



Faculty of Computer Science and Information Technology

***PATIENT MONITORING SYSTEM USING ARDUINO AND CLOUD
COMPUTING***

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(Network Computing)
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PATIENT MONITORIN



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Requirements for the degree of
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UNIVERSITI MALAYSIA SARAWAK

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DECLARATION

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ABSTRACT

Cloud computing is the practice of using a network of remote servers hosted on the Internet to store, manage and process data, rather than a local server or a personal computer. Nowadays, cloud computing has a significant impact on the healthcare industry for backup very important data if there is an emergency on personal computer or local server. This project describes health monitoring system that was developed in cloud services environment, which can wirelessly transmit and receive electrical signals from the patients. Arduino wifi shield is used to transmit and receive the data from Arduino Uno board, which connected directly with temperature sensor. The device gives many advantages to the patients since they can monitor anywhere and anytime continuously by the doctors and medical staffs using their Android via cloud computing. Otherwise, burden cost can be minimized in terms of installation and maintenance of wiring in the hospitals or clinics and the problems regarding the lack of spaces in ward can be settled down by using patient monitoring system using fully wireless system.

Table of Contents

ACKNOWLEDGEMENT.....i

ABSTRACTii

LIST OF FIGURES.....vi

INTRODUCTION.....1

 1.1 Background.....1

 1.2 Problem Statement.....2

 1.3 Objectives3

 1.4 Methodology.....3

 1.5 Scopes5

 1.6 Significant of the project5

 1.7 Report Layout6

 1.8 Conclusion6

LITERATURE REVIEW7

 2.1 Introduction.....7

 2.2 Related Research7

 2.2.1 Existing Patient Monitoring System7

 2.2.2 Comparison12

 2.3 Cloud Computing System.....14

 2.4 Proposed System.....20

 2.4.1 Temperature Sensor20

 2.4.2 Arduino Uno21

 2.4.3 Arduino Wifi Shield.....22

 2.4.4 Wifi Web Client Library22

 2.4.5 Temboo24

 2.4.6 Arduino v1.6.4 Software.....24

REQUIREMENT ANALYSIS AND DESIGN26

 3.1 Introduction.....26

 3.2 Hardware Design26

3.2.1 Temperature Sensor	28
3.2.2 Arduino Wifi Shield.....	30
3.2.4 Arduino Uno board	31
3.3 Software Design.....	34
3.3.1 Arduino Web Client Library	34
3.3.2 Temboo Software.....	35
3.3.3 Arduino version 1.6.4.....	36
3.3.4 Spreadsheet Tools	36
3.3.5 Android Studio	37
Implementations	38
4.1 Introduction.....	38
4.2 Hardware setup	38
4.2.1 Arduino Uno Board	38
4.2.2 Breadboard	39
4.2.3 Installing the Arduino IDE on Windows	40
4.2.4 Communicating Between Your Arduino and PC.....	46
4.2.3 Temperature Sensor	47
4.2.4 Arduino Wifi Shield.....	52
TESTING	60
5.1 Introduction.....	60
5.2 Temperature Sensor	60
5.2 Testing of Arduino wifi shield.....	64
5.2.1 Connection failed	64
5.2.2 Connection Success.....	65
5.3 Testing with Integration of Cloud Services	66
5.3.1 Google Spreadsheet.....	67
5.4 Testing with One User	70
5.5 Android Graphical User Interface Design	71
5.6 Complete prototype	76
CONCLUSION	78

6.1 Conclusion 78

6.2 Problems/Limitations..... 79

6.3 Future Works/Recommendations 80

References 81

Appendices 84

LIST OF FIGURES

Figure No.	Title	Page Number
1.1	Flow chart of patient monitoring system with fully wireless system	4
2.1	Block diagram of mobile telemedicine	9
2.2	Service platform functional architecture	10
2.3	Self supporting sensor (left) and complete front-end system with ECG and oxygen saturation sensors	11
2.4	Patient Monitoring Unit	15
2.5	Artemis Cloud	15
2.6	Data Acquisition Module	17
2.7	Patient monitoring and alerting system	18
2.8	Heartbeat sensor	19
2.9	A software system that integrates mobile and Cloud computing services	20
2.10	Melexis Contactless InfraRed Temperature Sensor	20
2.11	Arduino Uno	21
2.12	Arduino Wifi Shield	22
2.13	Connection of Wifi Shield	23
2.14	Icon of Temboo	24
2.15	Arduino version 1.6.4 Software	24
3.1	Block diagram of patient monitoring wireless sensor network	27
3.2	Flow chart of patient monitoring of cloud computing	28
3.3	MLX90614 Pin Configuration	29
3.4	Arduino wifi shield stack on top Arduino uno	30
3.5	Pins of Arduino wifi shield Connection	31
3.6	Arduino Temperature Sensor Project	32
3.7	Complete wiring for prototype	32
3.8	Flow Chart for Arduino Programming in Patient Monitoring Using Wireless Network	33
3.9	Android Studio icon	37

4.1	Arduino Uno board	39
4.2	USB Cable	
4.3	Breadboard	39
4.4	Arduino v1.6.4 Software	40
4.5	Interface for beginning of the installation	41
4.6	Source code on trying the Arduino program	43
4.7	Steps on “Tools” menu	44
4.8	The second step on “Tools” menu	45
4.9	Real Implementation on the Arduino Uno board	46
4.10	Schematic Diagram	47
4.11	Connection of MLX90614 on breadboard	48
4.12	View from Upward	49
4.13	View from Bottom	
4.14	Arduino Wifi Shield Front View	53
4.15	Arduino Wifi Shield Back View	
4.16	Download DFU program	55
4.17	Screenshot from the Terminal	57
4.18		
4.19	Before and After Attach on top of Arduino Uno	58
4.20	board	59
5.1	Screenshot from the serial monitor	61
5.2	Hand on top of sensor	62
5.3	Second results shown highest temperature	63
5.4 & 5.5	Connection Failed	64 – 66
5.6 & 5.7	Connection Success	
5.8 & 5.9	Screenshot from serial monitor send to Google Spreadsheet	66 – 67
5.10	Graph Design	69
5.11 & 5.12	Donna’s Result & Graph Design	70
5.13 & 5.14 & 5.15 & 5.16	Android Interface	71 – 75
5.17	Complete Prototype	77

Chapter 1

INTRODUCTION

1.1 Background

One of the first medical devices we encounter when we visit a hospital care unit is the patient monitoring system. Doctors and nurses are informed about the vital signs of patients by the system so that they can prepare themselves timely and provide appropriate treatment. Pulse rate, oxygen level and body temperature are the most important vital signs shown by the system. The measurement of vital signs must provide accurate and stable data at the same time without any intervention by the patient. The patient monitoring system also needs to detect emergencies and inform medical personnel when they occur.

What is telemedicine? Telemedicine is the utilization of telecommunication technology for medical diagnosis, treatment and patient care. The function of telemedicine is to provide expert-based healthcare through modern telecommunication or wireless communication and information technologies whenever there is a shortage of staff in the hospital. In addition, it is used for medical information exchanged from one place to another via electronic communications to improve patient's clinical health status (American Telemedicine Association, 2012) [1]. Patient monitoring is one of the telemedicine, which always needs improvement to make it better. It gives a new way to deliver health care services when the distance between the doctor and patient is significantly away, especially for the people in rural area.

Hjelm (2005) found that one of the benefit of telemedicine is reduced healthcare cost [2] because the information sending to the patient is less expensive only by using wireless communication and the doctors can monitor the patients from time to time and anywhere by using cloud computing. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

1.2 Problem Statement

As we know, patient monitor is vital for monitoring patients' condition especially particularly for patients who suffer from high blood pressures, diabetes and hypoxia (lack of oxygen saturation). Thus, demand on patient monitor is high but a variety of problems appeared in terms of lack of space in hospitals and also need high cost maintenance for wiring and installation. The system will be used to monitor the patients at home. As we are using fully wireless system, normally there will be no issues of wiring and their installation in the shape of ducting, sensors will be attached to the body, which will transfer the data to nearby gateway, using GSM gateway, the data will be transfer to cloud from where any doctor using their mobile phones can access the data.

1.3 Objectives

1. To design patient monitoring system for monitoring body temperature of the patients.
2. To develop wireless system of monitoring system using Arduino Uno and Arduino wifi shield.
3. To develop data monitoring system using integration between cloud and Android.

1.4 Methodology

Here is some brief description on the method that was used to implement the project. This project was divided into two parts, software and hardware parts. For the hardware design, it is focus on the main controller hardware, Arduino Uno board and Arduino wifi shield which connected to the temperature sensor by using jumper wires. Meanwhile, for the software design, Android studio, cloud service (Temboo) and Arduino programming were used. Some brief methodology in the form of flowchart is shown below in Figure 1.

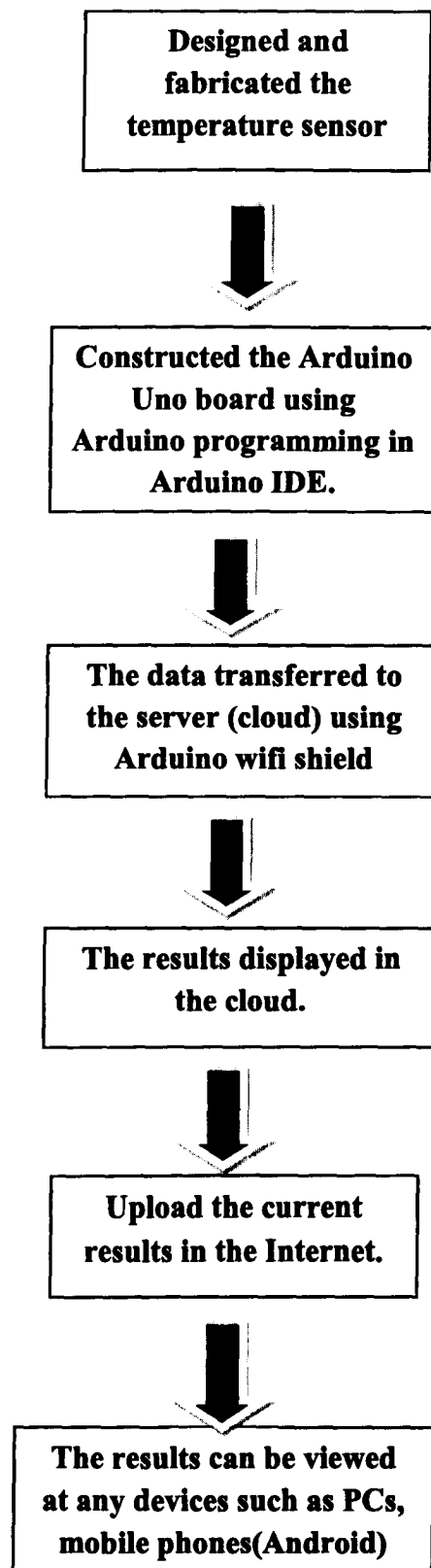


Figure 1.1 Flow chart of patient monitoring system with fully wireless system

1.5 Scopes

This project is implemented especially for patient who lives in the rural area or for those who cannot reach to the hospital for some emergency reasons. Therefore, this project enables the doctors and nurses monitor the patients anywhere from time to time using cloud server. The scopes in this project also include hardware and software parts. For the hardware part, temperature sensor will be developed in order to interpret the reading of body temperature. Both systems will be controlled by Arduino Uno board and Arduino wifi shield. For the software part, spreadsheet tool was functioned to display the graphical user interface on any screen devices. Android is used to display the results in any devices with the help of cloud computing.

1.6 Significant of the project

This project is very important for medical staff especially doctors and nurses to enable them know the patients' condition anywhere and anytime without going to the patients' living place unless if there is an emergency then the doctors and nurses have no other choice, they have to go to the patients' living place. This project is important for the patients who are living significantly away from the medical center and the patients do not have to walk far to get medical results. It is also useful for people who live in rural area, they can get the current results immediately only by using wireless sensor network with the help of cloud computing and can view the results using any devices. It is not limited to only one device which is computer. For those who cannot afford to buy computer, they can view the current results using mobile phones or other devices.

1.7 Report Layout

Chapter 1 explained the introduction of this project by giving brief description of the project such as the main objectives, the significance of this project as well as the main scope.

Chapter 2 explained the related work that has been done by other researchers that have slightly similar with this project.

Chapter 3 explained all the hardware and software that will be used during the whole of the project.

Chapter 4 explained the step by step of implementing the hardware including the installation process and connectivity of the output and input pins.

Chapter 5 explained the process of testing with the combination from both hardware and software and using only one user.

Chapter 6 is the conclusion of the project by explaining some problems and recommendations for future works.

1.8 Conclusion

In conclusion, for the overall requirement of this chapter, we can see that hardware and software together involved with some programming codes came together to make the patient monitoring system done successfully. The application of wireless network and cloud computing services made the data retrieved anywhere and anytime using Android safely and it makes the updating process done smoothly.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The idea of this project comes from the problems that faced by the doctors or medical staff to monitor the patient frequently because of far distance from the patients' house to medical centre, especially for those who lives in rural areas. Far distance becomes a problem because there is not enough space for all patients and they cannot afford to pay cost living in the hospitals for maintenance and wiring installations. This chapter also explains about the theory and basic concepts of electronic components that used in the project such as Arduino Uno board, ECG sensor, temperature sensor, patient simulator, Arduino version 1.6.4 software, Temboo and Android studio.

2.2 Related Research

2.2.1 Existing Patient Monitoring System

Team-42370 (n.d.) [3] found that there are many challenges in remote monitoring of patients in rural areas. One of the challenges is most patients have to leave after their first meeting with the doctors. This is of great concern because the patient is not completely recovered. This becomes an issue because the hospital is not provides enough space or beds for many patients. Apart from that, the patients are not able to be in the hospital longer due to lack of space or beds and also cannot afford to pay treatment cost as well as bills for hospital maintenance and wiring installations. Therefore, nowadays many health centers, hospitals,

doctors and patients have enough technology such as computers, Smartphone or tablets to access with the patients. The patients also have mobile phones with built in sensors such as camera that can take photos or provide a heartbeat measurement.

Saravanan, S. (2014) [4] introduced a remote patient monitoring in Telemedicine using computer communication network through Bluetooth, Wi-Fi and Internet Android Mobile. These systems are proposed because it involves transmission and receiving of biomedical signals using internet, but the cost for maintenance is high using satellite based communication. Apart from that, it is disadvantage for poor people in rural area due to highly cost of satellite based ambulance telemedicine. Therefore, the solutions are the bio signals are transmitted in video stream through internet in order to reduce noise by internet communication. In this case, there is no need of antenna in ambulance because it replaced by mobile communication and it is affordable for people in rural area. Mobile based telemedicine can transmit data of X-rays and scanning reports or patient details that stored in cloud. Bluetooth also have its roles by transmitting information for processing. At monitoring center, android phones receive information through Bluetooth because it helps to monitor patients remotely and secure their lives by giving emergency alerts. Diagram of mobile telemedicine is shown in Figure 2.1.

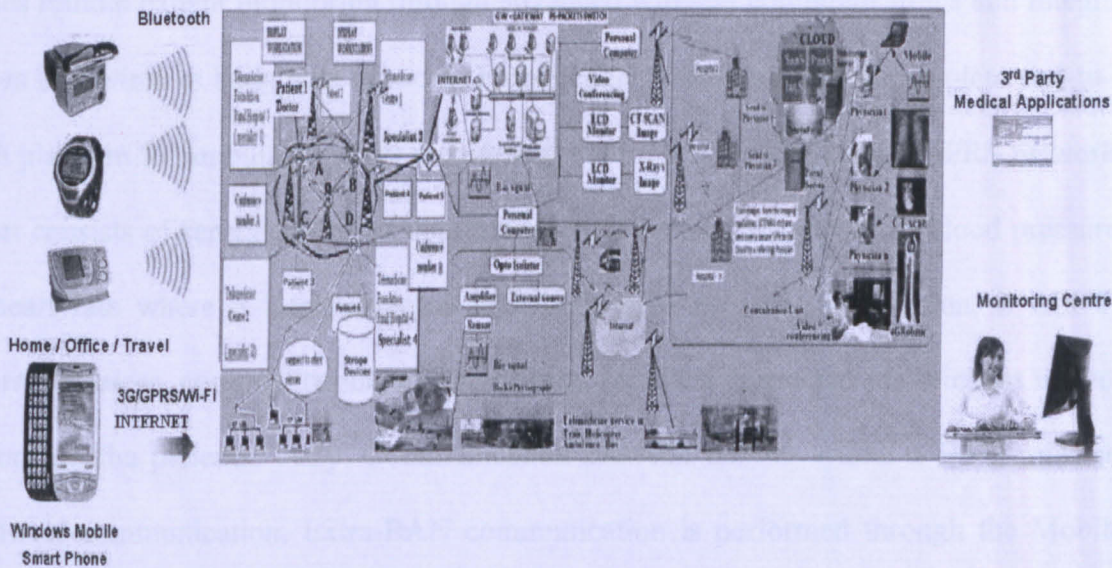


Figure 2.1. Block diagram of mobile telemedicine

Sivaranjani *et al.* (2012) [5] proposed automatic patient monitoring system using scatternet for critical care. This system involving the existing system that has the structural design of piconet topology, but piconet consists of only 8 nodes or less which is only one node will act as master. Due to less number of nodes in the network, the range of communication is very sufficient. This will be a problem for hospitals to monitor more number of patients. Therefore, to overcome the problems, scatternet is used by interconnecting more number of piconets to form a large network called scatternet. Here each piconet has local master nodes and it will interconnected via one global master node known as a bridge node. By adding up number of nodes, the range of communication in the network can be increase.

Halteren, *et al.* (2004) [6] introduced mobile patient monitoring based on MobiHealth System where the patients from far distance will be able to receive medical advice and full, detailed and accurate vital signs measurements wherever they are. Mobile health service platform

enables remote patient monitoring through advanced wireless communications and integration of sensors to a wireless body area network. MobiHealth system provides a complete end-to-end m-health platform for ambulant patient monitoring, deployed over UMTS and GPRS networks. This system consists of sensors part that constantly monitors vital signs such as blood pressure, ECG and heart rate where it interconnected with body area network. In addition, it will be have sensors, actuators, communication and processing facilities connected via wireless network that be worn on the patients' body. Communication between entities within a BAN referred to as intra-BAN communication. Extra-BAN communication is performed through the Mobile Base Unit and enables remote monitoring. Intra-BAN communication is based on short range wireless networks like Bluetooth and Zigbee, while extra-BAN communication employs GPRS and UMTS. Diagram of MobiHealth is shown below in Figure 2.2.

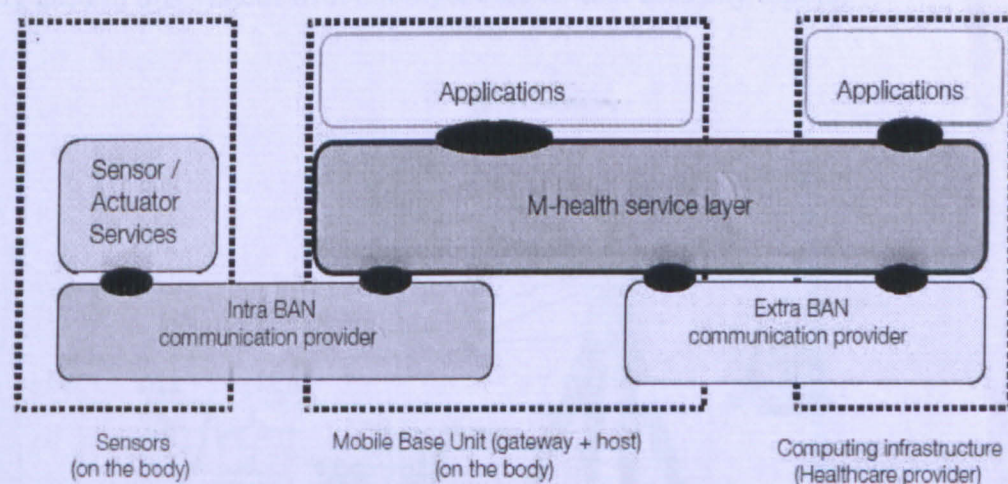


Figure 2.2. Service platform functional architecture

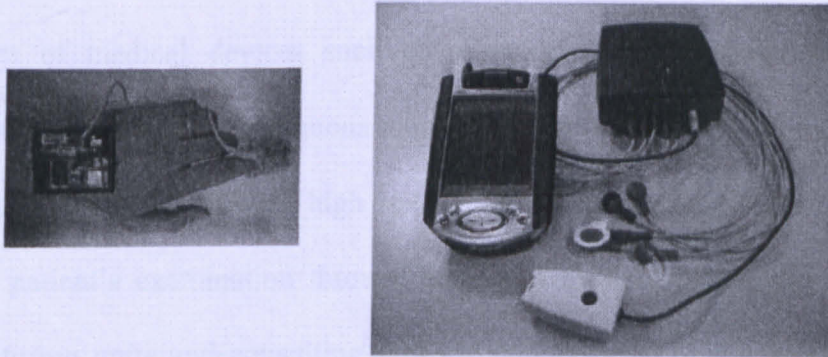


Figure 2.3. Self supporting sensor (left) and complete front-end system with ECG and oxygen saturation sensors

Ansari, *et al.* (2012) [7] introduced telemedicine concept for people in rural area which is a smart health care is used to diagnose diseases suffered by patients. This system is introduced especially for those who cannot afford to go to the hospital. Therefore, wireless sensor network is importantly used in this system with intelligent server that uses any topology.

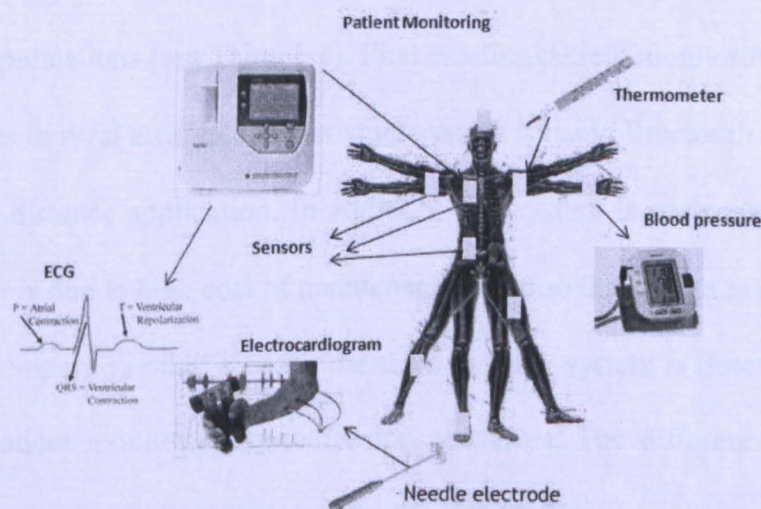


Figure2.4. Patient Monitoring Unit

Different electrodes connected to the patient via infrared sensors monitored by input unit. Different types of medical devices such as othoscopes and stethoscopes thermometer for implementation in this system. Continuous monitoring [13] through digital camera by using ECG and EMG machines that attached to high speed network computers, aiding with an interactive intensive care patient's examination through store and forward technology. The link between patient's monitoring units and consulting unit are connected with wireless switches. Wireless switches connect to WLAN APs through switch port and connected to the other patient/s monitoring network through other ports of that switch. Wireless network connections are reliable and flexible network for patients monitoring equipment by asking questions to detect any sign of emergency (Ansari *et al.*, 2012) [7]. Figure 2.3 and 2.4 explained the devices that be used in patient monitoring unit.

2.2.2 Comparison

There are five existing patient monitoring system mentioned above that are related different kinds of applications (see Table 1.1). First existing patient monitoring system is suitable for people who lives in rural area. Second existing system is using Bluetooth application and it is not suitable for far distance application. In addition, this system is not suitable for people who lives in rural area. It is due to high cost of maintenance because the system is using satellite based communications. Compare to other system, the third existing system is describe more about the use of automatic patient monitoring system using scatternet. The difference of this system to other system is the use of scatternet that enables the system to monitor large number of patients especially hospitals that provide many spaces for patients. The other two systems mentioned before this, it is suitable only for small number of patients and far distance. For the fourth system,

it describe more about intra-BAN communications and extra-BAN communications. Compare to other systems, this system is using sensors and actuator via wireless networks. The difference of this system to other system, it explained more application on long range and short range communications. Compare to other systems, it limited only one range but this system it apply on both range communications. On the fifth system, it is same with the first system but it is for those who cannot afford to go to hospitals. Compare to other systems, the system is using intelligent server to enable the system to monitor the patients efficiently and effectively.

Table 1.1 Table of Comparison

Patient monitoring system	Suitable for rural area	Cost	Implementation	System effectiveness	Number of patients used
Technology application	Very suitable	Low cost	Using Smartphone or tablets built in sensors	Effective to all patients	Large
Computer communication network	Not suitable	Very High Cost	Satellite based communication	Not very effective to all patients	Small
Scatternet	Not suitable for critical care	Very High Cost	Structural design of piconet topology	Not effective to all patients	Small
MobiHealth System	Very suitable	Low cost	Advanced wireless communications (UMTS and GPRS) and integration of sensors	Effective to all patients	Large
Telemedicine based Smart health care	Very suitable	High cost but affordable	Using intelligent server	Very effective to all patients	Large