Technische Universiteit **Eindhoven** University of Technology

Electromechanics and Power Electronics group

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Ir. C.G.E. Wijnands, university fellow (part-time)
Dr. J.L. Duarte, assistant professor
Dr.ir. J.W. Jansen, assistant professor
Dr.ir. H. Huisman, assistant professor (part-time)
Dr.ir. T.E. Motoasca, assistant professor
Dr.ir. J.J.H. Paulides, assistant professor

Mission

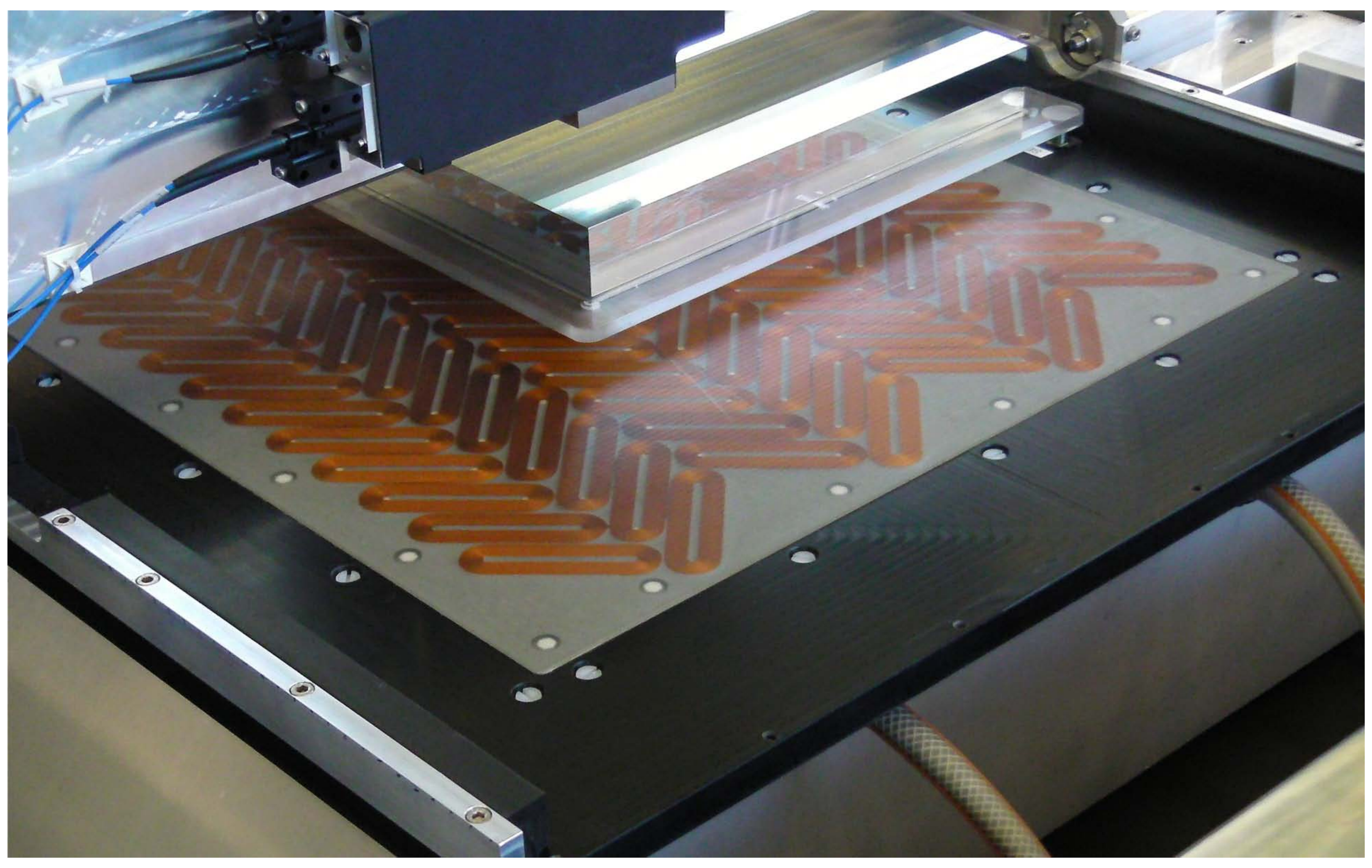
The mission of the Electromechanics and Power Electronics (EPE) group is to carry out fundamental research on enabling energy conversion theory, methods and technologies on which future developments in electromechanics, power electronics and motion systems are depending. The EPE group wants to remain the academic front runner in terms of sustainable energy conversion systems in the Netherlands.

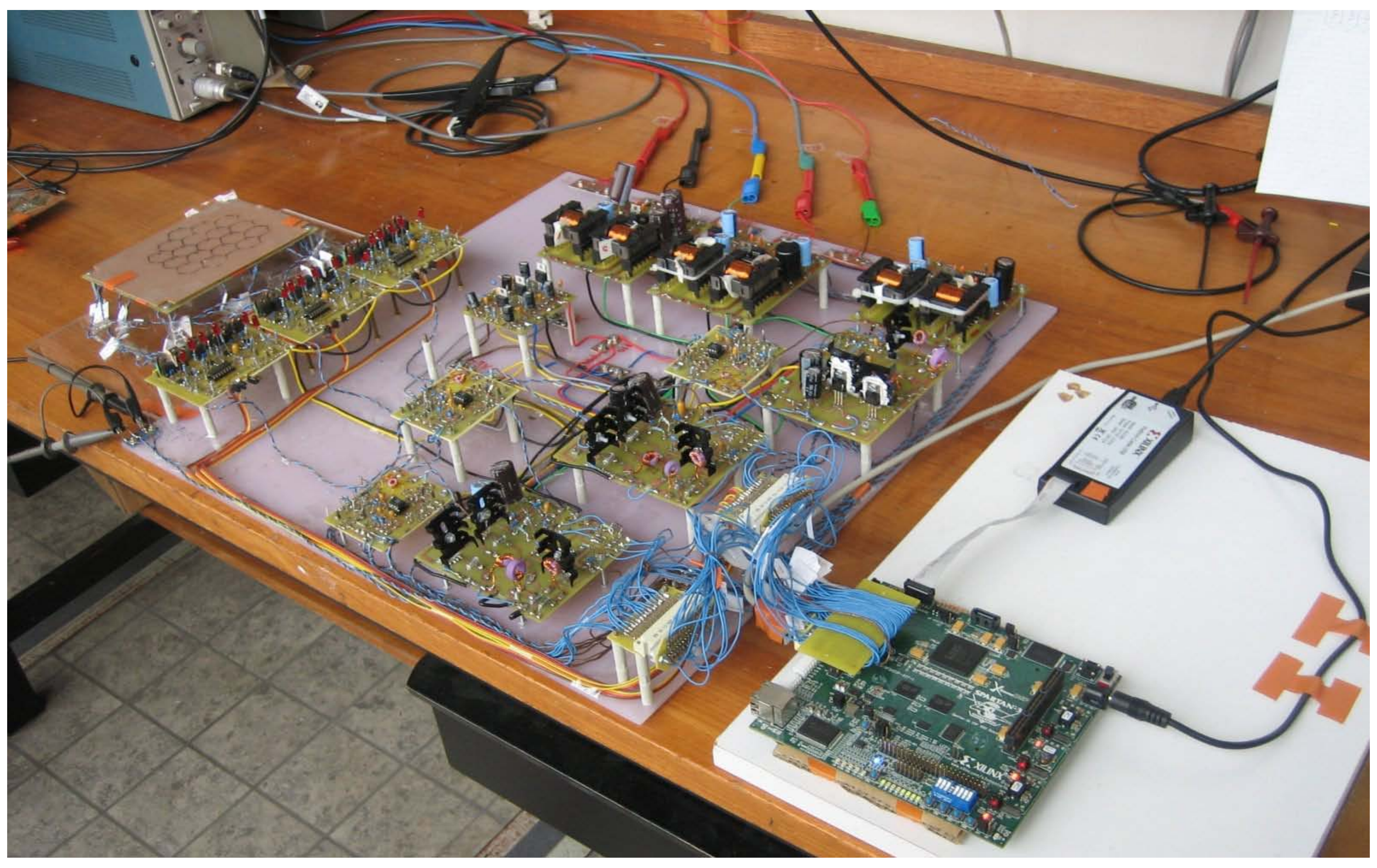
In many research projects both fundamental aspects as well as practical aspects are addressed because experimental verification is essential in our field. The EPE group has a modern and versatile laboratory infrastructure to carry out experiments. A mechatronic system approach is often required, in which not only specialists from the fields of electromechanics and power electronics but also from the fields of electromagnetism, material science, control engineering, mechanical engineering and thermodynamics are involved.

Research directions

The research in the EPE group has strongly grown in the past years because of the industrial demands for innovative and energy-saving conversion systems. The research has been greatly supported by the national and international programs, such as IOP-EMVT, Point-One, FP7 and by direct industrial grants. The research in the group is carried out in five interlinked directions:

- High-precision motion systems,
- Biomedical systems,
- More-electric and sustainable society,
- Batteries and other energy storage system
- Power electronics for industrial, medical and automotive applications.





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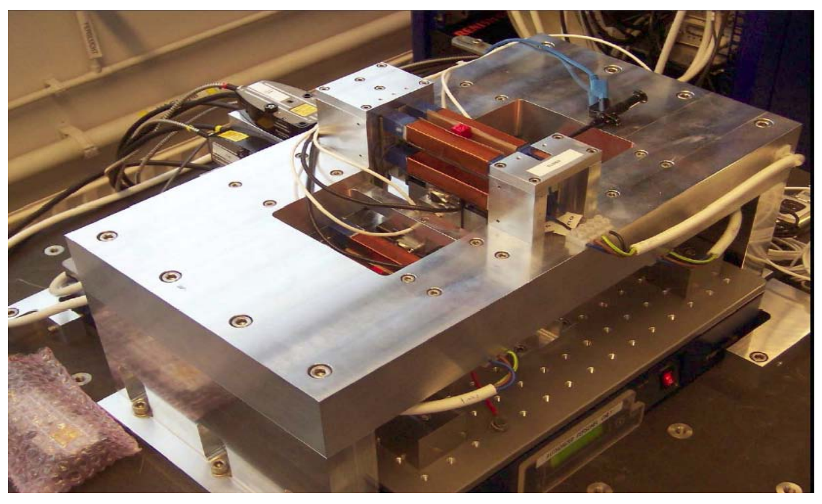
High-Precision Motion Systems

In high-precision equipment many actuators are assembled in large motion systems which can achieve (sub-) nanometer position accuracy. Smarter actuator solutions, in which multiple degrees-of-freedom, magnetic levitation, and contactless energy transfer are integrated in one design, will improve the accuracy, the speed and the acceleration of these systems.

Research into all transient aspects of energy conversion including dynamic force and field distributions and parasitic eddy-current and hysteresis effects must be carried out to create a new generation of high-precision actuators.



Magnetically levitated motion system.

Biomedical Systems

New electromechanical (micro) devices and technologies specially designed for medical applications have nowadays an important role in the society. The research challenge for the biomedical systems ranging from medical robotics and haptic surgical tools to medical implants and assisted life technologies is the design of new types of distributed actuators that will meet specific requirements of safety, mobility, flexibility, low power consumption, etc.

Fundamental research challenges are also the modeling of the interaction of low-frequency electro-magnetic fields with biological matter and the development of new devices and methods for electro-magnetic stimulation of brain, muscles, skin, etc.

More-Electrical and Sustainable Society

A more-electric and sustainable society can only be reached by high efficient and power density energy conversion systems. As these systems are increasingly complex it becomes harder to predict their behaviour. Hence, individual component optimizations and designs are not sufficient anymore. Therefore these advanced electrical components have to be modelled, designed and experimentally verified considering their system context.

This research creates system of systems that are verified with experimental data to achieve a more-electric and sustainable society by incorporating advanced highly efficient and power dense E-components.

Series-hybrid electrical truck.

Rechargeable Batteries and other Energy Storage Systems

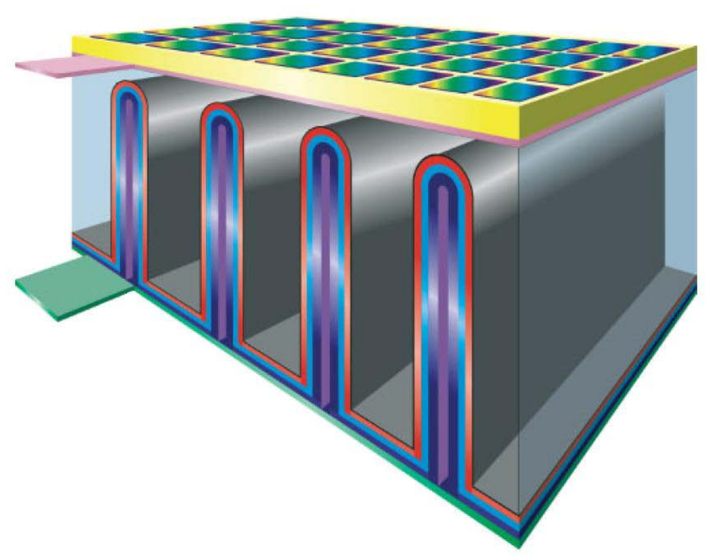
Modern society urgently needs more sustainable energy. It is commonly accepted that electricity storage systems are key for energy efficient technologies. Li-ion and nickel metal hydride (NiMH) batteries are examples of mature electricity storage technologies while hydrogen is considered as one of the most important future energy carrier. Efficient and safe operation of batteries requires sophisticated Battery Management Systems (BMS). The core of modern BMS is formed by a mathematical model of the battery (pack), emphasizing the importance of a deep understanding and ability to model complex (electro)chemical and physical processes occurring inside batteries.

Power Electronics for Industrial, Medical and Automotive Applications

Power electronics have become the most important power conversion technology in evermore applications because of their broad and unique capabilities. Power electronics have to provide reliable, efficient, small-sized, and cost-effective solutions for (hybrid) cars, all-electric ships and airplanes, and for flexibly distributing our energy sources around the globe. Also equipment for medical and diagnostic applications critically depends on miniaturized high-voltage and high-frequency power electronics.

The main challenges for power electronics are first integrating new technology development, like wide-bandgap semiconductors and near infinite computing power, and second, capitalizing on the synergy with electromechanical research, especially in the automotive area.

Multi-converter system.



Integrated micro-battery with solar cell.