# An Embedded Microcontroller for Electronic Stringing Machines


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**ABSTRACT**

This research will develop an embedded microcontroller for electronic stringing machines. We will design the hardware and software for the microcontroller to integrate the whole electric circuits, such as an interface circuit, a force measurement circuit and a motor driver. A robust force control law is derived to overcome the disturbance from the stiffness variation of the different strings. The proposed controller will obtain a good force accuracy of 0.1kgw and can solve the motor current oscillation problem under the steady-state stringing condition. We will use the IC L6203 to design a PWM-type motor driver. Through a protection circuit, the motor driver can suffer a big stringing current of about 4 A, and the back emf duce to the motor instantly shunted-down. The embedded microcontroller has many build-in functions. We will develop the software to replace the external circuits, including A/D, PWM generators, decoded circuits of encoders and noise- rejected circuits using those functions. Hence, the embedded system is an all-digital design to simplify the electric circuit. Finally, we apply the developed embedded microcontroller for the practice stringing machines.



Keywords : Embedded microcontroller ; PWM ; Driver


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**REFERENCES**


[1] C.L.-I. Boldea and F. Blaabjerg, “ Direct Torque Control of Sensorless Induction Motor Drives: A Sliding-Mode Approach ” IEEE Trans. on Industry Applications, vol. 40, no. 2, pp. 582-590, 2004.

[2] D. Howe, “ An Integrated Design Approach for Brushless DC Drive Systems ”, Permanent Magnet Machines and Drives, IEE Colloquium on pp. 211-215, 1993.

[3] F.-J. Lin, Y.-S. Lin, and S.-L. Chiu, “ Slider-Crank Mechanism Control Using Adaptive Computed Torque Technique ”, IEE Proc.-Control Theory Appl., Vol. 145, No. 3, pp.364-376,1998.

[4] Haci Bodur, “ Universal Motor Speed Control with Current Controlled PWM AC Chopper by Using a Microcontroller ”, Proceeding of IEEE International Conference Volume:1, pp. 394-398, Industrial Technology, 2000.

[5] K. Okamoto, T. Araki, and T. Iizuka, ” A DSP for DCT-Based and Wavelet-Based Video Codes for Consumer Applications, ” IEEE Trans. On Solid State Circuits, vol. 32, no. 3, pp. 460-467, 1997.

[6] L. E. Davis. “ Microprocessor Control of DC Motor Drives “ , IEEE Industry Appl. Conference Record pp.1782 - 1786 Vol. 2, 1992.

[7] M. Rodi ˇ c, and K. Jezernik, “ Speed-Sensorless Sliding-Mode Torque Control of an Induction Motor, ” IEEE Trans. on Industrial

Electronics, vol. 49, no. 1, pp. 87-95, 2002.
[8] M. Hashemnehrir,“ A Microcomputer Microprocessor Base DC Motor Speed Controller for Undergraduate Electric Machinery Laboratory “ IEEE Trans On Education, Vol.33, No. 4, pp. 341-345. November 1990.
[9] National Semiconductor Corporation, Linear Data book 1, 2, 3, Kaifa Book, 1998.
[10] National Semiconductor Corporation, Data Conversion/Acquisition Data Book, Kaifa Book, 1984.
[11] P. Z. Grabowski, M.P. Kazmierkowski, B.K. Bose, and F. Blaabjerg, ”A Simple Direct-Torque Neuro-Fuzzy Control of PWM-Inverter-Fed Induction Motor Drive, ” IEEE Trans. on Industrial Electronics, vol.47, no. 4, pp. 863-870, 2000.
[12] PIC18F8722 Datasheet, Microchip technology, 2004.
[13] R. Ourganti,“ Soft-Switched DC/DC Converter with PWM Control “, IEEE Transaction on Power Electronics, Volume: 13, pp. 102-114, Jan, 1998.
[14] R. J. Wai,“ Robust Control for Nonlinear Motor-Mechanism Coupling System Using Wavelet Neural Network, ” IEEE Trans. on System Man and Cybernetics-part B: Cybernetics, vol. 33, no. 3, pp. 489-497, 2003.
[15] S. V. Zadeh, ”Variable Flux Control of Permanent Magnet Synchronous Motor Drives for Constant Torque Operation, ”, IEEE Trans. on Power Electronics, vol. 16, no. 4, pp. 527-534, 2001.
[16] S. Ong, M.H Sunwoo, and M., Hong,“ A Fixed-Point Multimedia DSP Chip for Portable Multimedia Services, ” IEEE Workshop on Signal Processing System, pp. 94-102, 1998.
[17] S. Hamada,“ Two-switch Forward Soft-Switching PWM DC-DC Power Converter “, Electronic Letters, Volume:36, pp. 2055-2056, 7 Dec.2000.
[18] Texas Instruments, The TTL Data Book, Volume. 2, 1985.
[19] T. Konishi.“ A Performance Analysis of Microprocessor-Base Control System Applied to Adjustable Speed Motor Drives ”, IEEE Industry Applications. Vol. 1 a-16 No. 3 pp. 378-387, 1996.
[20] 施慶隆和劉晏維，”PIC18Fxx2微控制器原理與實作-使用組合語言及C語言”，宏友圖書公司，2004。
[21] 曾百由，“ 微處理器原理與應用 C語言與PIC18微控制器 ”五南圖書公司，2006。
[22] 盧鵬任和盧明智，”感測器應用與線路分析”，全華科技圖書股份有限公司，1996。