

# Remote control of an ultrasonic motor by using a GSM mobile phone

Erdal Bekiroglu<sup>a,\*</sup>, Nihat Daldal<sup>b</sup>

<sup>a</sup> Department of Electrical and Electronics Engineering, Faculty of Engineering and Architecture, Abant İzzet Baysal University, 14280 Bolu, Turkey

<sup>b</sup> Department of Electronics, Güvercinlik Technical High School, Ankara, Turkey

Received 9 August 2004; received in revised form 22 November 2004; accepted 12 December 2004

Available online 18 January 2005

## Abstract

In this study, remote control of an ultrasonic motor has been implemented by using a standard GSM mobile phone. To drive the ultrasonic motor a digitally controlled drive system has been designed. Then a tone decoder circuit and microcontroller have been added between output of a mobile phone and the drive system of the motor. This system is flexible to be controlled with both GSM and DTMF based phones. With the developed drive and control system the overall control of the ultrasonic motor has been achieved. The system has been tested for different speed, position and direction conditions successfully. The experimental results verify that the GSM controlled drive system is highly effective, reliable, proper and applicable to achieve remote control of the ultrasonic motor. This study gets novel and important point of view for GSM based remote control applications addition to the control of ultrasonic motors.

© 2004 Elsevier B.V. All rights reserved.

**Keywords:** Ultrasonic motor; Remote control; GSM; Mobile phone

## 1. Introduction

Ultrasonic motor (USM) is a new type of actuator that uses ultrasonic level mechanical vibrations as its driving source. USM has different construction, characteristics and operating principles than the conventional electromagnetic motors. High holding torque, high response characteristics, high torque density, silent operation, no electromagnetic noise and compact size are important features of USMs. Therefore, USMs have attracted for precise and accurate speed and position applications. USMs are used as actuators for industrial, medical, robotic, space and automotive applications [1,2].

On the other hand, USMs have some drawbacks that must be practically eliminated. The control characteristics of USMs are too complex. The motor parameters are time-varying owing to increase in temperature and changes in motor drive operating conditions such as driving frequency, source voltage and load torque.

In order to drive and control USMs several speed and position control systems have been already proposed. Inverter-fed servo control implementation incorporating a software based fuzzy-reasoning concept is proposed for speed control of the USM [3]. Two principles of resonant frequency tracking control strategies including sensor and sensorless schemes have been described for inverter-fed USM. The control method is realized by analog-oriented signal processing and PLL technique [4]. Fuzzy adaptive model-following position control for ultrasonic motor is implemented. A PC based computer control system is proposed for the ultrasonic motor drive. A servo control card is installed to the control computer including digital inputs/outputs and interface circuits [5]. A speed tracking servo control system has been presented for USM. This speed control includes driving frequency control loop with variable-gain strategy and the applied voltage control with reduction strategy for speed ripple of USM. A personal computer is used to control the drive system and another personal computer is used for measurement [6]. A DSP based computer control system has been proposed for ultrasonic motor drive using the LLCC resonant technique [7]. A complete model-based control for travelling wave type ultrasonic

\* Corresponding author. Tel.: +90 374 2534640; fax: +90 374 2534558.  
E-mail address: [bekiroglu\\_e@ibu.edu.tr](mailto:bekiroglu_e@ibu.edu.tr) (E. Bekiroglu).

- [5] F.J. Lin, L.C. Kuo, Driving circuit for ultrasonic motor servo drive with variable-structure adaptive model-following control, *IEE Proc. Electron. Power Appl.* 144 (3) (1997) 199–206.
- [6] Y. Izuno, T. Izumi, H. Yasutsune, E. Hiraki, M. Nakaoka, Speed tracking servo control system incorporating travelling-wave type ultrasonic motor and feasible evaluations, *IEEE Trans. Ind. Appl.* 34 (1) (1998) 126–132.
- [7] F.J. Lin, R.J. Wai, H.H. Lin, An adaptive fuzzy neural network controller for ultrasonic motor drive using the LLC resonant technique, *IEEE Trans. Ultrason. Ferroelectr. Frequency Contr.* 46 (3) (1999) 715–727.
- [8] J. Maas, T. Schulte, N. Fröhleke, Model-based control for ultrasonic motor, *IEEE/ASME Trans. Mechatron.* 5 (2) (2000) 165–180.
- [9] K.T. Chau, S.W. Chung, Servo position control of ultrasonic motors using fuzzy neural network, *Electric Components Syst.* 29 (2001) 229–246.
- [10] T. Senjyu, T. Kashigawa, K. Uezato, Position control of ultrasonic motors using MRAC and dead-zone compensation with fuzzy inference, *IEEE Trans. Power Electron.* 17 (2) (2002) 265–272.
- [11] J.S. Chen, I.D. Lin, Toward implementation of an ultrasonic motor servo drive using FPGA, *Mechatronics* 12 (2002) 511–524.
- [12] G. Bal, E. Bekiroğlu, Servo speed control of travelling wave ultrasonic motor using digital signal processor, *Sens. Actuators A* 109 (2004) 212–219.
- [13] C.E. Lin, C.C. Li, A.S. Hou, C.C. Wu, A real-time remote control architecture using mobile communication, *IEEE Trans. Instrum. Meas.* 52 (4) (2003) 997–1003.
- [14] T. Kubik, M. Sugisaka, Use of a cellular phone in mobile robot voice control, in: *Proceedings of the SICE, Nagoya, July 25–27, 2001*, pp. 106–111.
- [15] V. Astarita, M. Floarian, The use of mobile phones in traffic management and control, in: *Proceedings of the IEEE Intelligent Transportation Systems Conference, Oakland, August 25–29, 2001*, pp. 10–15.
- [16] P.M. Corcoran, P. Bigioi, E. Steinberg, Wireless transfer of images from a digital camera to the internet via a standard GSM mobile phone, *IEEE Trans. Consum. Electron.* 47 (3) (2001) 542–547.
- [17] H. Kanma, N. Wakayabashi, R. Kanazawa, H. Ito, Home appliance control system over Bluetooth with a cellular phone, *IEEE Trans. Consum. Electron.* 49 (4) (2003) 1049–1053.
- [18] L. Boquete, I. Bravo, R. Barea, M.A. Garcia, Telemetry and control system with GSM communications, *Microprocess. Microsyst.* 27 (2003) 1–8.
- [19] M. Hartman, E. Lowiec, P. Boguslawski, Water pumping stations remote control systems in depression area based GSM-900 cellular communications system, in: *Proceedings of the TCSET'2002, Lviv-Slavsko, February 18–23, 2002*, pp. 291–293.
- [20] G. Bal, E. Bekiroglu, Ş. Demirbaş, İ. Çolak, Fuzzy logic based DSP controlled servo position control for ultrasonic motor, *Energy Conversion Manage.* 45 (20) (2004) 3139–3153.

## Biographies

**Erdal Bekiroğlu** was born in Hasankeyf, Turkey, on June 13, 1973. He received his BSc, MSc and PhD degrees in electrical education from the Gazi University. He worked as a research assistant at Gazi University between 1996 and 2003. He is currently assistant professor at Department of Electrical and Electronics Engineering, Faculty of Engineering and Architecture, Abant İzzet Baysal University. His research interests are fuzzy logic, digital signal processors, drive and control of ultrasonic motors.

**Nihat Daldal** was born in Ankara, 1977. He received his BSc and MSc degrees in electronics and computer education from the Gazi University. He is currently working as a technical teacher at Güvercinlik Technical High School. His research interests are microcontrollers, remote control and security control systems.