externally driven permanent magnets and its effects on the magnetic force and torque at the tip of a Magnetic Guidewire (MG) directly determine the precision of its deflection and movement. To enhance the control accuracy of MGs within blood vessels, this study proposes an MG magnetic driving model based on a nonlinear magnetic field. The research begins by solving the distribution of the driving magnetic field and calculating the magnetic force and torque exerted on the axially magnetized permanent magnet embedded at the MG tip. Subsequently, a kinematic model of the MG, incorporating a single axially magnetized permanent magnet at its tip, is developed based on Euler-Bernoulli beam theory and Cosserat rod theory. Finally, the proposed model is validated through experiments. The results indicate that, compared to the finite element method, the magnetic field calculation error of the model is within 0.048 T, the prediction error of the MG tip deflection angle is less than 5°, and the MG posture reconstruction error is less than 0.5 mm. These findings provide theoretical support and experimental evidence for the precise control of MGs in vascular interventional surgeries.

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