Audio-Video Transmission System in Pre-hospital Treatment using WIBRO Technology

JiMan Kim, Chiyul Yoon, Kwak Min Ji, Sang Do Shin, Gil Joon Suh and Hee Chan Kim

***Abstract*— In pre-hospital treatment, paramedic personnel often experience difficulties due to the lack of medical knowledge and legal authority over medical treatment. To solve this problem, various IT technologies have been applied to provide direct communication between paramedic personnel and physicians. We proposed a new telemetric system which can transfer audio-video information in pre-hospital setting. Adapting WIBRO technology which is newly introduced mobile internet solution in Korea, we are able to transmit audio-video signals in real-time without limitation of the space and time, even in a running vehicle. In various situations, performance of the developed system was tested to confirm stable audio-video transmission. We anticipate that this type of system will be used in real emergency environments for pre-hospital management of patients.**

I. Introduction

WHEN pre-hospital treatment is given to emergency patients, telepresence of the physician would be very beneficial, because in those situations fast and adequate medical treatment is indispensable [1]. Especially trauma victim recovery often depends on how fast the patient receives appropriate medical care [2]. Emergency rescuers play an important role in those situations. In complex trauma cases, however, the paramedics have difficulties even in diagnosing the patient. They may need direct guidance regarding a diagnosing procedure and medical treatment and legal permission for their activities [3].

Thanks to the recent advances in telecommunication technologies, many different types of systems have been tried in pre-hospital treatment. For example, the Global System for Mobile communication (GSM) [4] and radio frequency wireless telecommunication were applied to the ambulance usage, and the Integrated Service Network (ISDN) [5] has been tested in fixed locations. Also, the Code Division Multiple Access (CDMA) technology [6] was applied as a form of emergency telemedicine system which can transfer various biological signals and captured images. But none of them could provide a continuous images of the emergency scene to the physician in real-time without limitation of distance.

Wireless Broad Band Internet (WIBRO), one form of the Mobile WIMAX, is a newly commercialized wireless internet service in Korea. It is available in Seoul Metropolitan region now, but service area is expanding gradually over the whole Korean. WIBRO provides 1M bps data transmission rate in average, and sustains its transmission rate in a vehicle moving as fast as 90km/h. Its fast data transmission rate and robustness to mobile applications make it suitable for pre-hospital treatment application. Not only inside of the building where internet access points are not available, but also in a running ambulance car, the paramedic personnel can communicate with emergency doctors in the hospital while sharing continuous image of the patient. With provided information the physician can give correct guidance which is vital in emergency cases.

Fig. 1. Developed EVAT system consisting of a PC cam on a protection goggle, a UMPC, and a mic-earphone set

II. Materials and Methods

A. System Description

The developed Emergency Audio Video Transmission (EVAT) unit consists of a PC cam, an audio set, an Ultra Mobile PC (UMPC), and a WIBRO Modem.

Figure 1 shows the entire system with all devices interconnected. A PC cam (TalkcamMX6, V-Gear, China) has an 1280×1024 resolution and a 30 fps maximum frame rate. It has an auto focusing function over 4cm to far distant

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without the user's control operation. Attached strongly on the center of an eye protection goggle (s-506V, OTOS, Korea), it provides almost same visual field of the wearer. The goggle was designed to be wearable over the eye glasses. The WIBRO modem, KWD-U1300, has an internal antenna, weighs 20g, and follows IEEE802.16e standard. The WIBRO modem provides the 2.5Mbs upload and 10Mbps download speed at maximum. The PC cam and the WIBRO modem are connected to the UMPC (B1SE, Wibrain, Korea) through an USB interface. The Wibrain B1SE features a light weight of 500g including battery, and a small size of 19cm in length. The total weight of the EVAT unit is less than 1kg so that it can be carried in a pocket of safety vest. Figure 2 shows a picture of a paramedic carrying the EVAT unit.

Fig. 2. Photograph of a model paramedic wearing the EVAT system.

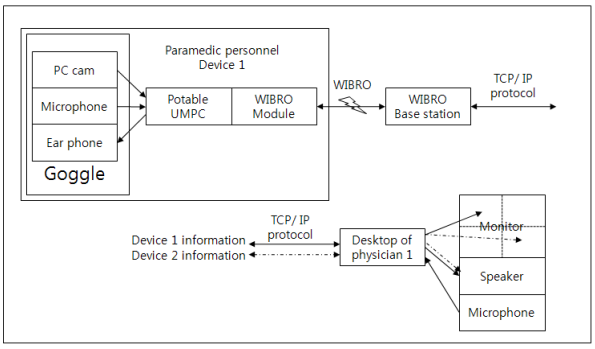

Fig. 3. Functional block diagram of the EVAT system.

B. *Functional Block Diagram*

A functional block diagram of the EVAT is shown in Figure 3. A potable UMPC which the paramedic carries is connected to internet via a WIBRO modem.

The EVAT unit can enable bi-directional audio transmission and unidirectional video transmission. While sending the real-time video images of a patient, the paramedic personnel can communicate with physician simultaneously. A desktop PC in the emergency room is waiting for a request of connection from the EVAT system. Once the request is accepted, the transmitted real-time video image is shown on the monitor. If there is another request of connection from the second EVAT system, the physician can decide whether he/she maintains the current connection or adds a new connection.

C. *Performance Evaluation*

TABLE I
PERFORMANCE TEST RESULT

Condition	RTT	AV delay	Maximum frame rate
Open space	105ms	< 0.3sec	5 fps
Inside building	118ms	< 0.3sec	5 fps
Moving Vehicle (30km/h)	152ms	< 0.6sec	4 fps
Moving Vehicle (70km/h)	220ms	<0.8 sec	3 fps

To evaluate the performance of the developed EVAT system, a test protocol was designed. We measured the round trip time (RTT) which is used for the evaluation of network performance, the time delay of audio video transmission, and the maximum frame rate. The protocol was repeated several times in an open space in downtown area, inside a building and in a running vehicle.

III. RESULT

Table I. shows the result of the performance test. When the EVAT unit operated stationary in an open space, it showed the best performance. Synchronized audio and video showed a delay less than 0.3 second.

Inside a building, the RTT slightly increased and the audio-video delay and the maximum frame rate maintained same level as in the open space performance. But we found a clear dependence on the location and the size of the building and the position inside the building. In a running vehicle, as velocity of the vehicle increased, performance of the EVAT unit decreased. At the speed of 70km/h, audio-video delay reached to almost 1sec. But quality of the transmitted voice signal was still maintained so that the communication was possible without difficulty.

Fig. 4. A captured photograph from the transmitted real time video images using the EVAT system.

The maximum frame rate varied 3-5fps depending on the situations. Although it is not smooth for human eye which regards 15 fps at least as a smooth movie, it was confirmed enough for transmission of medical information by emergency doctors. Fig. 4 shows a captured image of the transmitted video on the monitor of emergency room computer, showing hand and wrist of a model patient. Vein patterns and details of the skin are observable.

IV. Conclusion

A real-time audio-video transmission system for telecommunication between paramedics and emergency doctors in pre-hospital treatment was proposed. It showed a robust transmission performance in various situations including in an open space, inside building and in a running vehicle. The noblest feature of the developed system is its fast data transmission rate and wide coverage without any restriction. The developed EVAT system is now on the field test for its reliability, performance, and convenience in many real emergency situations including serious external wound, unconsciousness, stroke, heart attack, and labor and birth, etc.

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References

[1] Meade B. Barnett P, "Emergency care in a remote area using interactive video technology: a study in prehospital telemedicine," *Telemed Telecare 2002;8: 115-17*

[2] Hanna M. Söderholm, Diane H. Sonnenwald, Bruce Cairns, James E. Manning, Greg F. Welch, Henry Fuchs, "The Potential Impact of 3D Telepresence Technology on Task Performance in Emergency Trauma Care," *2007 Proceedings of the 2007 international ACM conference on supporting group work.*

[3] Kerry Sibert, M.D., Michael A. Ricci, M.D., Michael Caputo, M.S., Peter W. Callas, Ph.D., Frederick B. Rogers, M.D., William Charash, M.D., Ph.D., Pat Malone, Stephen M. Leffler, M.D., Harry Clark, Jose Salinas, Ph.D., James Wall, Ph.D., and Christopher Kocmoud, "The Feasibility of Using Ultrasound and Video Laryngoscope in an Mobile Telemedicine Consult," *Telemedicine and e-health, 2008;14(3)*

[4] Giovas P, Papadoyannis D, Thomakos D, "Transmission of electrocardiograms from a moving ambulance," *Telemed Telecare 1998;4 (suppl. 1):5-7*

[5] Brebner EM, Brebner JA, Ruddick-Bracken H, Wootton R, Ferguson J, "Evaluation of a pilot telemedicine network for accident and emergency work," *Telemed Telecare 2002;8 (suppl. 2):5-6*

[6] Jaemin Kang, Honggu chunr, Hyung Shin, Sang Do shin, Gil Joon suh and Hee Chan kim, "Preliminary evaluation of the use of a CDMA-based emergency telemedicine system," *Journal of Telemedicine and Telecare 2006; 12: 422427*

[7] Pavlopoulos S, Kyriacou E, Berler A, Dembeyiotis S, Kouttourit D. A, "novel emergency telemedicine system based on wireless communication technology," *AMBULANCE. IEEE Trance lnf Techmol Biormed1998;2:261-7*

[8] Curry GR, Harrop N, "The Lancashire telemedicine ambulance," *Telemed Telecare 1998;4:231-8*

[9] Nakajima I, Juzoji H, Usman K. A, "study on nationwide emergency medical network for ambulances via HEOs," *Proceedings of 6th international Workshop on Enterprise Networking and Computing Healthcare Industry 2004; 166-71*

[10] Cabrera MF, Arredondo MT, Quiroga J, "Integration of telemedicine into emergency medical services," *Telemed Telecare 2002;8 (suppl. 2):12-14*