DEVELOPMENT OF WIRELESS SURFACE ELECTROMYOGRAPHY FOR TELE-REHABILITATION APPLICATION: BODY AREA NETWORK

IMRAN BIN NAZIRI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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IMRAN BIN NAZIRI

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Special dedication to my beloved mother and father, my entire sibling and my kind hearted supervisor Dr. Soo Yew Guan, and all my dearest friends.

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ABSTRACT

This project is about to design a body area network for surface electromyography system by using wireless technology, replacing wired communication. MiWi application is used and applied to wireless network, which offers cheap wireless module. The system consists of two devices, sensor node and coordinator. The sensor node collects the data from the skeleton muscle, and transmits the signal packet through the air. The coordinator receives and processes the packet signal to an original signal that captured by sensor node. All the hardware for sensor node and coordinator is designed by using Programmable Interface Controller (PIC).

ABSTRAK

Projek ini adalah untuk mereka bentuk rangkaian komunikasi untuk permukaan sistem elektromiografi dengan menggunakan teknologi tanpa wayar yang menggantikan komunikasi berwayar. Aplikasi MiWi digunakan untuk rangkaian tanpa wayar ini menawarkan modul dengan harga dan kos yang murah. Sistem ini terdiri daripada dua peranti, nod sensor dan peranti pengumpul isyarat. Nod sensor mengumpul data dari otot rangka, dan menghantar paket isyarat melalui udara. Peranti pengumpul isyarat pula menerima dan memproses isyarat paket kepada isyarat asal yang dibaca oleh nod sensor. Semua perkakasan untuk nod sensor dan penyelaras direka dengan menggunakan Antara Muka Pengawal Aturcara (PIC).

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LIST OF FIGURE

CHAPTER 1

INTRODUCTION

In this chapter, introduction is made on some general information about electromyography (EMG), Body Area Network (BAN), objective, problem statement, scope and thesis outline of the project.

1.1 Electromyography

Electromyography (EMG) is a method that involves recording the electrical currents that activate skeletal muscle fibres. The electric current is started at the fibre membranes and looks like electrical waves that surpass along the fibre to encourage muscle contraction.

The instrument that that used to measure potential different produce by muscle is called electromyograph, which produces an electromyogram. The signal can be analyzed to detect medical abnormalities, activation level, and recruitment order or to analyze the biomechanics of human or animal movement.

Nowadays, the electrical currents are spotted by two electrodes that placed onto the surface of skin over muscle. Thus, during muscle contraction, the electrical current move through the tissue that overlying the muscle and detected by the electrode node on the skin surface. Because of these electrodes are not very sensitive,

the EMG signals are produced by a summation of electrical current from many muscle fibres. From the electrode nodes, the EMG signal surpassed an amplifier to avoid noise and boost its magnitude. Finally, the signals were to computer where it can be stored or analyzed.

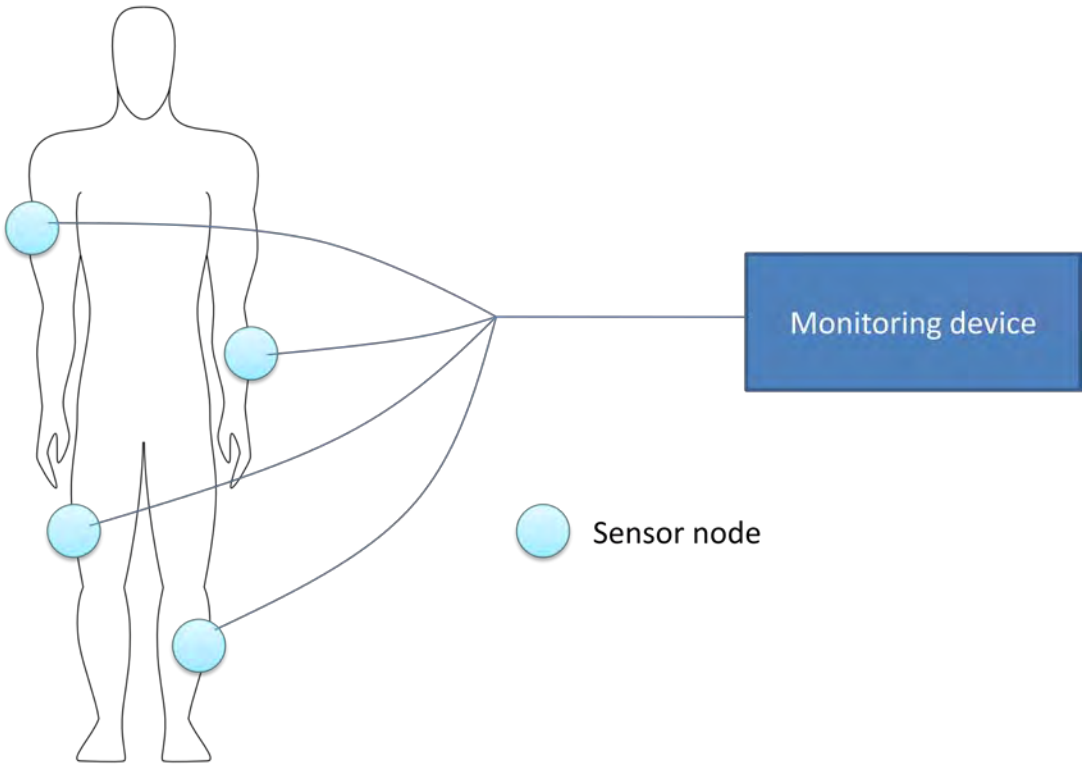

Figure 1.1: EMG system today using wire as their communication between sensor nodes and monitoring device

Furthermore, there many application and invention have been acquired regarding to the neural mechanism controlling movement via real-time measurement of electromyography (EMG) and body kinematics during task including walking, swimming and stretching.

Due to the current of an electrical wire between electrode and EMG device, the measurement is toward limitation. These technologies can effect by noise cause by wires. A lot of noise can affected the accuracy of EMG signal.

1.2 Body Area Network

Body Area Network (BAN) is a term to describe the application of wearable computing device. The device will equip with wireless communication between sensor nodes and remote station. The wireless network is used to monitor and analyze data from the patient. These technologies will help in development of cheap and health monitoring system with real-time update of medical records via Internet. The sensor node is integrated with wireless technology which can be used for rehabilitation of medical condition.

This implementation will replace the old-fashion wired technology inside human body that are comfortable and do not mess up with normal activities. The sensor in the human body will obtain any physiological changes to collect the data in order to monitor and analyze patient's health even tough at the different location. The data will transmit wirelessly to the remote station.

From the remote station, the data instantly transmitted in real time to the researcher or doctor via Internet. Any emergency can be detected early, so the physician can inform the patient by sending message or alarm.

Initial applications of BANs are expected to appear primarily in the healthcare domain, especially for continuous monitoring and logging vital parameters of patients suffering from chronic diseases such as diabetes, asthma and heart attacks.

For example, BAN network in place on a patient can alert the hospital, even before they have a heart attack, through measuring changes in their vital signs. A BAN network also can be applied on a diabetic patient could auto inject insulin though a pump, as soon as their insulin level declines.

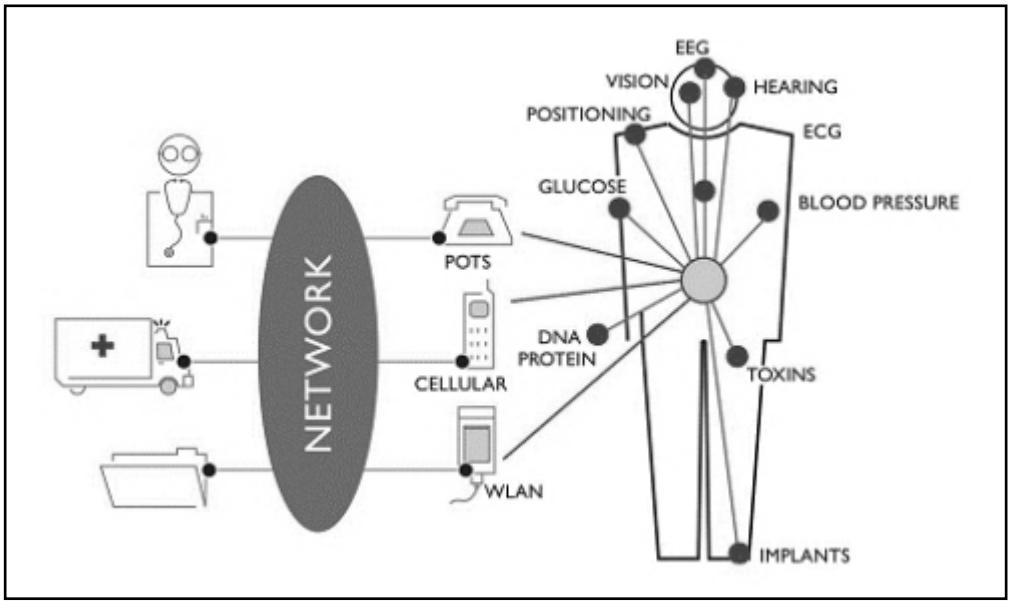

Figure 1.2: People will be carrying their personal body-area network and be connected with service providers regarding medical, sports and entertainment functions.

Other applications of this technology include sports, military, or security. Extending the technology to new areas could also assist communication by seamless exchanges of information between individuals, or between individual and machines.

1.3 Objective

The main objective of this research is to design a body area network for surface electromyography system of sensor using wireless technology. The other objective is to design EMG system using PIC microcontroller.

1.4 Scope

It is too vast for any single research work under a given time frame to cover all the topics related to development of wireless surface electromyography for tele-rehabilitation application. This project will focus on a certain properties of the system.

The project covers on implementation of wireless technology. It is include the use of MiWi technology. The project also applies the performance MiWi protocol topology.

1.5 Thesis Outline

This final year project report consist five chapters to elaborate about Development of Wireless Surface Electromyography for Tele-Rehabilitation Application: Body Area Network project which are starting with Introduction, Literature Review, Methodology, Result and Discussion, Conclusion and Recommendation.

Chapter I – Introduction discuss about background of the project, problem statement, objective, scope and the purpose of developing this project.

Chapter II – Literature Review consist about the background study and research before developing the Body Area Network. The content of the background studies such as comparison between existing wireless technology and protocol, type of PIC microprocessor and network topology. The content also compared with other research and journal made by previous researcher.

Chapter III – Methodology described about the methods or approaches used in solving projects. Among the main content of this chapter are Initial Planning, Planning, Requirements, Analysis and Design, Implementation, Testing, Evaluation and Deployment.

Chapter IV – Result and Discussion described about the methods that been used in this project and the advantages of the requirement have been chosen. The main requirements are the source code of the MiWi protocol.

Chapter V – Conclusion and Recommendation consist the summary of the project and recommendation for the future research. It also includes the future recommendation of the project.

CHAPTER 2

LITERATURE REVIEW

The aim of the present section is to review the technical and scientific state of the wireless surface electromyography device for tele-rehabilation. The features that will be discussed are Wireless Technology, PIC Microprocessor and network topology.

2.1 Wireless Technology and Topology

2.1.1 Introduction

Wireless telecommunications can be described as the transfer of information between two or more points that are not actually connected. The communication between the point distances can be short, for example as a few metres for television remote control, or as far as thousands or even millions of kilometres for deep-space radio communications.

The wireless technology includes a variety of types of mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. The other examples of wireless technology include GPS units, Garage door openers or garage doors, wireless computer mice, keyboards and Headset

(audio), headphones, radio receivers, satellite television, broadcast television and cordless telephones.

Wireless operations allow long-distance services, such as a very long range communications that is impossible or unrealistic to implement with the use of wires such as communication between space station with command centre on the earth. The term is usually used in the telecommunications industry to refer to telecommunications systems.

The examples of the wireless system are radio transmitters and receivers, remote controls, computer networks, network terminals and so on. Wireless communication also involved the some form of energy for example radio frequency (RF), acoustic energy, to transfer information without the use of wires. Information is transferred in this manner over both short and long distances.

2.1.2 Wireless Network

Wireless network can be defined as any type of computer network that is communicate between two or more device that are not connected by cables of any kind. It is a method used by homes, telecommunications networks and enterprise to decrease or avoid the cost of implementing cables into a building, or as a connection between ranges of equipment locations. Wireless telecommunications networks are usually applied and administered using a broadcast system called radio waves. This implementation takes place at the physical level (layer) of the OSI model network structure.

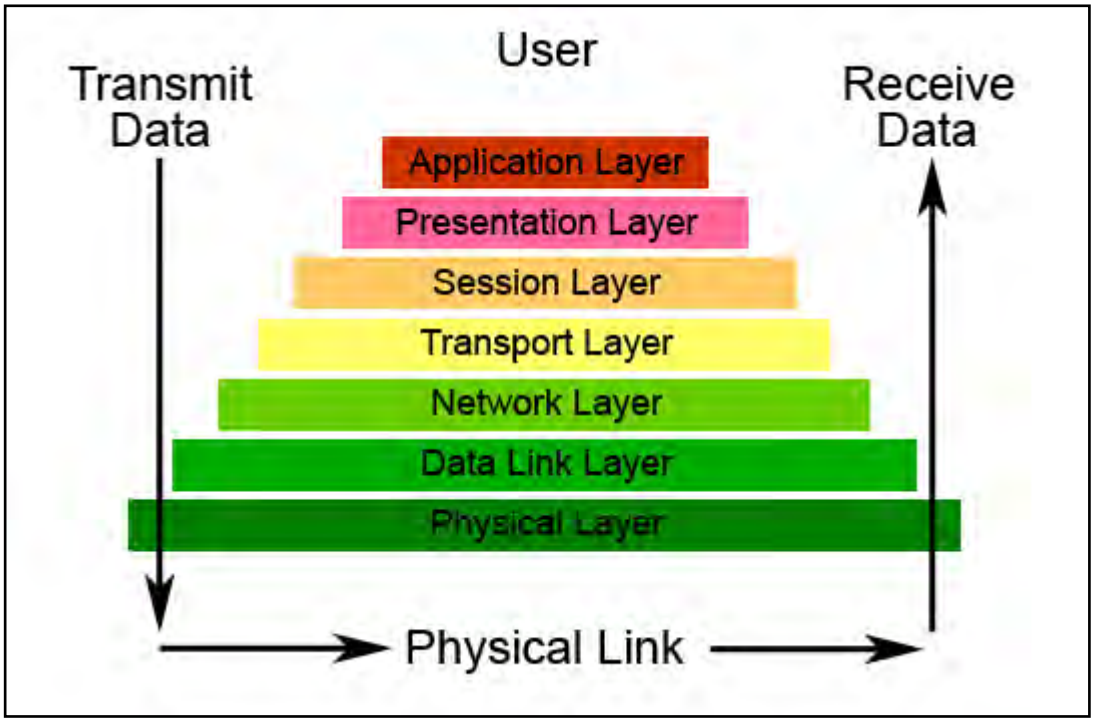

Figure 2.1: OSI model network structure. Wireless implementation take place on Physical layer

Wireless networking is used to fulfilled many human needs. The most general use is to connect laptop users who travel from location to location such as WI-FI. Another general usage of wireless technology is for mobile networks that connect via satellite. A wireless transmission method is a logical choice to network a Local Area Network (LAN) segment that must frequently change locations.

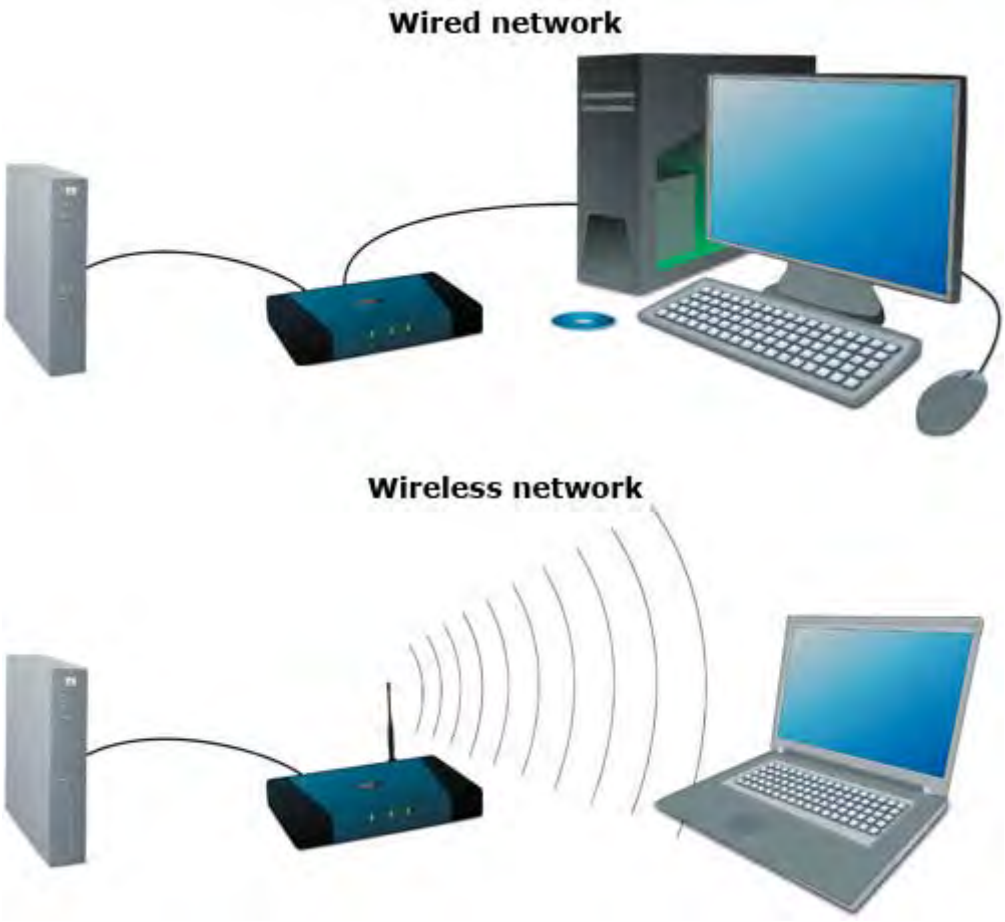

Figure 2.2: Wireless over wired technology

The situations that are justifying the use of wireless technology are to span a distance beyond the capabilities of typical cabling. Without wireless, a long distance communication will be too costly to apply because it requires long and high-end quality wire. The other reason is to provide a backup communications link in case of normal network failure. By using wired technology, it is not always doing well. It depends on the durability, quality and specification by wire manufacturer. So, wireless is the cheapest solution. Wireless network also used to remotely connect mobile users or networks. For example a administrator can controlled the all the guest computer operation in a workstation.

2.1.3 Wireless Types and Standard

The primary role of a sensor-based system is to obtain information such as temperature, flow rate, health machine, or electric signal from the muscle. While

generating data obtained from the sensor readings, the transmission of data to a monitoring or control system remains a challenge due to the cost and complexity of installing and maintaining communications networks.

For wireless networks, the need of industry standards has produced complicated sensor and reducing broad-based deployment. So, while sensors continue to develop, the technique of communicate between the node sensor and remote sensor also needs advance communication.

Most sensors are old-fashion wired into the systems that they are monitoring and controlling. Nowadays, wireless standards including Wi-Fi, Bluetooth, ZigBee, and MiWi have appeared which provide to give advantage over wired systems and reduce the risk of wireless communications.

One of the advantages of wireless is ease of installation and system flexibility. The technology has long been introduced but cost and reliability has hanged on. With Wi-Fi and Bluetooth now shipping in the tens of millions of units annually costs have fallen dramatically. New networking technology available in ZigBee and MiWi, the first wireless standard designed specifically for remote monitoring and control applications, can significantly improve the reach and reliability of wireless networks.

2.1.3.1 Wi-Fi

Wi-Fi is a trademark of the Wi-Fi Alliance that may be used with certified products that belong to a class of wireless local area network (WLAN) devices based on the IEEE 802.11 standards.

Wi-Fi allows local area networks (LANs) to be deployed without wires for client devices, typically reducing the costs of network deployment and expansion. Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANs.