Ronghai Qu (S’01–M’02–SM’05–F’18) was born in China. He received the B.E.E. and M.S.E.E. degrees from Tsinghua University, Beijing, China, in 1993 and1996, respectively, and the Ph.D. degree in electrical engineering from the University of Wisconsin-Madison, in 2002. In 1998, he joined the Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC) as Research Assistant. He became a Senior Electrical Engineer with Northland, a Scott-Fetzer Company in 2002. Since 2003, he had been with General Electric (GE) Global Research Center, Niskayuna, NY, as a Senior Electrical Engineer with the Electrical Machines and Drives Laboratory. From 2010, he has been a professor with Huazhong University of Science & Technology, Wuhan, China. Prof. Qu was the recipient of 11 awards from GE Global Research Center including the Technical Achievement and Management Awards. He has authored over 260 published technical papers including 5 best conference papers. Dr Qu is the also holder of over 80 patents/patent applications.

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List of the lecture topics with the titles and short abstracts

1. Flux modulation machines

Flux modulation machines, different from regular electrical machines, are with different stator and rotor pole numbers, and produce more steady torque based on the flux modulation effect. The special operation principle makes flux modulation machines high-torque density and low-pulsation torque. More design freedom leads to many novel machine topologies for different applications. This presentation will summarize the principle, topologoies, performance and applications of Flux Modulation Machines.

2. Linear Vernier machines

Direct-drive linear machines are used more frequently in linear motion systems due to the elimination of gear boxes, chains and screws couplings. Force density and force ripple are the most important performance indexes of linear machines, among which the former determines the machine volume and cost, whereas the latter influences the position accuracy. Regular linear permanent magnet (PM) machines cannot simultaneously realize high force density and low force ripple, while linear vernier PM machines do. The Vernier linear machine has been proven to exhibit ~50% lower ripple force and ~20% higher force density than the regular linear PM machines.

3. Multi-port electric machines

Multi-port electric machines have been developed to achieve complicated function, such as power-splitting in HEV and VSCF wind power generation by a compact structure. This lecture will give a comprehensive introduction over different multi-port machines, including application backgrounds, topologies and working principles, electromagnetic performance. Moreover, some challenges such as parasitic effects of multi-port machines are analyzed.

4. Superconducting electrical machines

Superconducting electrical machines are machines that apply superconductors to the field windings or even armature windings. They are with smaller volume, lower weight, higher efficiency and extremely high torque density compared with conventional electrical machines. They are promising in fields of high torque density or high power density, such as generators for offshore wind turbines, ship electric propulsion and even aero-propulsions for more-electric or all-electric aircrafts.

5. Axial flux machines

The presentation first gives an overview of the requirements of electrical machines for electric vehicles and discusses potential solutions with axial flux technique, including detached double-three phase winding AFPM, multi-disc flux modulation AFPM, multi-port (2M&2E) AFPM for HEV, to meet future cost, reliability and power density challenges. Specific mathematical model and model predictive current control for post-fault operation will be introduced as well for double-three phase machine. Different examples of electrical machine projects undertaken at HUST will then be presented to give an overview of the current research work being performed.

6. Vernier reluctance machines

This talk focuses on a new type of reluctance machine named stator DC excited Vernier reluctance machines (DC-VRMs). The basic theory and design issues of DC-VRMs are investigated. For the machine structure, DC-VRMs adopt double salient structure with single stator winding, and it can reduce copper loss significantly. All the windings can be arranged as non-overlapping concentrated coils to achieve short end windings and high reliability. DC-biased Vernier reluctance machines and DC-biased PM-assisted vernier machines will be introduced as well.