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Abstract of Doctoral Dissertation

A Study on Health Care System
Employing Intra-Body Communication

人体通信を用いたヘルスケアシステム
に関する研究

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The technology era that spread in the past years drastically evolved traditional structures and systems. A unique feature of the technology and telecommunication industry is the relatively cheap prices of hardware and software involved in these systems. This induced researchers to utilize technology and telecommunication driven tools in overcoming traditional challenges and limitation of the Health Care industry.

One of the major problems in the design of an efficient mobile Health Care system is the unit's power supply.

The low power requirements of intra-body communication (IBC) as compared to near field electromagnetic waves, makes it a better choice for its application in Medical Body Area Networks (MBANs) for mobile Health Care system. Intra-body communication in which the human body is used as a signal transmission guide has attracted much attention in the study of Body Area Networks (BANs); one of the reasons is because electromagnetic noise and interference have little influence on signal transmission when signals pass through the human body. These characteristics are superior to those of other radio-based network technologies, such as Bluetooth and IrDA etc. However, a complete detailed analysis of the model for signal transmission in IBC has not been conducted so far by the research community. Moreover, the optimum frequency of transmission for consuming the least amount of energy has not yet been determined and studied exhaustibly. In this dissertation, we investigated the transmission characteristics of radio waves in the human body as a conductor of signal up to 2.4 GHz with considering different transmitter power consumption and data transmission rates in different locations of human body. The evaluation of different data rates for a range of carrier frequencies has been done with error vector magnitude (EVM) as a measurement parameter.

In the chapter 1, the outline of challenges of wireless telecommunication in Health Care system is introduced. Firstly, the general perspective of global Health Care and its current situations and challenges are described. Then, the Health Care solutions in

wireless telecommunication are presented.

In the chapter 2, the basic knowledge of wireless Body Area Network, technology and applications are explained. It includes wireless body area network, intra body communication's introduction and the expatiation of intra body communication method. The survey and some proposes of indoor applications, outdoor applications and some potential applications are explained.

In chapter 3, the concept of point to point intra body communication for personal Health Care monitoring system is introduced. The system architecture comprising of a set of sensors, the base station, receiver and the communication network is proposed. Investigation on the transmission characteristics for the human body on BAN point-to-point intra-body communication between ECG sensor (transmitter) and a central hub (receiver) worn on the wrist. An experiment was conducted by considering two different kinds of modulation techniques viz. QPSK and BPSK. EVM was measured by varying the carrier frequency at different data rates. These modulation schemes for IBC in terms of EVM are evaluated and the variation of EVM with carrier frequency at different data rates is plotted. Experimental results have shown that both QPSK and BPSK could be used for IBC at high data rate using low transmission power with minimum range of -30 dBm and it also show that when transmission power decreases, the optimal carrier frequency shifts to the lower range of 75 MHz to 150 MHz and QPSK and BPSK provide good performance of high symbol rates up to 4 Msps in the case of transmission power of -30dBm in this range.

In chapter4, the concept of point to multi-point intra body hybrid communication for personal Health Care monitoring system is introduced. A system architecture comprising of a set of sensors, a base station, receiver and a communication network is proposed. Firstly, the transmission characteristics of the human body on BAN point-to-multi-point intra-body communication between central hub (transmitter) on the chest and sensors (receiver) worn on the wrists, head, waist are investigated. An experiment

was conducted by considering two different kinds of modulation techniques viz. QPSK and BPSK, and EVM was measured by varying the carrier frequency at different data rates. Although QPSK and BPSK could be used for IBC with high data rate., however, when we decrease transmission power, the optimal carrier frequency shifts to the lower range of 75 MHz to 150 MHz. QPSK and BPSK provide good performance of high symbol rates up to 4 Msps in case of transmission power of -30dBm in this range between central hub (transmitter) and the sensors at (wrists, head, waist). Secondly, Based on the proposed IBC optimal frequency, the Intra- body hybrid communication scheme with movable boundary as a promising scheme to apply on the body area network for the medical application. It provides higher throughput and less delay comparing with other communication schemes such as TDMA and Slotted Aloha. Regardless of the different types of sensors, which include those that transmit data randomly and periodically, the intra-body hybrid communication scheme is capable of adjusting the slots allocation to maximize the throughput and minimize the delay. The simulation was run under three different scenarios and it had further demonstrated that flexibility and efficiency of the proposed hybrid scheme.

In chapter 5, I conclude the dissertation and state the future works.