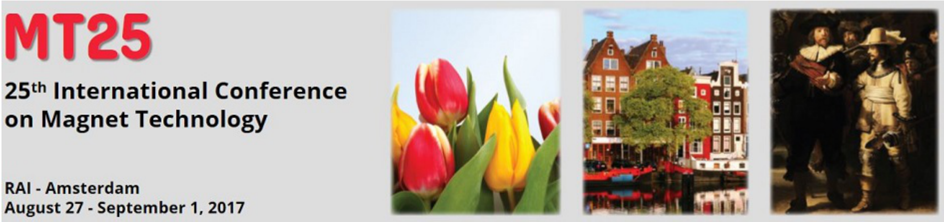

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Decoupling Control of Bearingless Synchronous Reluctance Motor Based on Differential Geometry

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Bearingless motors (BMs) with built-in magnetic bearings are receiving more and more attention. Compared with other types of BMs, the bearingless synchronous reluctance motor (BSRM) has been extensively investigated due to its advantages of simple structure, low cost, low temperature rising and high speed drive. The BSRM is a typical nonlinear multivariable system. There is a strong magnetic coupling among the electromagnetic torque and the radial suspension forces in the x- and y-direction. Therefore, the dynamic decoupling control is of particular importance to realize stable operation of the BSRM. The differential geometry method shows superiority in solving the problem of global linearization and decoupling control. In this paper, a new state feedback linearization method based on differential geometry theory is proposed to realize the decoupling control of the BSRM. Firstly, the mechanical structure and operation principle of the BSRM are analyzed, based on which the mathematical model is established. Secondly, the equation of state is established. The original nonlinear system is transformed to an equivalent affine nonlinear system. By using differential geometry theory and coordinate transformation, the state feedback control law is derived and this affine nonlinear system is transformed to three decoupled pseudo-linear subsystems, and then the closed-loop controllers are designed by using the single-input-single-output linear system theory. Thirdly, the simulation platform based on MATLAB/SIMULINK is developed. The simulation results show that the presented control algorithm based on the differential geometry theory can realize precise linearization of the original nonlinear system, and that the variables of motor speed, radial displacements in the x- and y-direction are decoupled effectively. Finally, the experimental platform of digital control system is established and experiments are performed. The corresponding experimental results show that the presented control algorithm realizes the stable suspension and rotation of rotor with satisfied dynamic and static performances.

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