Research Activities of Electric Machinery and Control Laboratory

Adviser: Chair Professor Faa-Jeng Lin
Department of Electrical Engineering
National Central University

2016-01-07
Areas of Research

- Intelligent control systems including fuzzy, neural network and GA
- Ultrasonic, synchronous and induction motor servo drives (rotating and linear)
- Magnetic levitation
- Piezoceramic actuator
- Induction generator system
- Nonlinear and adaptive control
- Power electronics
- Renewable Energy
- Microgrid
- DSP-based computer control systems and computer interface
- Digital and analog circuits, VHDL, Spice
Experimental Equipments
Experimental Equipments

- Linear Induction Motor
- Two-Axis Motion Control System
- Five Degree-of-Freedom Active Magnetic Bearing Control System
- Magnetic Levitation System
Experimental Equipments

Three-Phase Induction Motor Drive

Linear Induction Motor Drive

Linear Permanent Magnet Synchronous Motor Drive

High-Efficiency Permanent Magnet Synchronous Motor Drive
Experimental Equipments

- Three-Axis Stage with Linear Ultrasonic Motors
- Permanent Magnet Synchronous Wind-Turbine Generator
- Gantry Position Stage
- DSP28335 Based BLDC Motor Drive System
Experimental Equipments
Experimental Equipments

Wind Turbine Emulator and Induction Generator

Converter and Inverter for WTG

Inverter System for Microgrid

Electric Power Steering Emulator
Experimental Equipments

- Dynamic Signal Analyzer
- Programmable AC Power Sources
- Precision LCR Meter
- Digital Oscilloscope
Experimental Equipments

DC Power Supply (200V/25A)

Digital Oscilloscope (400MHz)

DC Electronic Loads

Programmable AC Power Sources
Experimental Equipments

- PV Emulator
- Three-Phase Power Analyzer
- Programable 3-phase Power Source
**Research Achievements**

Recurrent-Fuzzy-Neural-Network Control Linear Induction Motor Servo Drive Using Genetic Algorithm

System configuration of indirect field-oriented control LIM servo drive
Research Achievements

Recruitment-Fuzzy-Neural-Network Control Linear Induction Motor Servo Drive Using Genetic Algorithm

Control block of LIM servo drive with GA-based RFNN controller
Research Achievements

Fuzzy Sliding-Mode Control Linear Induction Motor Drive Using FPGA

Control block of FPGA-based LIM servo drive
Research Achievements

Robust Fuzzy-Neural-Network Sliding-Mode Control for Two-Axis Motion Control System

DSP-based two-axis motion control system
Robust Fuzzy-Neural-Network Sliding-Mode Control for Two-Axis Motion Control System

RFNN Sliding-Mode Control System

Reference Model

Adaptive Uncertainty Estimation

Robust Controller

Fuzzy Neural Network Estimator

Field-Oriented Control PMLSM Servo Drive

RFNN sliding-mode control system
Research Achievements

Frequency Control Induction Generator System Using Recurrent-Fuzzy-Neural-Network

Control block of induction generator system with RFNN control
Research Achievements

Frequency Control Induction Generator System Using Recurrent-Fuzzy-Neural-Network

Structure of four-layer RFNN
Research Achievements

Synchronous Motor Drive System Using DSP and CPLD

System configuration of field-oriented control PMSM servo drive
Research Achievements

Synchronous Motor Drive System Using DSP and CPLD

System block of PMSM servo drive

Electric Machinery and Control Lab, Department of Electrical Engineering, National Central University, Taiwan.
Research Achievements

X-Y-θ Motion Control Stage Using Linear Ultrasonic Motors

System block of X-Y-θ motion control stage
**Research Achievements**

X-Y-0 Motion Control Stage Using Linear Ultrasonic Motors

Robust SAFNN backstepping control system
Research Achievements

Magnetic Levitation System Using DSP

System block of magnetic levitation apparatus
Intelligent sliding-mode control system using a radial basis function network (SMCRBFN)
Research Achievements

Five degree-of-freedom active magnetic bearing system using PC

System block of five degree-of-freedom active magnetic bearing
Research Achievements

Five degree-of-freedom active magnetic bearing system using PC

Adaptive complementary sliding-mode control system using Hermite neural network
Research Achievements

Gantry position stage using DSP

System block of gantry position stage

DSP-based control computer

TMS 320VC33
parallel port
flash EPROM
D/A converter
encoder interface

X-axis motor drive

i_{qxx}^* 

Y1-axis motor drive

i_{qyy1}^* 

Y2-axis motor drive

i_{qyy2}^* 

X-axis PMLSM

Linear Scale

Linear Scale

Linear Scale

Y1-axis PMLSM

Y2-axis PMLSM
Cross-coupled synchronous control using Sugeno type fuzzy neural network estimator
**Research Achievements**

Sensorless drive system for PMSM compressor using dsPIC

System block of sensorless drive system for PMSM compressor
Research Achievements

Sensorless drive system for PMSM compressor using dsPIC

Control block of high frequency signal injection method
Research Achievements
Research Achievements

Intelligent control PV system using PWFNN with LVRT under grid fault
Research Achievements

Network structure of probabilistic wavelet fuzzy neural network (PWFNN)
Fault tolerant control led six-phase PMSM drive system using TSKFNN-AMF control
Research Achievements

TSK type FNN with asymmetric membership function

\[ net^2_j(N) = \begin{cases} -\frac{(y^1_i(N) - m_j)^2}{\sigma^2_j}, & -\infty < y^1_i(N) \leq m_j \\ -\frac{(y^1_i(N) - m_j)^2}{\sigma^2_j}, & m_j < y^1_i(N) < \infty \end{cases} \]

\[ y^2_j(N) = \exp(net^2_j(N)) \]

\[ y^i_q^*(N) = y^5_o = \sum_k w^5_k(N) y^k_i(N) \]

\[ y^4_k(N) = y^3_k(N) T_k(N) \]

Layer 5 (Output Layer)

Layer 4 (Consequent Layer)

\[ y^3_k(N) = \prod_j w^3_{jk} y^2_j \]

\[ T_k(N) = \sum_i c^i_{ik}(N) x^i(N) \]

Layer 3 (Rule Layer and TSK Type Fuzzy Inference Mechanism)

Layer 2 (Membership Layer)

Layer 1 (Input Layer)
Research Achievements

Micorgird system including storage, PV, WTG and islanding detection using intelligent control
Research Achievements

Intelligent control microgird system at grid connection mode
Research Achievements

Intelligent control microgrid system at islanding mode