MARIE CURIE ACTIONS

Energy-SmartOps

Integrated Control and Operation of Process, Rotating Machinery and Electrical Equipment

SIMULINK MODELS OF FAULTY INDUCTION MACHINES FOR DRIVE APPLICATIONS

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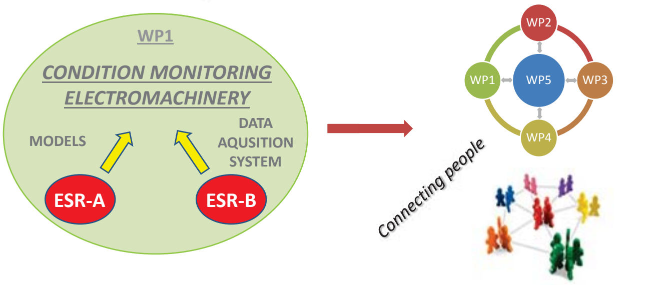
MY PROJECT IN ENERGY SMARTOPS

Energy efficiency and CO_2 reduction through control and operation process strategies



Prediction through analysis and diagnosis leads to value data used to decide for making decisions about control and operation strategies

PROBLEM STATEMENT

Fault diagnosis through detection of additional frequency components due to faults

1st Circuit Approach + Harmonic Balance Method (Mathematical Modeling)

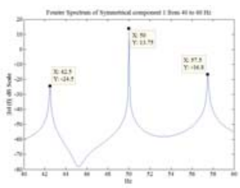
$$\frac{d}{dt}\begin{bmatrix}\Psi_{sd}\\ \Psi_{sq}\\ \Psi'_{rd}\\ \Psi'_{rq}\end{bmatrix}+\begin{bmatrix}-\omega_s\cdot\Psi_{sq}\\ \omega_s\cdot\Psi_{sd}\\ -\omega_r\cdot\Psi'_{rq}\\ \omega_r\cdot\Psi'_{rd}\end{bmatrix}+R\cdot\begin{bmatrix}i_{sd}\\ i_{sq}\\ i'_{rd}\\ i'_{rq}\end{bmatrix}=\begin{bmatrix}u_{sd}\\ u_{sq}\\ u'_{rd}\\ u'_{rq}\end{bmatrix}$$

$$R=\begin{bmatrix}R_s & 0 & 0 & 0\\ 0 & R_s & 0 & 0\\ 0 & 0 & R_r'^p\cdot(1+k_s+k_{as}\cdot cos(2\gamma_r)) & R_r'^p\cdot k_{as}\cdot sin(2\gamma_r)\\ 0 & 0 & R_r'^p\cdot k_{as}\cdot sin(2\gamma_r) & R_r'^p\cdot(1+k_s+k_{as}\cdot cos(2\gamma_r))\end{bmatrix}$$

$$J\frac{d\varphi_r{}^2}{dt}-D\frac{d\varphi_r}{dt}=\mathrm{T}_{elec}-\mathrm{T}_{load}\ ;\frac{d\varphi_r}{dt}=\omega_r$$

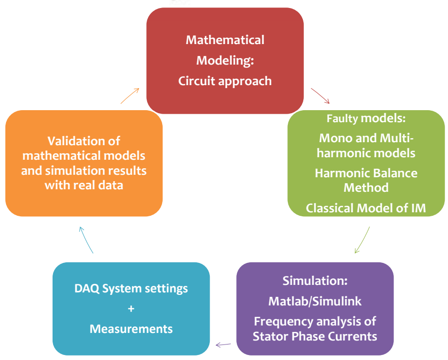
$$\begin{bmatrix}\Psi_{sd}\\ \Psi_{sq}\\ \Psi'_{rd}\\ \Psi'_{rq}\end{bmatrix}=\begin{bmatrix}L_{\sigma s}+L_m & 0 & L_m & 0\\ 0 & L_{\sigma s}+L_m & 0 & L_m\\ L_m & 0 & L'_{\sigma r}+L_m & 0\\ 0 & L_m & 0 & L'_{\sigma r}+L_m\end{bmatrix}\cdot\begin{bmatrix}i_{sd}\\ i_{sq}\\ i'_{rd}\\ i'_{rq}\end{bmatrix}$$

2nd Frequency Detection: Alternative algorithm of Fourier Analysis
+
Configuration DAQ System: Matlab/Simulink & Labview



METHODOLOGY

Faults: Cage asymmetry, Mechanical faults, Eccentricity, Stator Short circuits



MODEL PREDICTIVE CONTROL

Model predictive control (MPC), also known as receding horizon control, inherently handles input and state constraints by solving a constrained finite-time optimal control problem at each sampling instant.

x(k+1)=Ax(k)+Bu(k)
y(k)=Cx(k)+Du(k)
$x(k) = x_0$

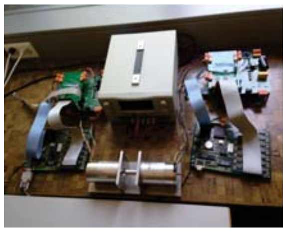
Subject to system constrains

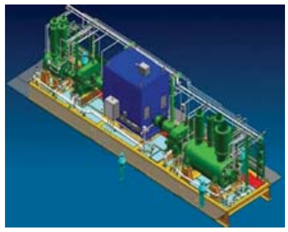
Wind turbine emulator

- Emulator ready for testing purposes – relations between inputs /outputs and system states and constraints
- Tracking problem: Characteristic Load Torque profile of Wind turbines

Future Work

- Load torque profile of axial compressors: convert mass flow and pressure ratio in speed and torque.

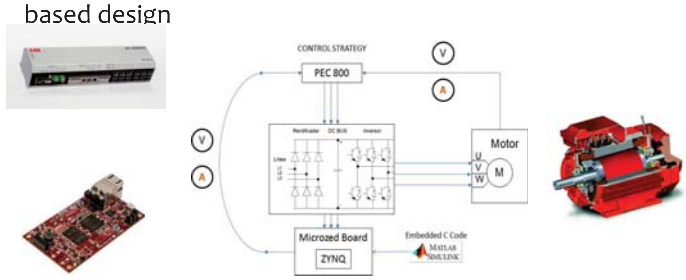




DRIVES APP. WITH FAULTY MODELS

Study of interactions between faulty models and drive applications

- C code and HDL coder generation from Simulink/Matlab
- Hardware-in-loop simulation
- Testing high-performance control system for model-based design



FUTURE WORK

- *Reduce Model of Mixed eccentricity and Stator short circuit*
- *End of IM test-bench setup + measurements*
- *Model predictive control of electrical motors*
- *Implementation of models into ARM+FPGA*

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