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REAL-TIME MEDICAL MONITORING SYSTEM DESIGN BASED ON INTRA-BODY COMMUNICATION

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ABSTRACT

With soaring of the sub-health population around the world, the traditional medical treatment has not met the increasing demand; it is urgent to create a modern nursing technology to provide service for human being. With development of the sensor technology and continuous improvement of the wireless communication technology, the new medical monitoring system has been gradually released from the traditional human-labor nursing. On the basis of development of the intra-body communication technology, a wireless, wound-free, portable medical system with real-time monitoring is proposed in this paper. In combination with the remote diagnosis system in the modern medical treatment, the sensor technology and the intra-body communication technology can be utilized to provide all-sided and real-time monitoring for individuals. Because data fusion can be effectively implemented between the systems and WAN & LAN, the model of the medical monitoring system for families is also presented in this paper, which offers guidance for further promotion of real-time medical monitoring.

Keywords: *Intra-Body Communication, Portable, Wearable Equipment, Medical Monitoring System*

1. INTRODUCTION

Due to the spread of chronic high-risk diseases, aging of population and increase of the sub-health population, people become more aware of their own health issues. The traditional medical mode, with the hospital as the center and the patient as the treated object, has not met increasing great demand of health care. A new medical mode is gradually breeding and developing worldwide, in which the community, families and individuals are regarded as the center, giving priority to disease prevention and health care together with early diagnosis and treatment. Along with the historic change of medical mode, workplaces, running features and objects of medical instruments will change. Obviously, the hospital-oriented traditional medical instrument design has not adapted the change in demand. Therefore, focus in research & development and market demand of current medical instruments is gradually shifting from the complex and large-scale medical equipment applied to hospitals to miniature, intelligent and networked medical monitoring instruments / devices applicable for families, communities and individuals. In view of engineering science, “miniaturized – portable - wearable” is the only developing direction of traditional medical instruments applied to communities, families and adapted to variation of medical mode. While development of the MEMS technology, the communication technology, the material technology, the biosensor technology etc. make it possible to develop wearable medical instruments. On the one hand, successful development of the wearable medical instrument may provide real-time monitoring of the sub-health population, on the other hand, the measured data can be stored in the database for patients. This kind of medical instrument provides the true and effective health monitoring database system for patients, meanwhile the data may also provide potent evidence for research of similar clinical cases. Establishment of the base station not only makes patients (especially disabled elderly people) able to obtain real-time diagnosis indoors, but also offers effective analysis data about clinical cases for scientific research institutions and hospitals.

In the second section of this paper, origin, classification and development of the intra-body communication are analyzed. In the third section, application of Body Area Network in the intra-body

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communication technology is presented. On the basis of the above sections, establishment of the real-time nursing system based on the intra-body communication technology is proposed in the fourth section as well as key technologies in development of the technology. The last section is to summarize all the paper.

2. INTRA-BODY COMMUNICATION

In 1995, Dr. Zimmerman [1] [2] from Massachusetts Institute of Technology proposed the concept of Body Area Network (BAN). Nowadays, the body area network technology has made a remarkable progress among many international universities and scientific research institutions. According to the coupling mode of the electric signal and human body, the intra-body communication may be divided into the following types: 1. capacitive coupling type; 2. current coupling type. Because implementation processes of the current coupling intra-body communication is not subject to ground connection and environment, so this communication type has better adaptability and stability than the capacitive coupling type and has developed as a new branch of the intra-body communication.

Figure 1 Wireless Intra-Body Communication Network

Figure 1 shows a prototype monitoring human physiological data based on the intra-body communication; human body may be signal-conductive, so this feature is utilized in the prototype; in addition, relevant signal detection sensors are mounted on positions (needing detection) of human body, so collected signals are wirelessly transmitted to the detecting PDA through human body.

Yet, research on the intra-body communication especially the current coupling intra-body communication is still in its infancy [3] [7]. Most of documents and achievements remain human experiments, prototype trail-manufacture and numerical simulation. Existing multi-channel models mainly include the equivalent circuit model and the finite element model (FEM), these models cannot be used to describe human-body channel characteristics properly and obtain correct understanding (with universal applicability) of distribution and transmission modes of the electric signal flowing into human body; furthermore, in essence, they cannot also be employed to explain reasonably internal mechanisms and external factors affecting quality of intra-body communication, just because of this, many different experimental results are produced and presentation of relevant problems only is given through inference. In short, absence of theoretical support in research on the intra-body communication restricts its further development to a great extent, which is the primary cause why the technology cannot be put into practical application all the time.

3. BODY AREA NETWORK

With progress of science & technology and aging of population, existing medical resource cannot extremely satisfy future healthcare demand of the old people and patients, especially in China, which has one fifth of the global population. In order to solve the problem, most countries are preparing actively. The key problem is that everyone is not willing to stay at the hospital all the time; on the one hand, resource in the hospital is limited; on the other hand, it is impossible for most patients to stay at the hospital at all times by reason of restriction of economy, work and other reasons, while their health status must be monitored in a real-time mode. As a result, the wireless monitoring medical system will become a mobile hospital with real-time monitoring in the future.

Figure 2 shows integration of Body Area Network and Wide Area Network, which effectively combines individual data with the public network to achieve interaction and sharing of relevant data by means of modern wireless network technology.

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4. WIRELESS MONITORING MEDICAL SYSTEM BASED ON INTRA-BODY COMMUNICATION

In the system, the intra-body communication technology is used to transmit various health indexes of human body to the user' PDA. PDA is connected with the wireless monitoring server in the region where the user stays, and it is used to send all of patient's health indexes back to the fixed medical diagnostic system and the treatment system through the server. In the case of rapid change in some indexes of the patient, the system will send out the control instruction to PDA through the server so as to allow the patient to wear the medical equipment for emergency rescue, at the same time it will send help signal via wireless communication to strive for the best treatment time for the patient. The schematic diagram of the wireless monitoring medical system is shown in Figure 3.

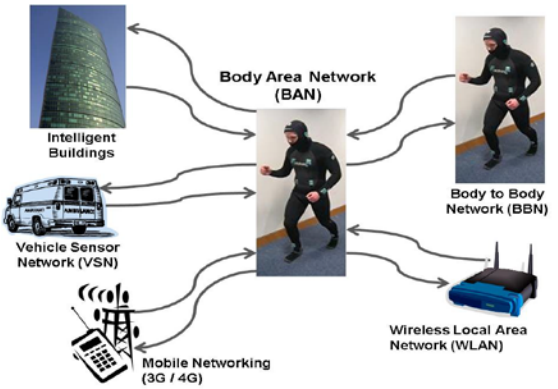

Figure 2 Signal Transmission In Body Area Network

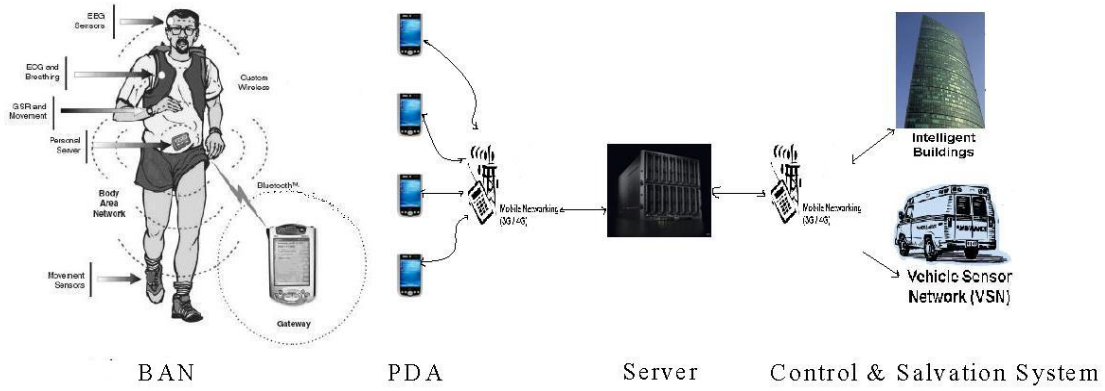

Figure 3 Wireless Monitoring Medical System

Figure 3 shows the wireless healthcare monitoring system established in combination with modern medical technology ideas based on the intra-body communication and the Body Area Network. The Body Area Network is formed by means of human body with human tissue as the signal transmission carrier. Signals collected in PDA are effectively integrated with public medical resources through modern wireless communication technology to create database and realize real-time monitoring, so as to achieve real-time and all-sided healthcare for the patients.

In the future medical monitoring system, as long as a person is equipped with the monitoring device, the device will monitor all of his physiological and health indexes in a real-time way, regardless of his activity at home, at the community or in the same city. These indexes are transmitted to the main-center (PDA) of the intra-body communication through the short-distance wireless communication network (Zigbee, GSM etc.). When PDA is mobile, the real-time monitoring information will be transmitted to the nearest signal acquisition server from the patient through the wireless network (WiFi, GPRS etc.). After pre-processing in the server, the data will be sent to the control system and the emergency medical system. According to the information obtained above, the control system will analyze the data sent back, and transmit the data to the healthy model; by means of the model the therapy advice for the patient will be transmitted back to the patient's PDA via the server. In the case of emergency, the server will send the emergency treatment instruction to PDA, and PDA will send the treatment instruction to the portable medical treatment device on the patient so as to inject the emergency treatment medicine; at the same time, the server will also transmit the aiding information to the nearest aiding equipment from the patient to gain the best treatment time. Moreover, the control system will keeps electronic medical records and health records for patients.

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On the one hand, operation of the overall system lowers patients' cost and saves a good deal of human and material resources. On the other hand, it provides a 24-hour monitoring service for patients, with proper safeguard for human life safety.

The system remains under construction; because human body is a complicated composite unit of tissues, effects of tissues on the communication channel must be firstly considered during signal transmission. During construction of the Body Area Network, the MAC protocol is chosen for networking and summarizing of signals. Summarized data will be applied to achieve data sharing and individual healthcare by means of the modern communication technology. Although the system is still in the experimental stage, its emergence is believed to be able to promote development of the traditional medical technology.

5. CONCLUSION

Although the system is still in the experimental stage and many key problems are not solved yet, for example, information transmission security, security and stability of the wireless network, automatic control of the portable equipment etc. need further improvement. However, research and development of the system is certain to provide safeguard for human health, and development of portable medical equipment plays an active role.

6. ACKNOWLEDGEMENTS

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REFERENCES

[1] T. G. Zimmerman, Personal Area Networks (PAN): Near-Field Intra-Body Communication. PhD thesis, Massachusetts Institute of Technology, 1995.

[2] T. G. Zimmerman, “Personal area networks: Near-field intrabody communication,” IBM Systems Journals, vol. 35, no. 3 and 4, pp. 609–617, 1996.

[3] M. Fukomoto, M. Shinagawa, and T. Sugimura, “Body coupled fingering: wireless wearable keyboard,” in Conference on Human Factors in Computing Systems (CHI’97), pp. 147–154, 1997.

[4] D. P. Lindsey, E. L. Mckee, M. L. Hull, and S. M. Howell, “A new technique for transmission of signals from implantable transducers,” IEEE Transactions on Biomedical Engineering, vol. 45, no. 5, pp. 614–619, 1998.

[5] C. S. Ikehara, E. Biagioni, and M. E. Crosby, Ad-hoc Wireless Body Area Network for Augmented Cognition Sensors In Foundations of Augmented Cognition, 2007

[6] D. Konstantas, A.T. van Halteren, R.G.A. Bults, K.E Wac, V.M. Jones and I.A. Widya. Body Area Networks for Ambulant Patient Monitoring Over Next Generation Public Wireless Networks. In: 14th IST Mobile and Wireless Communications Summit, 2004

[7] J.Y. Khan, M.R. Yuce and F. Karami. Performance Evaluation of a Wireless Body Area Sensor Network for Remote Patient Monitoring. Proc 30th IEEE International Conference on Engineering in Medicine and Biology Society (EMBS), 2008

[8] M. Sukor, S. Ariffin, N. Fisal, S.K.S. Yusof, and A. Abdallah. Performance Study of wireless Body Area Network in a Medical Environment.Proc. 2nd Asia International Conference on Modeling & Simulation(AICMS), 2008

[9]A. Donelli, J.R.C. Jansen, B. Hoeksel, P. Pedeferri, R. Hanania, J. Bovelander, et al.,Performance of a real-time dicrotic notch detection and predication algorithm in arrhythmic body aortic pressure signals, Journal of Clinical Monitoring and Computing 17 (2002) 182–185.

[10]W. Zong, T. Hedlt, G.B. Moody, R.G. Mark, An open-source algorithm to detect nset of arterial blood pressure pulses, Computers in Cardiology 30 (2003) 259–262.

[10] M. Aboy, J. McNames, T. Thong, D. Tsunami, M.S. Ellenby, B. Goldstein, An automatic beat detection algorithm for pressure signals, IEEE Transactions on Biomedical Engineering 52 (2005) 1662–1670.