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一种横磁通风力发电机的建模及参数优化设计

Modeling and optimization of transverse flux permanent magnet generator

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中文摘要:

在横磁通风力发电机的设计与测试研究中，高质量的输出电压对风电机组背靠背变流器的可靠运行具有重要的影响作用。该文将正交设计、支持向量机非线性回归分析以及粒子群智能优化算法相结合，提出了一种以输出电压谐波最小为优化目标的横磁通发电机优化设计方法。首先，在基于标量磁位求解的三维有限元模型基础上，确定对发电机空载反电势敏感度较高的设计参数作为优化变量；其次，通过正交试验建立参数样本空间，并运用最小二乘支持向量机实现电机电磁模型的非线性回归建模，为电机优化所需的大规模迭代运算提供高效的计算模型；最后利用粒子群算法良好的全局优化特性进行寻优操作。通过一台1.5 kW聚磁式横磁通永磁同步发电机设计，优化方案的空载输出电压谐波含量为14.36%，比初始方案有所降低，证明了建模和优化方案的正确性和工程实用价值。

英文摘要:

Transverse Flux Permanent Magnet Generator (TFPMG) is a new but appears to be interesting candidate in direct-driven wind turbines for high electromotive force (EMF) density in air-gap and high efficiency at low speed. However, the output voltage of TFPMG with high quality is the crucial issue for back to back converter. To lower harmonic contents of EMF, a novel modeling and optimization method which incorporates Least Squares Support Vector Machines (LSSVM), Orthogonal Design Method (ODM), and Particle Swarm Optimization (PSO) in generator design procedure was presented. Based on the three-dimensional finite element method with scalar potential, the relationships between the machine parameters with leakages were investigated. The ODM was used to generate geometric information of trial samples. Function approximation of sample information performed by the LSSVM regression analysis provides an efficient way for parameters optimization with large-scale iterative computation. With the global search ability as well as the independence on original solution characteristics, PSO algorithm was employed to find the optimal design, which can guarantee the harmonic coefficients of non-load output voltage up to 14.36%, lower than original design. The measured result obtained from a 1.5 kW prototype test rig evaluates the effectiveness of the nonparametric modeling and the optimization method.

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