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NEURAL NETWORK BASED FIXED-TIME CONTROL OF A FREE-FLOATING SPACE MANIPULATOR

Abstract

With the increasing urgent demand for on-orbit services of space devices, space manipulator has emerged as a focus point of research in spacefaring countries around the world. As one of the critical technologies in the field of aerospace, space manipulator plays a key role in on-orbit services, such as on-orbit assembly, on-orbit maintenance and on-orbit fuel refueling of spacecraft. The experience of the assembly and construction, maintenance and application of the International Space Station has shown that the use of space manipulator can assist or replace astronauts in completing on-orbit operation tasks in harsh space environments, improving the safety and benefits of space operations and applications, and substantially reducing the costs and risks of space exploration. Therefore, the system dynamics and control of space manipulator have received close attention. Given the importance of the space manipulator, it possesses a great challenge to control it accurately with the system converging and tracking quickly to achieve excellent results in the shortest possible or desired time. A fixed-time control method is proposed to address the problem of trajectory tracking for a free-floating space manipulator system. In the framework of fixed-time convergence, proposed are methods for model-based control and neural network learning., respectively. Neural networks are employed to address the uncertain components within the system, while radial basis function neural networks are applied to approximate the unknown elements inherent in the dynamical equations, it features excellent nonlinear approximation capability and advanced global approximation capability. The stability of the closed loop system is demonstrated according to the Lyapunov stability theory and the error in trajectory tracking converges to a small domain around zero. Simulation results show that the proposed control method has excellent trajectory tracking performance, can converge and compensate the uncertainty term of the system in a fixed-time, which verifies the effectiveness of the control algorithm.