开关磁阻电机自抗扰转矩控制系统研究

摘　要

开关磁阻电动机在工业制造、生产生活等领域有着广泛的应用，它的结构简单而坚固，工作稳定而可靠，效率高于很多传统电机，而由其构成的调速系统有很多可控参数，所以有很多控制方案。开关磁阻电机也有其固有的缺点：运行时的转矩脉动很大，还有严重的噪音和振荡问题。因此它的系统方案设计相比于其他电机更有局限性。学者们研究出一种瞬时转矩控制方案，它利用转矩分配函数技术，在一定程度上抑制了转矩脉动。但该方案依然难以解决当被控对象具有高度非线性和不确定性带来的转矩脉动的问题。为了解决这一问题，本次课题研究并利用自抗扰控制器对开关磁阻电机瞬时转矩控制系统进行改进与优化。

论文首先分析了开关磁阻电机的运行原理和工作特性，并重点对电机的数学模型进行了分析。然后，在众多电机控制方案中选择了瞬时转矩控制策略，该策略利用转矩分配函数来抑制转矩波动。在瞬时转矩控制策略的基础上，引入了另一种先进的控制理论——自抗扰控制对被控对象进行状态跟踪，通过估计整个系统的扰动误差对其进行前馈补偿，设计了转速环和转矩环的串级自抗扰控制器，提高了系统的动、静态特性，使系统运行更加稳定。该方案在降低转矩脉动的同时，使系统拥有更好的抗扰能力和鲁棒性。

最后，论文使用 MATLAB/SIMULINK 软件创建了该控制系统的仿真模型，对方案进行仿真试验。结果表明，与单一的瞬时转矩控制策略相比较，该方案在降低转矩脉动的同时，能提升系统的抗扰性和鲁棒性。验证了所提控制策略的可用性和有效性。

关键词：开关磁阻电机；瞬时转矩控制；转矩分配函数；自抗扰控制；鲁棒性

ABSTRACT

Switched Reluctance Motor（SRM） has a wide range of applications in industrial manufacturing, production and life. Its structure is simple and sturdy, its work is stable and reliable, and its efficiency is higher than many traditional motors. The speed control system composed of it has many controllable parameters. So there are many control schemes. Switched reluctance motors also have their inherent shortcomings: the torque ripple during operation is large, and there are serious noise and oscillation problems. Therefore, its system design is more limited than other motors. Scholars have developed an instant torque control scheme, which uses torque distribution function technology to suppress torque ripple to a certain extent. However, it is still difficult to solve the torque ripple problem caused when the controlled object has a high degree of nonlinearity and uncertainty. In order to solve this problem, this topic studies and uses the auto disturbance rejection controller to switch the reluctance motor instantaneously. The torque control system is improved and optimized.

The thesis first analyzes the working principle and operating characteristics of the Switched Reluctance Motor（SRM）, and focuses on the analysis of the mathematical model of the motor. Then, the instantaneous torque control strategy is selected in many motor control schemes, which uses the torque distribution function to suppress torque fluctuations. On the basis of the instantaneous torque control strategy, another advanced control theory is introduced——Auto Disturbance Rejection Control（ADRC） to track the state of the controlled object, feed forward compensation is performed by estimating the disturbance error of the entire system, and the speed is designed the cascade Auto Disturbance Rejection Controller（ADRC） of the ring and torque loop improves the dynamic and static performance of the system.The scheme reduces the torque ripple and makes the system have better anti-disturbance ability and robustness.

Finally, the research uses MATLAB/SIMULINK software to establish the

simulation model of the control system. Simulation results show that, compared with a single instantaneous torque control strategy, this scheme can improve the system's noise immunity and robustness while reducing torque ripple. The feasibility and availability of the proposed control strategy has been proved.

Keywords:Switched Reluctance Motor(SRM),Instantaneous Torque Control(ITC); Torque Share;Function(TSF); Active Disturbance Rejection Control(ADRC); Robustness