

ICT PHD

Research project for a PhD curriculum in ICT –Industrial Applications of ICT

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Proposed Title of the research: Design of more-electric tractors for a more sustainable agriculture

Keywords: (5) Electrical machines, power density, Sustainability, Torque density, Electric Tractors

Research objectives: --(max 10 rows)

Electrification in off-highway vehicles, such as tractors, is still in its initial stage. For these vehicles, movement is only a limited part of the work activity, as mechanical power to the power take-off (PTO) or hydraulic controls is typically required. This results in difficult identification of the best electrification strategy for the vehicle. However, interest in electric or hybrid tractors is on the rise. This is confirmed by both producers and the European Agency, which promotes initiatives in the field of sustainable growth, such as the Flagship Initiative "Resource efficient Europe".

The proposed research aims to obtain an improvement in the environmental sustainability of the vehicles and tools used in agriculture, in a manner consistent with the objectives of the national plan of recovery and resilience PNRR.

In particular, the specific objectives of the project are the following:

- Definition of the typical load profiles of the tractor considering different equipment and operating conditions;
- Identification of the best electrification topology for the vehicles to meet the required workload;
- Identification of the components to be electrified in the vehicles, definition of requirements and their sizing (motors, converters and related controls);

Proposed research activity -- (max 10 rows)

A complete model of the tractor will be developed through the project. This is important to fully understand the requirements and behaviour of the vehicle. The model, developed in matlab/simulink, will be optimized and fine-tuned thanks to the experimental data made available by the CNH company.

Various electrification topologies will be considered and implemented in the model, which will be used as a common tool for researchers. The model will include sub-models for each subsystem designed. The model will identify the requirements of the various loads: torque, speed and power, which will be suitably characterized. This will allow to precisely define the torque / power capacity of the various electrical machines and to obtain a complete energy balance of the vehicle. The analysis will consider different operations and workloads. As a result, it will be possible to define an appropriate configuration and design for each motor / drive, by considering separately the drive, power take-off and auxiliaries.

Supporting research projects (and Department)

The successful candidates will become part of the research team of electrical machines and converters of the University of Modena and Reggio Emilia, which has been working for some time on the issues of electrification with collaborations and participation in research projects at national, European and extra-European level. UniMore will make available the MeltingLab laboratory which collects equipment and devices for the design and test of converters and electrical machines.

Possible connections with research groups, companies, universities.

The activity will be carried out in close collaboration with the CNH company, which will make available its laboratories and databases of measurements collected in the field of the main operating parameters of the tractors. These data will represent a fundamental source of information for the definition of the hybrid architecture that will be developed. A period of work at one of the company's foreign offices is provided for a minimum period of 6 months. To this is added a period of 6 months at the CNH headquarters in Modena, for the study and collection of the data necessary for the research survey.