

EMERGENCY NURSE CALL SYSTEM

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Electrical - Microelectronics & Computer System)

Faculty of Electrical Engineering
Universiti Teknologi Malaysia

JUNE 2013

*Dedicated, in thankful appreciation for love, support and encouragements to my
beloved Holy Trinity, R and family.*

ACKNOWLEDGEMENT

First and foremost, I would like to express my heartily gratitude to my beloved Holy Trinity and R for their love, emotional support and encouragements throughout my master education period.

My sincere appreciation also goes to my supervisor, Assoc. Prof. Dr. Muhammad Nasir bin Ibrahim for his guidance, advices and enthusiasm given from beginning to the end in this project. His views and tips are useful indeed.

Nevertheless, appreciation also goes to my family who always had been so tolerant and caring all these years.

I would also like to thank to my postgraduate classmates and other party that had involved in assisting me and advising me in this project. Thank for their co-operations, guidance and helps in making this project successful.

Teo Gee Man, UTM

ABSTRACT

Hospital emergency nurse call system depend on fast response time. While several hospital nurse call system have already been developed in the market, we found that most of them suffer from speed and cost issues. Ordinary nurse call systems are costly with cable setup and not portable as they are fixed above patient's bed. One of the ways of solving this issue is by using portable nurse call system. With this system, patients will be able to call for help wherever they want. These certainly shorten response time for hospital's stuffs to reach patients. In this project, a new prototype of portable nurse call system that uses Wifi internet network is developed to improve the system mobility. A cheaper and easy programmed system development board (Arduino) was chosen. A Wifi module - Xbee module was added to the development board in order to connect to Wifi internet network. Some sensors were added to emulate a real system. System was then tested for its functionality and practicality. Data packets sent through TCP/IP were investigated. This portable developed system are able to speed up the response time of hospital's stuffs toward patients.

ABSTRAK

Sistem panggilan kecemasan juruawat di hospital bergantung kepada masa tindak balas yang cepat. Walaupun pelbagai sistem panggilan juruawat telah dibangunkan di pasaran, kami mendapati bahawa kebanyakan sistem mengalami isu kelajuan dan kos. Sistem panggilan juruawat yang ada di pasaran adalah mahal dari segi pemasangan kabel yang banyak dan tidak mudah alih kerana ia dipasang tetap di atas katil pesakit. Salah satu cara untuk menyelesaikan isu ini adalah dengan menggunakan sistem panggilan juruawat mudah alih. Dengan sistem ini, pesakit boleh meminta bantuan bila-bila masa mereka memerlukan. Masa tindak balas kakitangan hospital terhadap pesakit pasti dapat dipendekkan. Dalam projek ini, satu prototaip baru sistem panggilan juruawat mudah alih yang menggunakan rangkaian internet Wifi telah dibangunkan untuk meningkatkan mobiliti sistem. Untuk menjimatkan kos sistem dan penprograman yang mudah, papan Arduino telah dipilih. Satu modul Wifi - modul Xbee telah ditambah kepada papan Arduino untuk penyambungan kepada rangkaian internet Wifi. Beberapa sensor telah ditambah untuk meniru sistem sebenar. Sistem kemudiannya diuji dari segi fungsi dan segi praktikal. Paket data yang dihantar melalui TCP / IP juga telah dikaji. Sistem mudah alih yang dibangunkan ini dapat mempercepatkan masa tindak balas kakitangan hospital terhadap pesakit.

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LIST OF ABBREVIATIONS

ACK	-	Acknowledgement
B4A	-	Basic 4 Android
COM	-	Communication
GSM	-	Global System for Mobile Communications
GUI	-	Graphical User Interface
IDE	-	Integrated Development Environment
I/O	-	Input/Output
IP	-	Internet Protocol
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
NIC	-	Network Interface Controller
OS	-	Operating System
PIC	-	Peripheral Interface Controller
RAD	-	Rapid Application Development
RF	-	Radio Frequency
SEQ	-	Sequence
TCP	-	Transmission Control Protocol
UART	-	Universal Asynchronous Receiver Transmitter
USB	-	Universal Serial Bus

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CHAPTER 1

INTRODUCTION

This chapter gives an overview of the entire project, starting with the project background and problem statement, followed by the project objectives, scopes, and outline of the project report.

1.1 Background of Project

Today, healthcare is a major governmental expenditure in many countries. This is to maintain the health of people and to enhance the gradation of people quality life. Among healthcare, hospital always play an important role. When people have any sicknesses or emergencies, they will go to hospital and get for the proper treatment. Thus hospital organization system and services provided by hospital's stuffs are very important to increase the percentage of successful treatments. In order to decrease the percentage of death, treatments provided toward patients must be accurate and fast.

Nowadays hospitals are getting more crowded with more patients. Thus actions taken by hospital must be very accurate and fast in order to handle all needed patients. Ordinary existed emergency nurse call system is not portable and costly. To improve on this, a portable wireless emergency nurse call system will be developed. With this system, patients will be able to call for help anywhere in hospital area and hospital's stuffs will be able to reach patients in short time. Under usage of WiFi internet network, cost can be reduced as cabling setup is not required. Thus this system can contribute in reducing response time of treatments given to patients, decreasing the rate of death and also reducing system development cost.

1.2 Problem Statement

Due to the increase of patient crowd in hospital today, an enhanced and functional emergency nurse call system is required. Ordinary fix line emergency nurse call system was only located on top of patient bed and it cannot fulfill the need of mobility. It was also costly because of the cabling setup in whole hospital and its configuration was messy with cables. Then wireless nurse call system had been invented. This type of system was cheap in cost but it was also only located on top of patient bed and is not portable. Term wireless only means the connection between alarm button and central station. It was inconvenience when patients had emergencies outside the room. Thus more humanize emergency nurse call system should be developed. In order to do so, a portable alarm system should be developed. Under this system, a portable alarm button will provide to patients and a portable receiver will provide to stuffs. This was a new idea in order to save cost and shorten response time of hospital's stuffs in providing emergency services toward patients.

1.3 Objective of Project

This project proposes a prototype of portable wireless emergency nurse call system. Specifically, the proposal proposes the following:

- i. To develop a new prototype of portable wireless emergency nurse call system.
- ii. To do performance evaluation of developed portable wireless emergency nurse call system.

1.4 Scope of Project

There are three main parts in this project. First part, a prototype of a portable nurse call system will be developed. This nurse call system will consist of few emergency switches and sensor such as temperature sensor attached to a chosen development board. Then when a patient pressed the switches or had a sudden temperature changed, alarm will be triggered on automatically. Signals will then send to central nurse station through TCP/IP network. In order word, this portable nurse

call system must be able to communicate to central nurse station through Wifi internet network. Central nurse station will be part two in this project.

For part three, a system that enables hospital nurses to receive acknowledgement signals from central nurse station will be developed. Each nurse will have a portable mobile device on their hand. Both central nurse station and portable mobile devices were communicated to each other through WiFi internet network. The function of portable mobile device is to receive calls or messages from central nurse station. This ensures hospital nurses can be reached at any time and at any location in hospital. Furthermore, portable mobile devices will be loaded with patients profile particulars and information for easy look up by hospital's stuffs.

1.5 Project Report Organization

Chapter 1 of the thesis describes the background, problem statement, objectives, scope of the project and project report organization.

Chapter 2 describes the literature review on background and history of nurse call system, the ordinary fixed line and wireless nurse call system that had in the hospital nowadays and future development of nurse call system.

Chapter 3 describes the methodology used in this project such as choosing of development board, hardware part of developed portable nurse call system and operating system of portable mobile devices. This includes the development of the emergency switches system on board, central nurse station and portable mobile device.

Chapter 4 will describe the results of portable nurse call system. Experiments will be conducted and results will be collected. This chapter also includes discussions about the system.

Chapter 5 will conclude the project and some recommendations for future work will be discussed.

REFERENCES

1. Nurse call systems, <http://sandersfeld.de/en/categories/nurse-call-systems/>
2. Nurse call button, http://en.wikipedia.org/wiki/Nurse_call_button
3. F. Ongenaes, M.Strobbe, J.Hollez, G.DeJans, F.DeTurck, T.Dhaene, P.Demeester, (2008), *Ontology Based and Context-Aware Hospital Nurse Call Optimization*, Ghent University, Belgium.
4. S.Aswin, N.Gopalakrishnan, S.Jeyender, R.Gnana Prasanna, S. Pravin Kumar, (2011), *Design Development and Implementation of Wireless Nurse Call Station*, Institute of Electrical and Electronics Engineers (IEEE).
5. Lill Kristiansen, (2011), *Nurse Call via Personal Wireless Devices; Some Challenges and Possible Design Solutions*, NTNU and NSEP, Norway.
6. Arduino Uno Overview, <http://arduino.cc/en/Main/arduinoBoardUno>
7. Arduino Wikipedia, <http://en.wikipedia.org/wiki/Arduino>
8. DIGI XBee Products, <http://www.digi.com/products/xbee/>
9. Arduino Software Installer, <http://arduino.cc/en/Main/Software>
10. X-CTU Installer, <http://www.digi.com/support/productdetail?pid=3352>
11. Wireshark Org, <http://www.wireshark.org/>
12. Putty Org, <http://www.putty.org/>
13. Android Lost Web Application, http://www.androidlost.com/#controls_messages
14. Android OS, https://en.wikipedia.org/wiki/Android_operating_system
15. Basic4Android, <http://www.basic4ppc.com/>