Power Electronic Systems
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Lectures on Power Electronics and Mechatronics

Date	Feb. 21, 2020
Location	ETZ E81 / ETH Zurich, Gloriastrasse 35, 8092 Zurich
Time	8.30h – 9.30h

Prof. Dr. Elena Lomonova, TU Eindhoven, Netherlands

Electromagnetic Propulsion, Suspension and Levitation – New Concepts of Bearingless Systems for High-Precision Industry

Magnetically levitated planar motors are the best candidates of the electromagnetic motion systems for wafer scanners in the lithographic industry because of their clean-room and vacuum compatibility. Using the magnetic fields for bearingless motion concepts, they have to be controlled actively in six degrees-of-freedom for stable operation. Therefore, all force and torque components acting on the translator should be accessible and be decoupled. Typically, they provide the long stroke *xy*-movements, a short stroke along the *z*-axis, and small rotations around all axes. High-precision bearingless planar motors with magnetic levitation and sub-micrometer accuracy are usually of PM synchronous type. In contrast to these levitated planar motors, a novel enabling magnetic suspension system underneath a stationary frame – elevated propulsion stage is developed. It requires an attractive normal force between the frame and the translator to counteract the gravitational force, whereas magnetic levitation above a stationary frame is based on a repulsive normal force. In this respect, basically many topologies (synchronous PM, induction, reluctance ones) are applicable. Several possible topologies for both concepts of bearingless magnetically levitated and suspended systems are treated, a thorough electromagnetic analysis, and several design and performance criteria are discussed. The decoupling techniques for force and torque components are demonstrated with the aim to realize an active magnetic bearing principle. Additionally, the symmetrical propulsion behavior along x and y axes, and wireless energy transfer from the stationary platform to the moving platform are demonstrated. All theoretical findings are verified with experiments of fully operational magnetically levitated and suspended stages.

Biography

Elena Lomonova received the MSc degree (cum laude) in Electromechanical and Control Systems from the Moscow State University of Aerospace Technology (MAI), Russia, in 1982. She gained her PhD in 1993, researching powertrain and control systems for autonomous vehicles with multi-level power supply subsystems for on-board loads and laser equipment. In 1998 Elena started working for TU Delft, before joining TU Eindhoven in 2000. In March 2009 she was appointed Professor, becoming Chair and Head of the Electromechanics and Power Electronics (EPE) group at TU/e.

She contributes to the field of complex cyber-physical systems through her multi-disciplinary approach to fundamental and application oriented research in mechatronics and electromechanical motion systems, power electronic system architectures, and power converters. She has been involved in 45+ PhDs, has published over 300 peer-reviewed publications, 500+ scientific publications, is cited in over 4,900 papers, and awarded 15 patents. She is a reviewer of several scientific journals, and is serving as Associate Editor of IEEE Transactions on Power Electronics and the IEEE Mechatronics Journal. In 2016 she was the winner of the Nagamori Award, for her work on new concepts, design methods, development and realization of advanced multi-degrees of freedom permanent magnet actuation and vibration isolation systems. In 2019 she received the Lifetime Contribution to Magnetics Award, UK Magnetics.

The lecture is open to the public. The event takes place within the scope of the Swiss Chapter of IEEE Power Electronics Society.