DIN - DEPARTMENT OF INDUSTRIAL ENGINEERING

PhD Course in Mechanics and Advanced Engineering Sciences (DIMSAI)

PHD STUDENT POSTER - AY *2016/2017* **Curriculum number *2*** **Cycle *XXXII***

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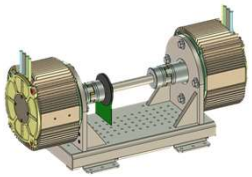
Modeling, control and diagnosis of hybrid powertrains

2017 Activities

Open Source ECU

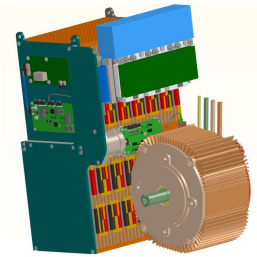
- An open source ECU has been developed in order to obtain a common hardware platform capable to run customized model based, real time control algorithms for hybrid powertrains.
- It contains all the hardware to acquire all the sensors and drive the actuators that can be found in a modern GDI or Diesel ICE.



B2B test bench for electric machines

Back to Back testing is accomplished through two identical machines, one is functioning as a motor while the other is functioning as a brake. This configuration gives many advantages, such as:

- **Testing time is halved** since we can evaluate two points of the motor characteristic at the same moment.
- **The power supply requirements are drastically reduced**: the energy recovered by braking is directly fed back to the motor. In this way the only the power to be supplied to the system is the power lost due to inefficiencies (about 20% of the total power)
- Expensive and bulky power supplies or electrical loads are no longer required.



Battery pack and inverter development.

Within the MotoStudent project, a battery pack and an inverter for an electric motorbike will be designed

- State of the art BMS together with high speed current sensor allows precise SOC and SOH estimation for each cell.
- Online individual **cell balancing** for reduced charging time.
- Solid state **gas sensor** allows immediate detection of cell venting for improved safety.

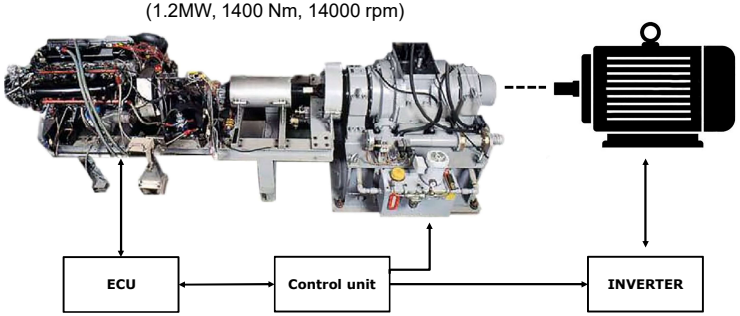
Novel semiconductor technologies such as SiC and GaN are under evaluation in order to obtain higher power density and efficiency compared to industry standard IGBT modules.

Planned for 2018

Electrically Assisted Water Brake

Conventional water brakes are known to offer high power capability, small size, light weight, and low manufacturing costs. The major drawback is that they exhibit poor dynamic performance, restricting the field of use to the steady-state testing. The idea is to couple the water brake with a relatively small electric machine that can cover the performance gaps of the water brake during load change transients. Such configuration can also give additional benefits such as partial energy recovery and the ability to start the ICE without an external starter.

Conventional high speed hydraulic dynamometer for racing car engine test
(1.2MW, 1400 Nm, 14000 rpm)



Challenges and goals:

- Mechanically couple an electric motor to an existing, off-the-shelf, water brake
- Apply the know-how acquired during this year to design and control an electric drive for such motor
- Develop a model-based control system that takes into account the characteristics of both machines in order to obtain a braking torque characteristic comparable or better to conventional Eddy current brakes.

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