Telemedicine Beyond the Borders by Broad Band in Asia-Pacific Area

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Telemedicine Beyond the Borders by Broad Band in Asia-Pacific Area

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Abstract— **We have established a medical network in Asia-Pacific area with high-quality moving image with broad band internet lines since February, 2003. Broadcasting real-time demonstration of medical procedure and teleconference with medical-quality videos with Digital Video Transport System (DVTS) and High Definition TeleVision (HDTV) with mpeg2, both need 25-30 Mbps, were useful to learn medical techniques (surgery, endoscope, etc.) and to exchange professional opinions beyond the geographical border. In this project, we have conducted 23 events in categories of teleconference (9 times), live transmission of medical procedure (7 times), and remote attendance to scientific medical meetings (7 times) between 5 countries (Korea, China, U.S.A, Australia and Japan) until 11th November 2004. There has been no major communication/ethical problem. With these experiences and current achievements, we hope to extend this advanced network system to whole Asia-Pacific countries to share medical skills and knowledge.**

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I. Introduction

There have been two categories in the telemedical application for the internet. One is to transmit medical information on narrow band infrastructure by compression or selection of the contents which we need to send. Another is to transmit exhaustive amount of contents with minimal delay on broad band infrastructure to transfer accurate medical information including high quality of moving images. As the former category, many trials have been conducted in telemedicine project for country side or for remote islands. Some of them are effectively working nowadays (1). In contrast, trials in the latter category are still few. Thus, we started to establish the international telemedicine system by broad band in Asia-Pacific area in February, 2003 (2).

Medical care level and medical social system are varied among countries in Asia- Pacific area because of a disparity in economic power and differentials in policies, religions and customs. The medical information does not distribute easily beyond the borders, and we usually are not aware of even the existence of the differentials in medical care. The distribution of medical information with internet beyond the borders makes medical staffs keenly aware of the differentials, and uncovers the relative advantage and disadvantage in the medical field in each country.

In this paper, we show how we have developed the medical network, and how it is expanding in Asia-Pacific area.

II. Materials and Methods

A. Organization

The Hyeonhae/ Genkai project was established to use the Korea-Japan Cable Network (KJCN) for development of informatics research and friendship between Korea and Japan in 2001 (3). As a subproject of the Hyeonhae/ Genkai project in medical field, we started to use KJCN for medical teleconference and remote medicine.

B. Network Configuration

As shown in Fig. 1, we have used several networks to

connect to institutes in the Asia-Pacific countries.

Figure 1 The network configuration in Asia Pacific area in the project. The solid lines show the network we have established, and the broken lines show the network we are planning to establish.

Two KJCN cables lay submarine between Busan, Korea and Fukuoka/Kitakyushu, Japan. The distance between Busan and Fukuoka is about 300 km. We used Korea Advanced Research Network (KOREN) between Busan and Seoul area (Seoul and Gayang) (4). From Busan to Beijing, we used KOREN and CERNET. To the Tokyo station (National Cancer Center office), we used APII from From, and to the Honolulu and Cairns, we used the APAN line from Tokyo.

C. Transport protocol and terminal system organization

We have used internet protocol version 4 for transmission in this project. In the case of the meeting of the 17th Asia- Pacific Advanced Network (APAN) in Honolulu on 29th Jan. 2004, we used internet protocol version 6 between Fukuoka and Honolulu venue.

We set up teleconference system and streaming system of recorded video image with bi-direct transmission using Digital Video Transport System (DVTS) on internet protocol on the network described above. DVTS is an open source free ware supported by WIDE project (5).

In a pathological teleconference, we need the best quality of the moving image of the microscope operated by a pathologist. Thus, we started to try to use High Definition TeleVision (HDTV) in telepathology event in this project from the summer in 2004.

We have used cipher system (C4-VPN, Focus systems Co.) for internet transmission to protect patient's privacy, when we send live images of a patient.

III. RESULTS

We classify the telemedical events in this project into three categories. The first category is regular teleconferences by connecting conference rooms in both sides. We introduce new techniques and new knowledge each other, and exchange opinions. The second is live demonstration of medical procedure, including surgical operation, and endoscopy techniques. We can learn new skills by real time, detailed image as we talk with operator. The third is remote attendance to scientific conferences by network. We can hear lectures, make presentations, and have greeting messages remotely.

Figure 2 The first telemedicine event between Seoul and Fukuoka in the project on 12th February 2003.

We connected the first medical network between Seoul, Korea and Fukuoka, Japan on 12th Feb. 2003 (Fig. 2). So far, we have conducted 23 events in categories of regular teleconference (9 times), live transmission of medical procedure (7 times), and remote attendance to scientific medical meetings (7 times) between 5 countries (Korea, China, U.S.A, Australia and Japan) until 10th November 2004 (Fig. 3).

We could have events only 7 times in 2003. However, in 2004, we have already done 16 events so far, and have several plans.

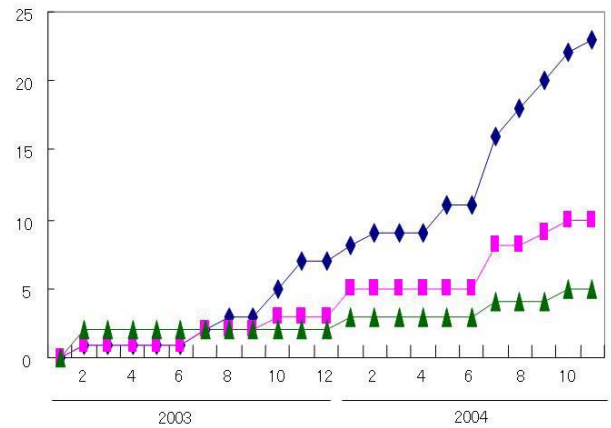

Figure 3 The numbers of events (diamond), connected institutions (rectangle), and countries (triangle) in this project. We will have two more events November 2004.

The transmission of moving images with two lines of DVTS for bi-direction communication over internet protocol was successfully performed. We had transmitted live image of medical staffs in conference room or meeting venues, the live image of endoscopic surgery/ microscopic surgery/ ERCP procedure/ microscopic pathological image, and recorded digital video of endoscopic surgery/ robotic surgery /transplantation surgery in the network (Table 1). The attendants discussed each other on the medical system/ medical procedures for one hour to eight hours at each conference.

- Endoscopic surgery
  (gall bladder, stomach, small intestine, colon)
- Microsurgery
  (neurosurgery)
- Robotic surgery
- Endoscope
  (Endoscopic Retrograde Cholangiopancreatography)
- Transplantation
- Pathology

Table 1 Contents of the events in this project until November, 2004.

The patient history and preoperative images were also shown with still-images. The quality of the image was as good as the original digital video. The surgical anatomy was correctly identified and the procedures were well understood. The frame rate of 30 per second was obtained, and the movie was smooth and not sluggish. The sound was clear, however, there was jittering during the entire course by packet loss.

The time delay was less than 0.3 sec between Korea and Japan, and a little longer with other countries (e.g. about 0.5 sec between China and Japan), what made no stress for discussion by each endpoint.

IV. Discussion

We are extending the medical network with DVTS and HDTV on internet protocol in Asia-Pacific area. The number of the events, the connecting institutes, and partner countries are increasing rapidly in the past 1.5 years (Fig. 3). From our experience of DVTS experiments, we have understood that DVTS has several advantages to be used in broad-banded medical network.

DVTS is open source free ware and we can download it from Web site (5). We just need to prepare only two PCs with DV port and a commercially available digital video camera before we use it in each end terminal.

For medical use purpose, the image should have high quality. DVTS can transmit high quality moving image (SD level).

Because of no compression in DVTS processing, it produces only short delay, which is enough short to discuss in natural way. We want to avoid another stress with the language problems in discussion with foreigners.

We can make multi-channel with DVTS contents easily. In telemedicine, we like to use information of multiple sources.

On the other hand, DVTS has also disadvantages as below.

DVTS needs 30 Mbps as transmission bandwidth to send full frame for a single channel. We have a limitation to extend the network by the available bandwidth in the area.

DVTS has a little complicated human interface to be used by the medical staffs. Thus, we have always needed engineering supports.

DVTS supports transport of high quality moving image, however, the transmitted sound has not been cared much. Packet loss makes jittering noise.

We are also trying to transmit HDTV moving image with mpeg2 compression for pathology event from the summer 2004 (Fig 4). Transmission of HDTV with mpeg2 uses about 25 Mbps, which is a similar bandwidth as DVTS needs. The HDTV image is much better than DVTS, however, the delay time is over than 1.0sec because of compression process. The cost for HDTV equipment is much expensive compared with DVTS.

Figure 4 In the summer of 2004, we started a transmission of HDTV with mpeg2 compression using internet protocol. The photograph shows that Kyushu University Hospital

provided the microscopic image of HDTV with MPEG2 compression to the venue of the meeting of 63rd Japanese Association of Cancer in Fukuoka on 30th Sep. 2004.

At the point of November 2004, there has been no major communication/ ethical problem so far.

Because of political boundary, medical communication was difficult among Asia-Pacific area in spite of their close location. By using this new medical network system, we can communicate and exchange medical information over the national border with minimum stresses. In contrast that the knowledge of medical science is uniform and can spread via one-way transmission, information about medical techniques and healthcare concept are often unique in local regions and vary in areas and areas. The present system will help to remove a barrier of medical communications and to standardize them using high quality moving images. We are planning to try next generation network technology in this project including internet protocol v6 multicasting among the Asia Pacific countries.

We have established high-quality video transmission system over internet protocol among Asia-Pacific countries, which is easy to perform, reliable and economical. On the basis of the current results, the minimal requirement for digital video transmission for telemedicine is about 30 Mbps with DVTS or HDTV with mpeg2 per channel. These will be a promising and very helpful tool of network for the regional, and worldwide remote medicine in the future.

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