UNIVERSITI PUTRA MALAYSIA

DESIGN AND DEVELOPMENT OF A HANDHELD BLUETOOTH-BASED APPLICATION SYSTEM FRAMEWORK FOR CONTROLLING AND MONITORING REMOTE DEVICES

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DESIGN AND DEVELOPMENT OF A HANDHELD BLUETOOTH-BASED APPLICATION SYSTEM FRAMEWORK FOR CONTROLLING AND MONITORING REMOTE DEVICES

By

MD. NAZMUS SAADAT

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Partial Fulfillment of the Requirement for the Degree of Master of Science

June 2006

DEDICATED TO

My Mother Mrs. Rabeya Khatun, my Father Md. Borhan Uddin, my Brother Md. Robiul Hasanat and his family, my loving little sister Iffat Ara Chaity, my Father in Law Sk. Afzal Hossain, My Mother in Law Mrs. Laila Parveen, my soulmate and beloved wife Fariah Afzal Tuli and all teachers and friends throughout my life.

May Allah reward you the best.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in partial fulfilment of the requirement for the degree of Master of Science

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June 2006

Chairman : Professor Borhanuddin Mohd. Ali , PhD

Faculty : Engineering

For short range wireless communication, Bluetooth technology is well known standard while competing with other short range wireless standard like Infrared, WiFi, and UWB. Bluetooth is being used worldwide today. Its point to multipoint and no line of sight facility has removed the obstacles that some other hugely used technology like IrDA had. This work focuses on designing and developing an application system framework for controlling and monitoring remote devices wirelessly using Bluetooth within its standard range. For example, any Bluetooth enabled PDA, laptop or mobile phone can be used for controlling the household devices like lights, air con or digital audio systems in room environment or this can be used for industrial machine controls and office environment for various purposes starting from switching devices to acquiring real-time data from working systems or from sensors. Also the system can be used for robotic aspects in short range distance.

The system design went through number of different tests and real time simulations to assure performance issues. The results show that it provides the standard features of system services with acceptable quality in data transmission and reception and controlling remote devices and the user application and interfaces are very much convenient to interact with.

Finally, a prototype has been developed according to the design. The test results measured using the prototype verify the system design and confirm the standard performance of services.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia untuk memenuhi sebahagian daripada keperluan Ijazah Master Sains

PEMBANGUNAN SISTEM PENJANAAN DAN PEMANTAUAN BERASASKAN PERANTI PEGANGAN TANGAN BLUETOOTH

Oleh

MD. NAZMUS SAADAT

Jun 2006

Pengerusi : Profesor Borhanuddin Mohd. Ali, PhD

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Untuk komunikasi tanpa wayar jarak dekat, teknologi Bluetooth adalah piawaian yang diketahui umum bersaing dengan piawaian tanpa wayar jarak dekat yang lain seperti Inframerah, WiFi, UWB dan sebagainya. Hari ini, Bluetooth digunakan di seluruh dunia dalam peranti-peranti mudah alih. Bercirikan satu titik ke pelbagai titik dan ketidakperluan kepada garis nampak menjadikan ia lebih baik berbanding teknologi yang telah meluas penggunaannya seperti IrDA. Kerja ini tertumpu kepada rekabentuk dan pembangunan kerangka kerja satu sistem aplikasi untuk mengawal dan mengawasi satu peranti kawalan jauh tanpa wayar mengunakan Bluetooth di dalam lingkungan jarak piawaiannya. Sebagai contoh, sebarang PDA, komputer riba atau telefon mudah alih yang memiliki Bluetooth boleh digunakan untuk mengawal peralatan-peralatan rumah seperti lampu, pendingin hawa, sistem audio digital dan sebagainya di dalam sesebuah bilik atau ia juga boleh digunakan untuk mengawal mesin kilang atau di pejabat untuk pelbagai tujuan dari menghidupkan peranti hingga kepada pemerolehan data masa nyata daripada sistem kerja atau daripada sensor. Ia juga boleh digunakan untuk kawalan robotik dalam lingkungan jarak dekat.

Sistem ini melalui beberapa ujian yang berbeza dan simulasi masa nyata untuk memastikan prestasinya yang positif. Keputusan menunjukkan ia memberikan ciri-ciri piawaian perkhidmatan sesuatu sistem dengan kualiti yang boleh diterima dalam penghantaran dan penerimaan data dan mengawal peranti kawalan jauh dan di mana aplikasi pengguna dan antaramuka mudah digunakan.

Akhir sekali, satu prototaip berdasarkan reka bentuk telah dihasilkan. Keputusan ujian ke atas prototaip mengesahkan reka bentuk mematuhi piawaian prestasi servis yang dikehendaki.

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Bismillahir Rahmanir Rahim- everything goes by the mercy of Allah, the most gracious the most merciful. I am grateful to him to give me the chance for higher studies and everything. Then I am grateful to my parents and family who are always by my side.

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I certify that an Examination Committee has met on 9th June 2006 to conduct the final examination of Md. Nazmus Saadat on his Master of Science thesis entitled "Design And Development Of A Handheld Bluetooth-Based Application System Framework For Controlling And Monitoring Remote Devices" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded a relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as partial fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.

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MD. NAZMUS SAADAT

Date:

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LIST OF ABBREVIATION

PDA	Personal Digital Assistant
WLAN	Wireless LAN
IrDA	Infrared
WAP	Wireless Access Protocol
PIC	Peripheral Interface Controller
ADC	Analog to Digital Converter
SU	Slave Unit
MU	Master Unit
L2CAP	Logical Link Control & Adaptation Protocol
VDI	Visual Device Initializer
BER	Bit Error Rate
SPP	Serial Port Profile
RSSI	Received Signal Strength Indication

CHAPTER 1

INTRODUCTION

1.1 Introduction and Problem Statement

Along side the growth of computing power, recent times have seen large advances in the area of networking and communications, mainly by the explosion of the wireless and Internet technology. These developments are now seeing smaller mobile devices such as PDAs and mobile phones empowered with the WLAN, BLUETOOTH, IrDA, and Wireless Access Protocol (WAP) providing users with the convenience of access to information on the connected devices and networks.

Wireless control over remote devices is a great challenge for current time while everything wired is turning to wireless and of course without line of sight is important to take into consideration. Till now many remote device controlling systems are using Infrared. Bluetooth has some advantages over IrDA like it uses radio frequency and does not have line of sight problem. Moreover, it is available in most of the standard handheld devices like PDA, Mobile phone and also in form of dongles that can enable any desktop or laptop to use Bluetooth. This work focuses on developing and implementing systems that can be used for controlling and monitoring remote devices wirelessly using Bluetooth technology with handheld devices. The system can use any Bluetooth enabled PDA or Mobile Phone or Laptop to control remote slave devices at home, office and industry within the standard range.

1.2 Objectives

The objectives of this thesis are:

1. To develop functionalities to communicate and use Bluetooth chip for accessing the in built vendor supplied radio services and independent services.
2. To control the Bluetooth radio services by programming high performance Peripheral Interface Controller (PIC).
3. To develop user interface program for the user device or master device (such as for PDA, mobile Phone, desktop or laptop).
4. To develop circuitry for practical implementation of the wireless control and monitoring systems.
5. To test the total implementation for stable performances and prototyping and converting the prototype to a product prototype.
6. To test the performance of the developed system and its critical points of data handling.

1.3 Scope of work:

This research work will present a design and a prototype according to the design, which will be able to achieve the objectives stated in section 1.2. This work does not develop any integrated Bluetooth radio module rather it uses off the shelf radio module and Microchip's PIC18FL6720 together to develop the wireless remote control and monitoring system. C18 compiler and MPLAB, Win CE 3.0 and Flexipanel Interface Designer are used for software development.

1.4 Thesis arrangement

Chapter 1 describes introduction, objectives and scope of the work mainly. Chapter 2 makes a critical and useful literature review. Chapter 3 will discuss the design and development methodologies and will describe the performance entities for the evaluation of the system prototype. Chapter 4 will show the developed system, its real time implementation with test and simulation results. Finally Chapter 5 will conclude.

REFERENCES

[1] G. Záruba, S. Basagni and I. Chlamtac, BlueTrees – Scatternet formation to enable Bluetooth-based personal area networks, in: Proceedings of the IEEE International Conference on Communications, ICC 2001, Helsinki, Finland, Vol. 1 (11–14 June 2001) pp. 273–277.

[2] C. Petrioli, S. Basagni and I. Chlamtac, Configuring BlueStars: Multihop scatternet formation for Bluetooth networks, IEEE Transactions on Computers 52(6), Special Issue on Wireless Internet (2003) pp 779–790.

[3] Z.Wang, R.J. Thomas and Z. Haas, BlueNet – A new scatternet formation scheme, in: Proceedings of the 35th Hawaii International Conference on System Science (HICSS-35), Big Island, Hawaii (7–10 January 2002).

[4] B Fridtoof Feldbusch , "The BTRC Bluetooth remote control system"Alexander Paar, Manuel Odendahl, Ivan IvanovJuly 2003, Personal and Ubiquitous Computing, Volume 7 Issue 2

[5] Satyajit Chakrabarti, S. Liyun Wu, Son Vuong, Leung, "A Remotely Controlled Bluetooth Enabled Environment" V.C.M. Consumer Communications and Networking Conference, 2004. CCNC 2004, IEEE, 5-8 Jan. 2004 pp:77 - 81

[6] T. Hodes, M. Newman, S. McCanne, R. Katz, J.Landay, "Shared Remote Control of a Video Conferencing Application: Motivation, Design, and Implementation," SPIE Multimedia Computing and Networking (MMCN), Proc. SPIE, vol. 3654, 1998, pp. 17-28.

[7] T. Hodes, R.Katz, "A Document-based Framework for Internet Application Control," 2nd USENIX Symposium on internet Technologies and Systems (USITS), 1999, pp. 59-70.

[8] B. Myers, H. Stiel, and R. Gargiulo. "Collaboration Using Multiple PDAs Connected to a PC." Proceedings CSCW'98: ACM Conference on Computer-Supported Cooperative Work, Seattle, 1998, WA. pp. 285-294.

[10] Sevillano, J.L., Díaz, F., Jiménez, G., Cascado,D., Civit-Balcells, A., "An analytical model of Inter-channel Interference in Bluetooth-Based Systems", IEEE MWCN, pp. 384-388. 2002. ISBN/D.L.: 0-7803-7606-4.

[11] Fridtjof Feldbusch, Alexander Paar, Manuel Odendahl, Ivan Ivanov. "The BTRC Bluetooth remote control system" IEEE 2003, Personal Ubiquitous Computing,Vol 7, Issue 2, (July 2003), pp: 102-112, ISSN:1617-4909, ACM Digital Library.

[12] I. Chlamtac and A. Faragó, A new approach to the design and analysis of peer-to-peer mobile networks, Wireless Networks 5(3) (1999) pp: 149– 156.

[13] A Remote Controlled Wireless Enabled Environment, Satyajit Chakrabarti, Liyun Wu, Son Vuong, Victor C.M. Leung, Consumer Communications and networking Conference, 2004. CCNC 2004

[14] The information home appliance control system - a Bluetooth universal type remote controller Jia-Ren Chang Chien; Cheng-Chi Tai; Networking, Sensing and Control, 2004 IEEE International Conference on Volume 1, 21-23 March 2004 age(s):399 - 400 Vol.1

[15] Temperature sensor information, http://www.national.com/pf/LM/LM35.html, Last Accessed on 01/01/2006.

[16] Deepak Jayanna, Gergely V. Záruba, A Dynamic and Distributed Scatternet formation Protocol for Real-life Bluetooth Scatternets, Proceedings of the 38th Hawaii International Conference on System Sciences – 2005.

[17] Microchip MPLAB, PIC and Data Sheets, http://www.microchip.com, Last Accessed on 01/01/2006.

[18] Bluetooth Module, manuals, www.flexipanel.com, Last Accessed on 12/07/2006.

[19] Alps Electric Company Ltd, Japan. Alps Virtual Cable Light, Firmware Revision
B3_10 Release Note Document Version 1.0-2003.

[20] Bluetooth info, specifications, SIG info, www.bluetooth.org, Last Accessed on 05/06/2006.

[21] AT Command Set info, http://encyclopedia.thefreedictionary.com/Hayes+AT+command+set, Last Accessed on 05/05/05.

[22] Bluetooth Specification Version 1.2 [vol 2], Section 4.1, page 37 of 790, 5th November 2003.

[23] General Bandwidth info for variaous wireless technologies, http://en.wikipedia.org/wiki/List_of_device_bandwidths, as on 15/05/06.

[24] Lee, W.S., Burks, T.F., Schueller, J.K., 2002. Silage yield monitoring system. ASAE Paper No.: 02-1165. Science Direct, The American Society of Agriculture Engineers, St. Joseph, Michigan, USA.

[25] Cugati, S., Miller, W., Schueller, J., 2003. Automation concepts for the variable rate fertilizer applicator for tree farming. In: The Proceedings of the 4th European Conference in Precision Agriculture, Berlin, Germany, June 14–19.

[26] Liu, G., Ying, Y., 2003. Application of Bluetooth technology in greenhouse environment, monitor and control. J. Zhejiang Univ., Agric. Life Sci. Science Direct, 29, 329–334.

[27] Nagl, L., Schmitz, R.,Warren, S., Hildreth, T.S., Erickson, H., Andresen, D., 2003.Wearable sensor system for wireless state-of-health determination in cattle. In: Proceedings of the 25th IEEE EMBS Conference, Cancun, Mexico, September 17–21.

[28] Development of a low cost, GPS-based upgrade to a standard handheld gamma detector for mapping environmental radioactive contaminationm J. Paridaens / Applied Radiation and Isotopes 64 (2006), Science Direct, pp: 264–271.