JMAG-RT: A General and Accurate Motor Model for Real-time Simulation of Motor Drives

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Real-Time 2010
June 27-30, 2010
Paris, France

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About US

- *JSOL*
  - *Employees : 1,300*
  - *Offices : Tokyo, Osaka, Nagoya, Sapporo*
  - *Businesses : IT consulting, System integration, **CAE***

- *Computer Aided Engineering (CAE) Business*
  - *Mechanical*
    - *LS-DYNA*
    - *JSTAMP*
  - *Fluid flow*
    - *AcuSolve*
  - *Electromagnetic*
    - *JMAG*
    - *EMC Studio*

Today's Electrical Machine Design

- *Requirements for electrical motors are becoming so high; very powerful, very efficient and very low cost.*
- *Electric motors are a mature product with over 100 years of history that are difficult to innovate.*
- *To achieve this goal, most efforts are focused in the details.*

Today's Electrical Machine Design

- *Small changes to detail have worked, e.g. modifying shapes of cores and using fine structures have realized higher performance.*
  - *M. Kaizuka, "Development of 2005 Model Year ACCORD Hybrid", JMAG Users Conference 2005*
  - *A.Takehara, "Development and Challenges of Motors for Toyota's Hybrid Vehicles", JMAG Users Conference 2009*

HILS and the Machine Design

- *Why are machine designs' efforts ignored?*
- *Simple inductance (Ld-Lq) models can NEVER capture the behavior of the machine.*
- *The behavior model can be composed from measurements. However, the value of simulation is evaluating things without 'real' systems or devices.*

JMAG-RT for HILS

- *A solution is use of FEA which can capture the details and predict characteristics without having 'real' machines.*
- *JMAG uses JMAG-RT to automatically generate accurate motor models by extracting characteristics of the motor in FEA.*
- *JMAG-RT runs in SILS/HILS.*
  - *C. Dufour et al, "Modern Hardware-In-the-Loop Simulation Technology for Fuel Cell Hybrid Electric Vehicles", JMAG users conference 2007*

Evolution of JMAG-RT

- *ISSUES*
  - *More accurate models are required.*
    - *Today's machines have higher energy density and higher magnetic saturation that leads to more complex behavior than before.*
  - *Who will make JMAG-RT?*
    - *We know…*
      - *HILS people hate FEA.*
      - *FEA people are not so cooperative for HILS.*

Evolution of JMAG-RT

- *‘More accurate models are required.’*
- *The higher accuracy can be achieved with the latest version of JMAG-RT.*
  - *It captures slot-harmonics under magnetic saturation to reproduce accurate torque, current and voltage.*

Evolution of JMAG-RT

- *‘Who will make JMAG-RT?’*
- *JMAG-Express is now available. You can make your own JMAG-RT models in JMAG-Express without any FEA skill or knowledge.*

Evolution of JMAG-RT

- *Current developments*
  - *Loss models*
  - *Temperature dependency*
  - *Induction machines*

Summary

- *An electric motor is a key component for P.E. systems and is evolving with 'innovative' ideas.*
- *The innovative ideas are implemented in details which have been ignored in HILS.*
- *JMAG FEA provides an accurate motor model, JMAG-RT, which can represent those details.*
- *The latest version of JMAG-RT works well for today's high energy density machines.*
- *JMAG-RT is continuously enhanced to respond to market demands.*