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Control design of a magnetic catheter navigation system for cardiac arrhythmias

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Nowadays, remotely-controlled catheter ablation has emerged as a novel approach to reduce fluoroscopy exposure and provide stable and reproducible catheter movement during in cardiac surgeries for arrhythmias. A remote catheter magnetic navigation system (MNS) which provides real-time navigation of the catheter in the heart is under development in IEE. The catheter navigation system consists of eight magnets aligned spherically, which generate the dynamically shaped magnetic field around the heart of the subject, about 15 cm3 region with a maximal uniform field of 0.2 Tesla. An X-ray generator is mounted underneath the subject's torso while the image detection system is above the subject's torso. Eight four-phase power supplies, which excite the eight magnets to create the needed magnetic field in time, are controlled by a programmed navigation software via a joystick providing the console. Different from CGCI, the magnetic field in our MNS is homogeneous in the navigation region, which only exerts sufficient torque on the ablation catheter tip, while the push/pull of the ablation catheter is carried out by another special device, with a stepping motor to push or pull the catheter. The navigation algorithm, which determines the performance of the system, is the soul of the catheter magnetic navigation system. In this article, how the navigation algorithm works is firstly introduced, and then four navigation algorithms are proposed and compared, and finally a navigation algorithm with simplicity and no dead zone in spherical coordinate system is chosen. Preliminary test results show that this navigation algorithm has good practicability and robustness and thus can be applied to the remote catheter magnetic navigation system.

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