A Study on the Requirement of Collaboration System for Live Surgery in Hospital

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Abstract. In digital imaging technology and the development of the network in the field of medicine, there are growing expectations for telemedicine. In particular, a live surgery which many doctors show the information of patient to make an accurate diagnosis and to perform a surgery should be considered a lot of features to design a collaboration system. In this paper we organize these considerations and established system named CyberLab in Seoul National University Hospital to the motto of the fusion of information and communication technology and medicine is described.

Keywords: medical infrastructure, cyberinfrastructure, cyberlab, live surgery.

1 Introduction

The increase of the supply of mobile device is leading the need which user wants to see the High Definition video or more better like UHD (Ultra HD). To satisfy the need, there are two necessary and basic parts that are enough network bandwidth and high resolution display. In medical field, it is very important requirements to provide a clear image, video and minimum delay. Nowadays, video data encoding (H.264, H.265, MPEG, HEVC, etc.) or transfer technique (almost of video data transfer is using UDP protocol) is developing continuously. That means the requirement in researcher side is the infrastructure that researcher can get the proper service and give an accurate diagnosis. With these phenomenon, important of collaboration environment is getting larger and, recently, the term of convergence is rising with remarkable development of science and technology. Through convergence in various fields, there is predictable expectation which is same the rising effect –mix up or win-win- with sharing of knowledge and mixing of different technology.[1] Korea Institute of Science and Technology and Information have doing an outstanding project to construct total 15 cyberinfrastructures via CI called cyberlab to help the scientist and student. Among them, 4 cyberlabs is constructed in hospital to lead the innovation of medical research field. With the advantages of the cyberlab that are resolution and size of the display and network, the digital image and video encoding and transfer.

The structure of the paper is as below: introduction part shows the necessary of this research, related work part introduce the several conception to understand our system. After then, there is brief introduction of cyberlab. Next part is to explain of medical cyberlab and find the system requirement of collaboration. In last part, conclusion part, summary and contribution are shown.

2 Related Work

CI is a term first used by the US NSF in 2003, and it typically is used to refer to information technology systems that provide particular powerful and advanced capabilities. Definition of CI in Wikipedia is to describe research environments which support advanced data acquisition, data storage / management / integration / mining / visualization and other computing and information processing services distributed over Internet beyond the scope of a single institution.[2][3] CyberGATEs that is an abbreviation of Cyber Gate using Advanced Technology for Education and rEsearch is the Cyberinfrastructure (CI) which is constructed by KISTI since 2010. They have located in 15 different universities and research institutes in KOREA.[4] Cyberlab is based on Cyber-Commons is how to collaborate both within a university and between universities or hospitals. Jason Leigh who is a professor and director of Electronic Visualization Laboratory and the software technologies research center at UIC define the Cyber-Commons with four roles which are numerous display to show many data on one screen, high-definition image to support smooth communication, high-capacity network bandwidth to connect with each CI and computing resources, connection to supercomputing or mess storage system or high-speed network.[5] With this principle, we redesigned K-Cyber-Commons to appropriate in Korea culture. As network infrastructure, we use KREONET is a national R&D network supported by Ministry of Education, Science and Technology in Korea, and has been managed and operated by KISTI since 1988 [6]. Construction Status of Cyberlabs in Korea

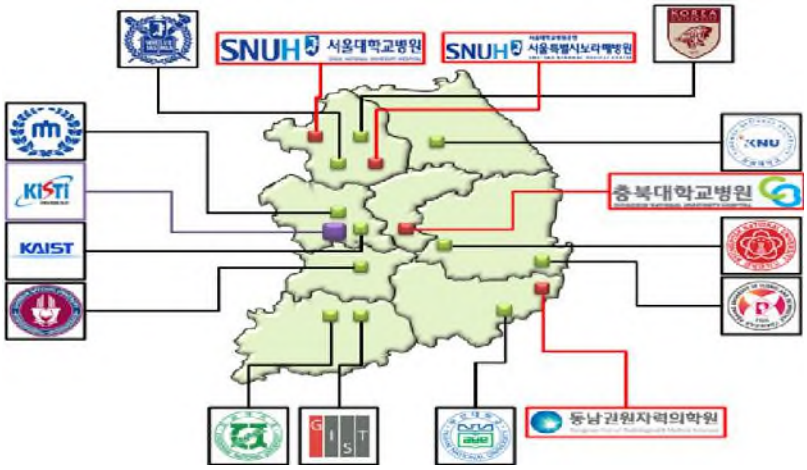

Fig. 1 Construction Status of Cyberlabs in Korea

In related work session, there are two concepts to help our system. Among cyberlabs, 4 cyberlabs for research are constructed in hospitals. In medical field, if it were cyberinfrastructure to enhance the collaboration, it can create good synergy effect. To do this, we redesign cyberlab model and implementation.

3 Collaboration System Requirement in Medical Field

In the first phase to construct cyberlab, main focus is that first point is display resolution. The LED panels which are consists of display has 1920x1080 same as High Definition video quality. Total resolution of the display is 11520x3240 and total size is 6200mm width, 3500mm height, bezel size is 73mm with 42inchi 18 panels. To collaboration, we choose the commercial product because it serves strong stability for maintenance and is convenience to installation. Second point is network capability. KISTI operates national research network named KREONET. KREONET is providing a 10Gbps backbone, in the form of the SuperSiReN (DaeDuk advanced science and technology research network) linking 7 organizations (KISTI, KAIST, KBSI, KARI, KRIBB, KIGAM, and CNU) to boost their advanced applied R&D and tests with a high performance network. KREONET also provides 30 more 1Gbps high-bandwidth lines as a state-of-the-art applied R&D network for advanced applied R&D. The international R&D network service of KREONET provides a 10Gbps high performance network infrastructure, similar to the global science and technology cooperation R&D network GLORIAD, through close cooperation with various advanced countries including the USA, China, Russia, Canada, and the Netherlands, among others, for the purpose of promoting international-level R&D cooperation and state-of-the-art technological R&D.[6] Also we use KREONET to guarantee the 1Gbps network bandwidth between each cyberlab. Normally, for transfer the HD video, minimum bandwidth is 4Mbps but in the case of medical field, the size of data which can be share and transfer for proper diagnosis.

In the second phase, we concentrate on the special situation it is bi-path live surgery environment. The design purpose of first phase is telepresence and data sharing. But in the hospitals, cyberlabs are Seoul Boramae Medical Center, Seoul National University Hospital, ChungBuk National University Hospital, Dongnam Institute of Radiological & Medical Sciences, through the live surgery a lot of educational action and researches are implemented. To support these researches, our system should be connected to medical devices which are davinchi robot, endoscope, EMG camera and etc.

Table 1. Legacy collaboration system vs cyberlab.

	Legacy system	*Cyberlab*
Network	~100 Mbps	1~10Gbps
	General purpose network	Research network
Environment	Projection base	20 megapixel NTD
Remote connection	impossible	Possible

Figure 2 shows doctor`s explain with live surgery using Divinchi robot video in live with 7 different cyberlabs. In the case of live surgery video streaming, most sensitive concern is video delay. There are a lot of consideration factors to influence the video delay. However, as I shown above, programmable matter is not consideration. The different between education cyberlab and research cyberlab is mass-contents sharing (MCS) system. The MCS system should guarantee lower 0.2 sec delay on the internal network. Normally, commercial codec like Polycom or Cisco has over 2sec delay to video transfer. For successful and efficient collaboration environment and knowledge sharing, it is not an appropriate value of delay. Figure 3 shows block diagram how to construct the bi-path live surgery environment. The term of bi-path live surgery means it can communicate each other that are located in different place.

Fig. 2 Live Surgery-Divinchi robot

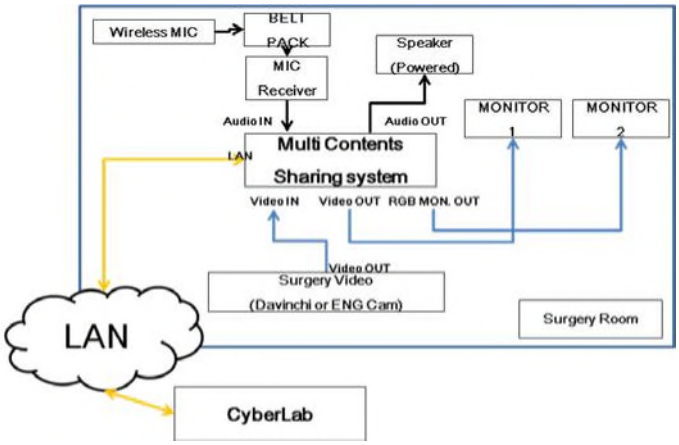

Fig. 3. Block Diagram for Bi-Path Live Surgery

Our MCS system can transfer audio and video with minimum transfer delay. And there are audio system and 2 monitors in surgery room for bi-path communication. Generally, to do the live surgery, the environment is made by subcontracting.

Live surgery can be used for education and diagnosis. Penn state Hershey surgical weight loss opened the operating room to biology students at Carlisle high school.[7] The different between Penn state university and cyberlab is the definition, resolution, display size, and delay time. In the case of cyberlab, definition and resolution is very clear with LED panel and upper UHD resolution and minimum transfer delay.(nearly real time, hard to recognition)

4 Conclusion

We introduce the outstanding cyberinfrastructure called cyberlab. Among the rest, the target of our work is the cyberlabs for research which is medical field. In this case, there are two difference phase to design the system because of special purpose to use our system. The purpose is the bi-path live surgery and, for that, we consider some system requirements which basic requirements are clear audio system, sufficient resolution, and minimum video transfer delay within 0.2sec.

Display: multi-contents can be displayed in same time. Cyberlab can display 8 different contents. Display has high resolution for definition and concentration. The size of display should be enough large to display the proper size content.

Network: generally, 4M bps network bandwidth is enough with commercial codec. But the critical disadvantage of commercial codec is upper 2sec delay. 2sec is enough to recognize the time different each other. In the case of collaboration and remote meeting, the delay is not critical matter. But it can be occurred the big problem on the live surgery or real time diagnosis even if the delay is barely 2 sec.

Audio system: in these kinds of system, there are several people who charge whole system. For 3 years, we operate the cyberlabs, almost of error report is system

understand lack or malfunction operate. Audio is influential part of system because an instant noise can be break the concentrate and mood.

We have done to construct the bi-path live surgery environment. But other parts we did not considerate will be found. Our system has expandability for preparation. We will monitor a lot of live surgery and international conference which uses cyberlab. And then, the system requirements are gathered, cyberlab will be evolved.

Fig. 4 cyberlab use for hospital-lecture, seminar, collaboration, etc.

Acknowledgement. This work was supported by the National Research Foundation of Korea (NRF) through contract N-12-NM-IR19.

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