

Liaw, Chang-Ming (廖聰明)

Professor

Ph.D., National Tsing Hua University, 1988

Power Electronics, Motor Drive, Electric Machine Control

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Dr. Liaw was born in Taichung, Taiwan, ROC, on June 19, 1951. He received the B.S. degree in electronic engineering from Tamkang College of Arts and Sciences, Taipei, Taiwan, in 1979, and the M.S. and Ph.D. degrees in electrical engineering from National Tsing Hua University, Hsinchu, Taiwan, in 1981 and 1988, respectively. In 1988, he joined the faculty of National Tsing Hua University as an associate professor in electrical engineering. Since 1993, he has been a professor in the Department of Electrical Engineering. His areas of research interest are Power Electronics, Motor Drive and Electric Machine Control.

Dr. Liaw is a life member of the CIEE and a member of the IEEE. He currently is an editorial member of the IEE Proceedings, Electric Power Applications; an editor of the International Journal of Electrical Engineering; and a member of technical committee of the Chinese National Laboratory Accreditation (CNLA).

Publication Lists (2001~2005)

1. Journal Papers:

- [1] K. H. Chao and C. M. Liaw, "A three-phase soft-switching inverter for induction motor drives," IEE Proceedings, Electric Power Applications, vol. 148, no. 1, pp. 8-20, 2001. (SCI,0)
- [2] H. C. Chen, M. S. Huang, C. M. Liaw, Y. C. Chang, P. Y. Yu and J. M. Huang, "Robust current control for brushless DC motors," IEE Proceedings, Electric Power Applications, vol. 147, no. 6, pp. 503-512, 2001. (SCI,1)
- [3] B. J. Kang and C. M. Liaw, "Harmonic spectrum randomization for hysteresis current-controlled PWM inverter via robust spectrum shaping," IEEE Transactions on Aerospace and Electronic Systems, vol. 37, no. 2, pp. 619-629, 2001.
- [4] C. M. Liaw, R. Y. Shue, H. C. Chen and S. C. Chen, "Development of a linear brushless DC motor drive with robust position control," IEE Proceedings, Electric Power Applications, vol. 148, no. 2, pp. 111-118, 2001. (EI);(SCI,2)
- [5] C. M. Liaw, T. C. Lin, H. C. Chen and S. C. Chen, "Position control of a LBDCM drive," Electric Power Components and Systems, vol. 29, pp.1089-1109, 2001. (SCI,0)
- [6] C. M. Liaw, K. H. Chao and R. S. Guo, "A robust robust speed controller with VSS tuning of disturbance cancellation for induction motor drive," Asian Journal of Control, vol. 3, no.4, pp.309-318, 2001.
- [7] B. J. Kang and C. M. Liaw, "A robust hysteresis current-controlled PWM inverter for linear PMSM driven magnetic suspended positioning system," IEEE Transactions on Industrial Electronics, vol. 48, no. 5, pp. 956-967, 2001. (SCI,1)

- [8] K I. Hwu and C. M. Liaw, "Robust quantitative speed control of a switched reluctance motor drive," IEE Proceedings, Electric Power Applications, vol. 148, no. 4, pp. 345- 353, 2001. (SCI,1)
- [9] B. J. Kang and C. M. Liaw, "A robust hysteresis current-controlled PWM scheme with fixed switching frequency," IEE Proceedings, Electric Power Applications, vol. 48, no. 6, pp. 503-512, 2001. (SCI,1)
- [10] C. M. Liaw, Y. M. Lin and K. H. Chao, "A VSS speed controller with model reference response for induction motor drive," IEEE Transactions on Industrial Electronics, vol. 48, no. 6, pp. 1136-1147, 2001. (SCI,1)
- [11] H. C. Chen and C. M. Liaw, "Current-mode control for sensorless BDCM drive with intelligent commutation tuning," IEEE Transactions on Power Electronics, vol. 17, no. 5, pp. 747-756, 2002. (SCI,0)
- [12] B. J. Kang, L. S. Hung, S. K. Kuo, S. C. Lin and C. M. Liaw, " H_{∞} 2dof control for the motion of a magnetic suspension positioning stage driven by inverter-fed linear motor," Mechatronics, vol. 13, no. 7, pp. 677-696, 2003.
- [13] B. J. Kang and C. M. Liaw, "Development of a robust random switching hysteresis PWM inverter for linear positioning control," Electric Power Components and Systems, vol. 30, no. 7, pp. 741-767. 2002. (SCI,0)
- [14] K I. Hwu and C. M. Liaw, "Quantitative speed control for SRM drive using fuzzy adapted inverse model," IEEE Transactions on Aerospace and Electronic Systems, vol. 38, no. 3, pp. 955-968, 2002. (SCI,2)
- [15] C. M. Liaw, W. C. Yu and T. H. Chen, "Random vibration test control of inverter-fed electrodynamic shaker," IEEE Transactions on Industrial Electronics, vol. 49, no. 3, pp. 587-594, 2002. (SCI,0)
- [16] S. H. Li and C. M. Liaw, "Modelling and quantitative direct digital control for a DSP-based soft-switching-mode rectifier," IEE Proceedings, Electric Power Applications, vol. 150, no. 1, pp. 21-30, 2003. (SCI,1)
- [17] M. S. Huang and C. M. Liaw, "Improved Field-Weakening Control for IFO Induction Motor," IEEE Transactions on Aerospace and Electronic Systems, vol. 39, no. 2, pp. 647-659, 2003. (SCI,0)
- [18] K I. Hwu and C. M. Liaw, "Intelligent tuning of commutation for maximum torque capability of a switched reluctance motor," IEEE Transactions on Energy Conversion, vol. 18, no. 1, pp. 113-120, 2003. (SCI,0)
- [19] M. S. Huang and C. M. Liaw, "Transient performance improvement control for IFO induction motor drive in field-weakening region," IEE Proceedings, Electric Power Applications, vol. 150, no. 5, pp. 521-530, 2003. (SCI,1)
- [20] H. C. Chen, S. H. Li and C. M. Liaw, "Switch-mode rectifier with digital robust ripple compensation and current waveform controls," IEEE Transactions on Power Electronics, vol. 19, no. 2, pp. 560-566, 2004. (SCI,1)
- [21] S. H. Li and C. M. Liaw, "Development of three-phase switch-mode rectifier using single-phase modules," IEEE Transactions on Aerospace and Electronic Systems, vol. 40, no. 1, pp. 70-79, 2004.
- [22] S. H. Li and C. M. Liaw, "On the DSP-based switch-mode rectifier with robust varying-band hysteresis PWM scheme," IEEE Transactions on Power Electronics, to vol. 16, no. 6, pp. 1417-1425, 2004.

- [23] S. H. Li and C. M. Liaw, "Paralleled DSP-based soft switching-mode rectifiers with robust voltage regulation control," *IEEE Transactions on Power Electronics*, vol. 19, no. 4, pp. 937-946, 2004.
- [24] M. S. Huang and C. M. Liaw, "On the control of a field-weakened induction motor having improved transient and static performances," *Electric Power Components and Systems*, vol. 32, no. 6, pp. 587 – 609, 2004.
- [25] M. S. Huang, "Speed control for field-weakened induction motor drive," *IEE Proceedings, Electric Power Applications*, vol. 152, no. 3, pp. 565-576, 2005.
- [26] W. T. Su and C. M. Liaw, "Adaptive Positioning Control for a LPMSM Drive Based on Adapted Inverse Model and Robust Disturbance Observer," *IEEE Transactions on Power Electronics*, to appear, 2005.
- [27] J. L. Chen, J. W. Chen, H. C. Chen, Y. C. Chang, C. C. Yang and C. M. Liaw, "Front-end low-frequency SMR and its control for PMSM drive," *IEE Proceedings, Electric Power Applications*, vol. 152, no. 4, pp. 905-914, 2005.
- [28] W. T. Su and C. M. Liaw, "Robust compromising control of LPMSM servo drive with mass identification and large command change," *IEE Proceedings, Electric Power Applications*, to appear, 2005.

2. Conference Papers:

- [1] H. C. Chen and C. M. Liaw, "Current-mode control and intelligent commutation tuning for sensorless BDCM drive," *IEEE 2001 Applied Power Electronics, Conference (APEC)*, pp. 872-878, 2001.
- [2] K. I. Hwu and C. M. Liaw, "Intelligent tuning of commutation for maximum torque capability of a switched reluctance motor," *Proc. National Symposium on Automatic Control*, pp. 586-591, 2001.
- [3] K. I. Hwu and C. M. Liaw, "Development of simulation environment for switched reluctance motor drive," *Proc. National Symposium on Automatic Control*, 2001, pp. 744-749, 2001.
- [4] B. J. Kang and C. M. Liaw, "A random switching three-phase hysteresis current-controlled PWM inverter for linear position control," *Proc. National Symposium on Automatic Control*, pp. 592-598, 2001.
- [5] M. S. Huang and C. M. Liaw, "Field-weakening control of an IFO induction motor drive," *Proc. National Symposium on Automatic Control*, pp. 984-990, 2001.
- [6] H. C. Chen, S. H. Lee and C. M. Liaw, "Switch-mode rectifier with robust ripple cancellation and input current waveform controls," *R.O.C. Symposium on Electrical Power Engineering*, pp. 47-52, 2001.
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- [8] K. I. Hwu and C. M. Liaw, "Speed control of an SRM drive using fuzzy inverse model parameter tuning," *R.O.C. Symposium on Electrical Power Engineering*, pp. 385-390, 2001.
- [9] S. H. Li, H. Y. Tsai and C. M. Liaw, "Three-Phase Switch-Mode Rectifier Constructed using Single-Phase Modules," *2002 IEEE Region 10 Conference on Computer, Communications, Control and Power Engineering Proceedings*, pp. 2003-2006, 2002.
- [10] M. S. Huang and C. M. Liaw, "Field-weakening control for an induction motor drive,"

- 2002 IEEE Region 10 Conference on Computer, Communications, Control and Power Engineering Proceedings, pp. 1994-1998, 2002.
- [11] W. T. Su, C. M. Liaw and S. C. Chen, "Quantitative and robust direct digital control for a LBDCM driven positioning stage," ISIE 2002, Proceedings of the 2002 IEEE International Symposium on Industrial Electronics, vol. 4, pp. 1190-1195, 2002.
 - [12] M. S. Hwang and C. M. Liaw, "Improvement Study of $1/\omega_r$ Field-Weakening Method for Induction Motor," R.O.C. Symposium on Electrical Power Engineering, pp. 1420-1426, 2002.
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 - [15] M. S. Huang and C. M. Liaw, "Speed control performance improvement for induction motor with field-weakening," R.O.C. Symposium on Electrical Power Engineering, pp. 99-103, 2003.
 - [16] S. S. Liaw, R. Y. Jair, C. M. Liaw, S. P. Chien, M. Z. Liu and J. F. Shieh, "Design and implementation of a solenoid servo drive with quick response," R.O.C. Symposium on Electrical Power Engineering, pp. 1174-1178, 2003.
 - [17] S. H. Li and C. M. Liaw, "Development of a modified T-connected three-phase switch-mode rectifier," R.O.C. Symposium on Electrical Power Engineering, pp. 734-738, 2003.
 - [18] K. Y. Wu, W. T. Su and C. M. Liaw, "Robust waveform control for single-phase inverter," R.O.C. Symposium on Electrical Power Engineering, pp. 1730-1735, 2004.
 - [19] W. T. Su and C. M. Liaw, "Adaptive inverse model control for a LPMSM drive with robust disturbance observer," R.O.C. Symposium on Electrical Power Engineering, pp. 1905-1910, 2004.
 - [20] Y. W. Lin, R. Y. Jair and C. M. Liaw, "Comparative switching controls in vibration and acoustic noise reductions for DSP-based switched reluctance motor," R.O.C. Symposium on Electrical Power Engineering, pp. 1899-1904, 2004.
 - [21] J. L. Chen, J. W. Chen, H. C. Chen, Y. C. Chang, C. C. Yang and C. M. Liaw, "Front-end low-frequency SMR and its control for PMSM drive," R.O.C. Symposium on Electrical Power Engineering, pp. 1742-1747, 2004.
 - [22] W. T. Su, K. Y. Wu, G. T. Guo and C. M. Liaw, "On the development of single-phase inverter and its robust waveform control," IEEE International Symposium on Industrial Electronics- ISIE 2005, pp. 701-706, 2005.
 - [23] J. Y. Chai and C. M. Liaw, "Current and voltage tracking controls for a DSP-based SMR," IEEE International Symposium on Industrial Electronics- ISIE 2005, pp. 695-700, 2005.
 - [24] C. M. Liaw, K. T. Kuo, W. T. Su and W. C. Shen, "Three-Phase Inverters Constructed by Single-Phase Modules," R.O.C. Symposium on Electrical Power Engineering, pp. 382-387, 2005.
 - [25] J. Y. Chai, C. M. Liaw, T. H. Chen and J. Y. Chiu, "Robust Digital Control and Comparative Performance Evaluation for High-frequency DC/DC Converters," R.O.C.

- Symposium on Electrical Power Engineering, 388-392, 2005.
- [26] H. J. Chang and C. M. Liaw, "On the Front-End Converter and Its Control for Switched Reluctance Motor," R.O.C. Symposium on Electrical Power Engineering, 393-397, 2005.
 - [27] C. Y. Hou, Y. C. Chang and Chang-Ming Liaw, "Establishment of a Switched Reluctance Generator and its Closed-Loop Control," R.O.C. Symposium on Electrical Power Engineering, 433-438, 2005.
 - [28] W. T. Su, C. Y. Kuo, C. M. Liaw and C. T. Chang, "Dynamic Load Sharing Control for Switch-Mode Rectifier Fed Parallel Induction Motors," R.O.C. Symposium on Electrical Power Engineering, 753-758, 2005.

3. Project Reports:

- [1] "Design and implementation of digitized linear motor drive," Supported by Chung Shan Science Research Institute, 90.01.01~90.12.31, 2001.
- [2] "The study of digital current sharing control for power converters," Supported by Delta Electronics, 89.07.01~ 90.07.31, 2001
- [3] "Development of sensorless interior permanent magnet brushless DC motor drive and its application to compressor load, (90.7.1- 90.12.31), Supported by Energy and Resources Laboratories, Industrial Technology Research Institute, 2001.
- [4] "A study in speed control performance improvement of a switched reluctance motor," Supported by National Science Council, (89.8.1-90.7.31), NSC89-2213-E-007-145, 2001.
- [5] "Performance improvement study of converter and control for switched reluctance motor drive," Supported by National Science Council, (90.8.1-91.7.31), NSC90-2213-E-007-068, 2002.
- [6] "Development of robust varying-band hysteresis PWM scheme for converters," Supported by National Science Council, (90.8.1-91.7.31), NSC90-2213-E-007-072, 2002.
- [7] "Analysis and design of electromagnetic mechanism with quick response," Supported by National Science Council, (91.01.01-91.12.31), 2002.
- [8] "Design and implementation of digital linear motor drive," Supported by Chung Shan Science Research Institute, (91.01.01~91.12.31), 2002.
- [9] "Performance improvement and applications for a sensorless interior permanent magnet synchronous motor drive," (91.01.01~91.11.30), Supported by Energy and Resources Laboratories, Industrial Technology Research Institute, 2002.
- [10] "Study of inverter modularization for brushless DC motors," Supported by Chung Shan Science Research Institute, (91.07.24~91.12.15), 2002.
- [11] "Development of Some Key Technologies for Digitally Controlled PWM Converters (1/3)," Supported by National Science Council, (91.8.1-92.7.31), NSC91-2213-E-007-101, 2003.
- [12] "Performance improvement study of converter and control for switched reluctance motor drive (1/2)," Supported by National Science Council, (91.8.1-92.7.31), NSC 91-2213-E-007-100, 2003.
- [13] "Variable frequency and variable voltage control performance improvement study for a sensorless motor driven air conditioner," (92.03.01-92.11.30), Supported by Energy and Resources Laboratories, Industrial Technology Research Institute, 2003.
- [14] "Optimal design for traction system of a light-rail vehicle," Supported by Chung Shan Science Research Institute, (92.01.01~92.12.31), 2003.

- [15] "Analysis and design for permanent electromagnetic devices," Supported by Chung Shan Science Research Institute, (92.04.30~92.11.15), 2003.
- [16] "Researches of Advanced Control Techniques for Motor drives," Supported by Chung Shan Science Research Institute, (92.05.01~92.11.15), 2003.
- [17] "Development of Some Key Technologies for Digitally Controlled PWM Converters 2/3)," Supported by National Science Council, (92.8.1-93.7.31), NSC92-2213-E-007-41, 2004.
- [18] "Performance improvement study of converter and control for switched reluctance motor drive (2/2)," Supported by National Science Council, (92.8.1-93.7.31), NSC 92-2213-E-007-040, 2004.
- [19] "Optimal design for traction system of a light-rail vehicle (II)," Supported by Chung Shan Science Research Institute, (93.01.01~93.12.31), 2004.
- [20] "Operating performance improvement study for invert-fed motor driven air conditioner," (93.03.01-93.11.30), Supported by Energy and Resources Laboratories, Industrial Technology Research Institute, 2004.
- [21] "Development of some key technologies for digitally controlled PWM converters 3/3)," Supported by National Science Council, (93.8.1-94.7.31), NSC93-2213-E-007-23, 2005.
- [22] "Development of advanced converters and driving control techniques for switched reluctance motor (1/3)," Supported by National Science Council, (93.8.1-94.7.31), NSC93-2213-E-007-107, 2005.

4. Other Publications:

- [1] "System parameter estimation from sampled data" Control and Dynamic Systems, Vol. 63, pp. 161-195, Academic Press, 1994.
- [2] "Fuzzy control with reference model following response", Academic Press, Fuzzy Theory Systems: Techniques and Applications, Vol.1, pp.129-158, 1999.

5. Patents:

- [1] "A multi-functional small battery energy storage system" (81153), (with Mr. C. M. Lee), 1993.3.21-2003.3.20. (with Mr. C. M. Lee).

6. Current Projects

Project Title: Development of Some Key Technologies for Digitally Controlled PWM Converters.

Principal Investigator: C. M. Liaw

Funding Source: National Science Council, ROC. (08/2002-07/2005)

Abstract: This project mainly concerns the development of some key technologies for DSP-based digitally controlled PWM converters. In the PWM switching aspect, a robust varying-band hysteresis current control (HCC) PWM scheme is developed to let the harmonic spectrum be randomly distributed. First, the effect of varying-band on the harmonic spectrum of a HCC PWM inverter is intuitively analyzed. Then accordingly, the proposed random switching control approach is developed. Besides, a robust spectrum shaping technique is further developed to let converter possess the desired harmonic spectral characteristics. A

switch-mode rectifier is established and utilized as a study example to evaluate the effectiveness of the proposed control approach.

Project Title: Performance improvement study of converter and control for switched reluctance motor drive.

Principal Investigator: C. M. Liaw

Funding Source: National Science Council, ROC. (08/2001-07/2004)

Abstract: The switched reluctance motor (SRM) possesses some inherent disadvantages, such as highly nonlinear winding inductance and generating torque, the generation of acoustic noise and torque ripple, etc. Although a lot of researches have been made to improve the driving performance of the SRM, there are still many aspects worthy of studying. In the first year of this three-year project, we have finished the development of a DC-link voltage boosting circuit and a ZVT soft-switching converter. In this second-year project, the researches are emphasized on (i) study for the effects of commutation instant and current waveform on the operating performances of SRM; (ii) the performance evaluation method; (iii) development of intelligent commutation tuning mechanism to obtain better torque generating capability and conversion efficiency.

Project Title: Operating performance improvement study for invert-fed motor driven air conditioner.

Principal Investigator: C. M. Liaw

Funding Source: Energy and Resources Laboratories, Industrial Technology Research Institute, ROC. (02/2004-11/2004)

Abstract: The inverter-fed AC motor driven air conditioner may possess good operating performance, particularly for the one driven by brushless DC motor (BDCM), which is established using permanent synchronous motor (PMSM). Moreover, owing the inconvenience of installing position sensor, the sensorless motor drive is more suitable for this application. However, air conditioner is an interdisciplinary plant consisting of power electronics, motor, machine, compressor load, etc. Suitable match between constituted components is indispensable to yield satisfactory overall performance. Different motor must be matched with specific inverter and switching control. More importantly, each type of inverter-fed motor possesses its key parameters, which can be properly tuned to obtain better performances in torque generating capability, air conditioning capability, and energy conversion efficiency. Other performance parameters further include electric power quality, acoustic noise, electromagnetic interference, etc. If the inverter is equipped with a front-end switching-mode rectifier (SMR) to establish its DC-link voltage, one can apply PAM and/or PWM switching techniques to yield better high-speed driving performance and line drawn power quality. As far as the efficiency improvement issue is concerned, suitable V/f ratio programming and inverter soft-switching are the effective means. Based on the already established background, the major purpose of this project is to perform the operating performance improvement study for an invert-fed motor driven air conditioner.

Project Title: Researches of Advanced Control Techniques for Motor drives.

Principal Investigator: C. M. Liaw

Funding Source: Chung Shan Science Research Institute, ROC. (05/2003-11/2003)

Abstract: Motor is the most commonly used actuator for industrial driving applications.

However, a motor drive belongs to an integrated mechatronic system consisting of motor, mechanical load, converter or inverter, sensor and controller. As generally recognized, the driving performance of a motor drive is much affected by the output characteristics generated from the inverter. And the harmonics of inverter output are dependent on the PWM switching technique employed. A special type of motor is powered by a specific inverter using specific switching control. Some inverters provide sine wave output and some square wave one. And moreover, the tuning for key parameters according to the structural features of motor is necessary to obtain better torque generating capability. In addition, the advanced control is indispensable to yield good dynamic speed and/or position control performances. As far as the competition of motor drive product is concerned, the power density, the reliability, the cost and the ease of operation are the key factors.

Although many types of motor drives were being manufactured in Taiwan, the ability of manufacturing high-performance motor drive is still to be upgraded. Among these, the thorough understanding about the practical issues of a motor drive for an engineer or a researcher is the most important one. The major purpose of this project is to survey the existing technologies and to study the advanced technologies for improving the performance of motor drives.

Project Title: Optimal design for traction system of a light-rail vehicle (II).

Principal Investigator: C. M. Liaw

Funding Source: Chung Shan Science Research Institute, ROC. (01/2004-12/2004)

Abstract: Light-rail vehicle (LRV) is cost-effective in construction, and it can be established for improving the transportation quality in urban area. The light-rail vehicle has been employed in many countries. In Taiwan, the experimental systems have also been successfully established, and the improvement work is continually being made. As generally recognized, LRV is a mechatronic system consisting of power electronics, electric machine, mechanical system, control system, sensing and transducing systems, etc. The satisfactory performance can be achieved only if each constituted subsystem is properly designed, and the proper match between subsystems is made. In the last-year project, the following issues of LRV have been preliminarily studied: traction power system configuration, power quality, driving performance of an inverter-fed induction motor, system component modeling and simulation, traction load model, etc. However, there are still many topics worth further studying to yield improved driving performance, and eventually, to achieve the optimal design of LRV system. The research works in this project are arranged as follows: (1) Study and analysis for the specifications, driving control and performance of LRV; (2) Study for the match between induction motor and inverter, and their selections; (3) Establishment and effectiveness evaluation of equivalent circuit, parameter estimation, performance analysis and measurement for induction motor; (4) Performance analysis and measurement for inverter-fed induction motor; (5) Switching methods of inverter, spectral analyses of inverter input and output, effects of inverter generated harmonics; (6) Analyses for motor drive power flows during driving and braking operations, and the chopping dynamic braking control; (7) Analysis for the input and output characteristics of ac-to-dc front converter; (8) Application of switch-mode rectifier in LRV system; (9) Parallel operation control for multi-motors system; (10) Surge protection for the power electronic systems being connected in DC-link; (11) Energy consumption analysis for LRV; (12) The sensing technique and the experimental performance evaluation for LRV; (13) The study for load model parameter estimation; (14) Model

establishment and simulation for the constituted components in LRV system.

Project Title: Development of digital controlled DC/DC converter

Principal Investigator: C. M. Liaw

Funding Source: ACBEL Polytech Inc. ROC. (10/2004-09/2005)

Abstract: The traditional hybrid PWM control IC-based converter system possesses the merits of low cost, ease of understanding in analysis and design of controller, simplicity in tuning and adjustment of controller parameters, etc. But it suffers from some inherent disadvantages of analog controller, such as having drift and offset effects, inconvenience in changing control law. In the past decades, the digital control has been successfully applied and become gradually matured in motor drives, owing to their low dynamic response speed nature. However, the analog control in DC/DC converters and power supplies is difficult to be successfully replaced by digital one with comparable control performance, particularly for the converters with higher response speed. In addition, the high cost, the complicated construction of control scheme, difficult to make the design and tuning of control algorithms are also the chief reasons of its progress obstacle. Recently, the progress being made in the microcontroller and DSP has increasingly promoted the capability of digital control in converter and power supply systems. The major purpose of this project is to perform the feasibility study of fully digital control for DC/DC converter systems. After choosing the suited DSP and control algorithms, the controller digitization and performance evaluation of converters are made.

7. Teaching Laboratory – Electric Machines Lab.

(Room: 103, EE – CS Building)

Supported Courses:

- (1). EE3830- Electrical Power Engineering
- (2). EE3840- Electrical Machines Lab (V)
- (3). EE4830- Power Electronics
- (4). EE4840- Electric Machine Control
- (5). EE4710- Electrical Power System

Facilities:

- (1). MG – set
- (2). Power scope
- (3). Power analyzer
- (4). RLC load
- (5). Power transformer
- (6). Motor
- (7). Generator
- (8). Eddy-current brake
- (9). Frequency converter
- (10). Wattmeter
- (11). Clip-on AC power meter
- (12). Digital power analyzer
- (13). PLC
- (14). Control unit

- (15). Power supply
- (16). X-Y recorder
- (17). Plotter
- (18). Step motor
- (19). Digital torque meter
- (20). Spectrum analyzer
- (21). Synchroscope
- (22). Function generator
- (23). Clamp tester
- (24). Digital tachometer

8. Research Laboratory – Electric Machine Control

(Room: 503, EE – CS Building)

Research Topic:

Electric Motor Drives and Power Converters.

Facilities:

- (1). PCs
- (2). Scanner (X1)
- (3). Hp Laser printer (X2)
- (4). Digital oscilloscope (X4)
- (5). Power supply (X12)
- (6). Function generator (X4)
- (7). White noise generator (X1)
- (8). Control system analyzer (X1)
- (9). Programmable AC source (X1)
- (10). Smart electric load (X1)
- (11). EMI receiver (X1)
- (12). Isolated amplifier (X1)
- (13). Power waveform monitor (X1)
- (14). Current gun (X3)
- (15). Current probe amplifier (X2)

Supporting projects:

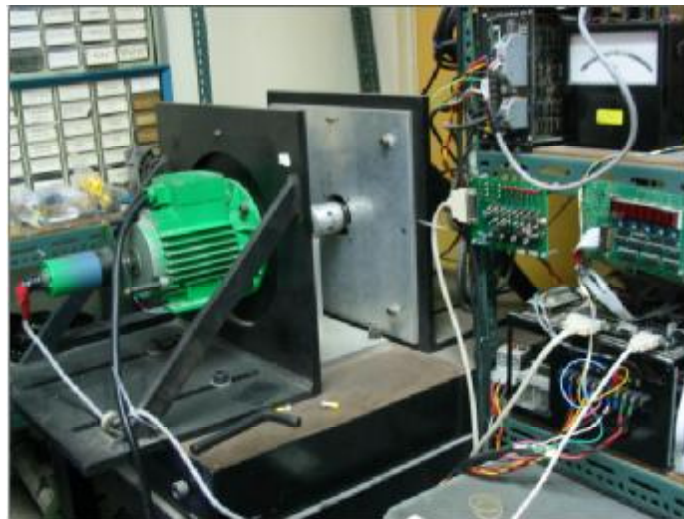
- (1). Development of some key technologies for digitally controlled PWM converters.
- (2). Performance improvement study of converter and control for switched reluctance motor drive.
- (3). Operating performance improvement study for invert-fed motor driven air conditioner.
- (4). Researches of advanced control techniques for motor drives.
- (5). Optimal design for traction system of a light-rail vehicle (II).
- (6). Development of digital controlled DC/DC converter.

Current Research Plants (Research Laboratory – Electric Machine Control)
(Room: 503, EE – CS Building)

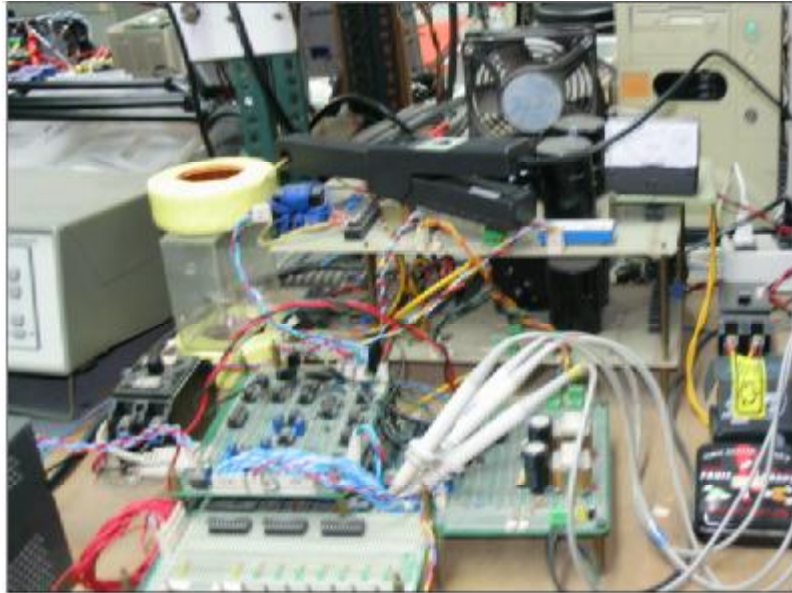
Liner permanent-magnet synchronous motor drive



Induction motor drive



Switch-mode rectifier



Inverter systems



Switched-reluctance motor drive



Rotary permanent-magnet synchronous motor drive



■ 研究內容 (Research Contents)

(1)、電力電子及切換式電源供應器

- (a)、隨機PWM切換技術、頻譜整型技術及其於轉換器之應用研究。
- (b)、EMI濾波器之分析設計。
- (c)、開關式整流器之研製及其量化與強健電流、電壓控制。
- (d)、由單相單模組組接成之三相開關式整流器及其電流、電壓控制。
- (e)、由單相變頻器之強健波形控制，由單模組變頻器組接成之三相變頻器及其強健波形控制。。
- (f)、具軟性切換之開關式整流器之研製。
- (g)、轉換器動態模式之推導與估測。
- (h)、轉換器動態模式之隨機估測技術。
- (i)、光隔離迴授電源供應器之模式化與控制。
- (j)、模組式電力功率調控器之研製。
- (k)、轉換器與電源供應器之數位控制、實現及應用研究。
- (l)、數位控制直流轉換器研發。
- (m)、轉換器與電源供應器之隨機估測與控制研究。
- (n)、轉換器與電力功率調控器之DSP多模組並聯控制。

(2)、馬達驅動系統及其實用控制技術之研發

- (a)、線性直流無刷馬達驅動系統之建立、定位之量化與強健控制、未知質量之大命令定位控制。
- (b)、開關磁阻式馬達驅動系統之建立、其前端轉換器之開發、增壓電路及其控制、轉矩產生能力最佳化之調控技術、軟式切換轉換器之研製、調適式反模式前向控制器之開發。
- (c)、開關磁阻式馬達驅動系統之振動與噪音降低技術研究開發。
- (d)、軟性切換變頻器及其於感應馬達驅動應用之研究。
- (e)、磁場導向感應馬達驅動系統：(1)、變頻供電感應馬達操作特性及馬達設計實務考量研究；(2)、間接式磁場導向感應馬達驅動系統調適性磁場導向機構之研究；(3)、弱磁控制、具延遲元件之速度控制；(4)、無速度感測控制。
- (f)、無感測直流無刷馬達驅動系統之開發。
- (g)、實用控制技術：開發一些控制器以增進感應馬達驅動系統之外迴路控制

性能：(1)可變結構控制器；(2)模糊控制器；(3)雙可調度控制器；(4)適應控制器；(5)強健控制器；(6)以類神經為主之適應控制器。

(h)、隨機調制技術之開發。

(i)、永磁同步馬達建構之直流無刷馬達驅動系統之建構、其電流之強健控制、其無位置感測控制、換向前移之智慧調控、變頻器於空調機之驅動應用研究。

(j)、馬達驅動系統前端轉換器之研發、PAM及PWM切換控制技術之開發。

(k)、輕軌車之組成系統之搭配及設計、其驅動特性模擬系統建立研究。

(l)、電磁閥之設計與激勵控制。

(m)、切換式音頻放大器之研製及其控制。