Endoscopy Transmissions System for Remoteness Medical Diagnoses

Mohamed Ezzeldin A. Bashir[1], Ibrahim Musa Ishaq[2], Makki Okasha[2], Kwang Sun Ryu[2], Soo Ho Park[2], Keun Ho Ryu[2]

[1]*Faculty of Computer Science & Information Technology, University of Medical Science and Technology, Khartoum, Sudan*

mohamed.izzeldin@umst-edu.sd

[2]*Database and Bioinformatics Laboratory, School of Electrical and Computer Engineering, Chungbuk National University, South Korea*

{ibrahim, makki, ksryu, soohopark, khryu}@dblab.chungbuk.ac.kr

Abstract

Endoscopy is a medical procedure that allows a doctor to observe inside of the body without performing major surgery by using state-of-the-art technology to reduce the damage to human tissue when performing diagnostic or endoscopic surgery. Modern telecommunications and computer technologies enable the delivery of expert consultations and remote diagnoses that previously required transportation of patients or medical specialists. In this paper we design tele-endoscopy system by developing the high quality video transfer using the smooth streaming method.

Keywords: Endoscopy, Telemedicine, and Smooth Streaming

1. Introduction

Endoscopy is a medical procedure that uses an instrument called an endoscope .The endoscope is put into the body to look inside (for diagnostic purpose) sometimes used for certain kinds of surgery which called minimal invasive surgery (MIS) [1].

Minimally invasive surgery is becoming more and more common in hospitals. These procedures are performed through tiny incisions instead of one large opening. Because the incisions are small, patients tend to have quicker recovery times and less discomfort than with conventional surgery all with the same benefits.

During a minimally invasive procedure, surgeons make several small incisions in the skin just a few millimeters, in some cases. A long, thin tube with a miniature camera attached at the end (called an endoscope) is passed through one of the incisions. Images from the endoscope are projected onto monitors in the operating room so surgeons can get a clear (and magnified) view of the surgical area. Special instruments are passed through the other openings. These instruments allow the surgeon to perform the surgery by exploring, removing, or repairing whatever's wrong inside the body.

In some cases, a patient might be scheduled for a minimally invasive procedure, but after getting a view inside the body the surgeon might have to "convert" the procedure to an open (conventional) surgery. This may be because the problem or the anatomy is different from what the surgeon expected. Fig. 1 shows an endoscopy system.

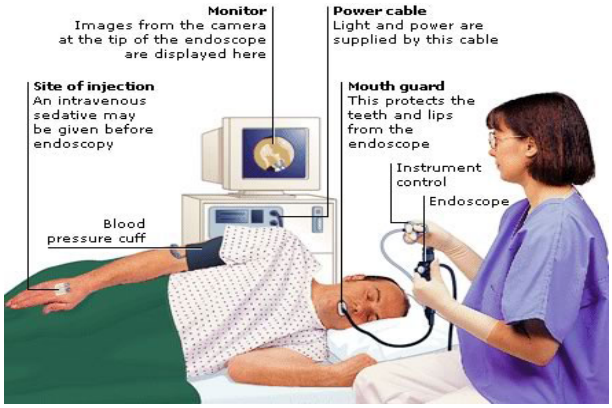

Figure 1. Endoscopy system

There are many different kinds of endoscopes, or “scopes.” Most are like thin, hollow tubes that allow the doctor to look right into the body. Most are lighted, and some have a small video camera on the end that puts pictures on a computer screen. Some endoscopes are stiff, while others are flexible. Endoscopes can vary in length and shape.

Depending on the area of the body being looked at, the endoscope may be put in the mouth, anus, or urethra. In some cases, it's put in through a small incision (cut) made in the skin. Table I shows type of endoscopy surgery and their location.

Table 1. Type of endoscopy surgery and their location

Type of endoscope	Put in through	Body part or area(s) looked at	Name(s) of procedure
Arthroscope	Cuts in the skin	Joints	Arthroscopy
Bronchoscope	Mouth or nose	Trachea (windpipe) and bronchi (tubes going to the lungs)	Bronchoscopy, flexible bronchoscopy
Colonoscope	Anus	Colon and large intestine	Colonoscopy, lower endoscopy
Cystoscope	Urethra	Bladder	cystoscopy, cystourethroscopy
Hysteroscope	Vagina	Inside of uterus	Hysteroscopy
Laparoscope	Cut(s) in the abdomen (belly)	Space inside abdomen and pelvis	Laparoscopy, peritoneal endoscopy
Sigmoidoscope, flexible sigmoidoscope	Cut(s) in the Chest	Space between lungs and chest wall	Thoracoscopy, Pleuroscopy

While endoscopic surgery is clearly advantageous in terms of patient outcomes, the procedure is more difficult from the surgeon's perspective when compared to traditional, open surgery like:

- The surgeon has limited range of motion at the surgical site resulting in a loss of dexterity.
- Poor depth perception.
- Surgeons must use tools to interact with tissue rather than manipulate it directly with their hands. These results in an inability to accurately judge how much force is being applied to tissue as well as a risk of damaging tissue by applying more force than necessary. This limitation also reduces tactile sensation, making it more difficult for the surgeon to feel the tool endpoints move in the opposite direction to the surgeon's hands due to the pivot point, making laparoscopic surgery a non-intuitive motor skill that is difficult to learn [2].

Although there are highly skilled primary health care providers located around the region, there is still relative isolation of a large part of the population, due to lack of expertise and large distance, Easy access to medical care has been difficult for many patients.

Training non-physician personal to perform diagnostic endoscopy and to transmit images to a central hospital, where experienced endoscopists can review the procedures, may improve the health for patients in remote areas.

In this paper we utilize technology to transmit endoscopy video using smooth streaming technique. We give historical background of telemedicine, overview of the proposed tele-endoscopy system, we conduct and experimental work by comparing each live source video with the reference one that already recorded at the beginning to diagnosis suspected endometrial malignancy. Finally we give a conclusion and future work.

2. Telemedicine background

Historically, telemedicine can be traced back to the mid to late 19th century [3,4] with one of the first published accounts occurring in the early 20th century when electrocardiograph data were transmitted over telephone wires [5]. Telemedicine, in its modern form, started in the 1960s in large part driven by the military and space technology sectors, as well as a few individuals using readily available commercial equipment [4-6]. Examples of early technological milestones in telemedicine include the use of television to facilitate consultations between specialists at a psychiatric institute and general practitioners at a state mental hospital [7], and the provision of expert medical advice from a major teaching hospital to an airport medical centre [8]. Recent advancements in, and increasing availability and utilization of information and communication technology (ICT), telemedicine by the general population have been the biggest drivers of telemedicine over the past decade, rapidly creating new possibilities for health care service and delivery. This has been true for developing countries and underserved areas of industrialized nations [9].

The replacement of analogue forms of communication with digital methods, combined with a rapid drop in the cost of ICTs, have sparked wide interest in the application of telemedicine among health-care providers, and have enabled health care organizations to envision and implement new and more efficient ways of providing care [4-6].

The introduction and popularization of the Internet has further accelerated the pace of ICT advancements, thereby expanding the scope of telemedicine to encompass Web-based applications (e.g. e-mail, tele-consultations and conferences via the Internet) and multimedia approaches (e.g. digital imagery and video).

These advancements have led to the creation of a rich tapestry of telemedicine applications that the world is coming to use.

Shuji ShimizuA. etal (2002) has presented Tele-endoscopy influence of data compression, bandwidth and simulated impairments on the usability of real-time digital video endoscopy transmissions for medical diagnoses. Which present experimental network established between two German referral endoscopy centers, using the Asynchronous Transfer Mode (ATM) protocol. At first, routine gastrointestinal video endoscopies were transferred through the network for prospective evaluation of the feasibility of the technical equipment and its usability for diagnostic tele-endoscopy, based on the video image quality. Secondly, the image quality and usability for correct telemedical diagnosis were evaluated prospectively in a double-blind experimental setting in relation to variations in the methods of data compression used, transmission bandwidths, and simulated transmission errors. The qualitative requirements in diagnostic video endoscopy, however, are obviously much higher than previously assumed, since experienced endoscopists detected a loss of image quality and a reduction in diagnostic usability with any reduction in the technical specification [10].

Stephan A.etal (2003) have presented a way to provide diagnostic quality for remote populations, The procedures were observed simultaneously by the endoscopist and a gastroenterologist observing from a remote station connected by 4 integrated services digital network telephone lines. The interpretation of the findings by both was compared and concordance for diagnosis of major and minor lesions was analyzed as well as Tele-endoscopic image quality was adequate to support diagnosis of abnormal lesions by the remote observer. Technical issues included worsening image quality caused by mild pixilation during rapid endoscope movement and rare loss of the telephone lines [11].

Hahm JSA.etal (2004) has presented telemedicine with digital video transport system, method is proposed to Using telemedicine, and it is able to send surgical images not only to domestic areas but also to international area. Moreover could discuss the condition of surgical procedures in the operation room and seminar room. The Korean-Japan cable network (KJCN) was structured in the submarine between Busan and Fukuoka. On the other hand, the Korea advanced research network (KOREN) was used to connect between Busan and Seoul. To link the image between the Hanyang University Hospital in Seoul and Kyushu University Hospital in Japan, it started teleconference system and recorded image-streaming system with DVTS on the circumstance with IPv4 network. [12].

3. Endoscopy transmissions system

The designed system is based on Internet information service (IIS), which is a group of Internet servers (including a Web or Hypertext Transfer Protocol server and a file transfer protocol server) and smooth streaming which is designed to deliver a compelling, uninterrupted streaming experience to view regardless of their network connectivity and computer capability. Figure. 2 illustrates the video streaming architecture.

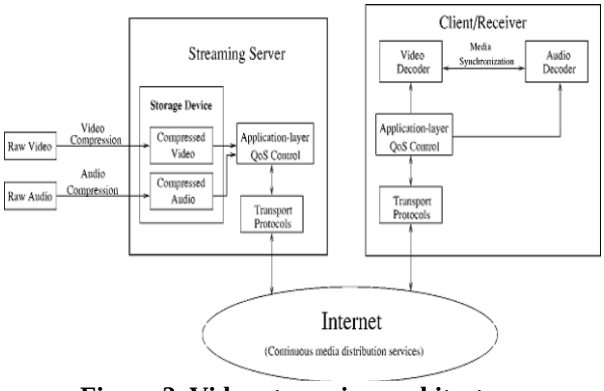

Figure 2. Video streaming architecture

Raw video and audio data are pre-compressed by video compression and audio compression method and then saved in storage devices. Upon the client's request, a streaming server retrieves compressed video/audio data from storage devices and then the application-layer quality of service (QoS) control module adapts the video/ audio bit-streams according to the network status and (QoS) requirements. After the adaptation, the transport protocols packetized the compressed bit-stream and then the video/audio packet to the internet. Packet may be dropped or experience excessive delay inside the internet due to congestion. Packets that are successfully delivered to the receiver, they first pass through the transport layers and then are processed by the application layer before being decoded at the video/audio decoder. To achieve synchronization between video and audio presentation, media synchronization mechanisms are synchronization between video and audio presentation, media synchronization mechanism are required.

Video download is similar to a normal file download, but it is a large file so it required much more time and storage spaces. Accordingly, we utilize smooth streaming technique, which is splitting the video into parts, transmit these parts in succession, and

enable the receiver to decode and playback the video as these parts are received without having to wait for the entire video to be delivered [13].

4. The experimental works

4.1. Environment

We used an imaging system compose of endoscope camera, and camera control unit, firewire 1394 card, firewire 1394 cable, internet information service (IIS). An Internet Media Services employed to enables delivery of live or on-demand digital media content, including Windows Media Audio (WMA) and Windows Media Video (WMV). Also we utilized (Notepad ++) it is a source code editor and Notepad replacement that supports several languages. Microsoft Expression Encoder which is an advanced audio/video-encoding and live-broadcasting application, Microsoft Silver light which is an application framework for writing and running rich Internet applications. Smooth Streaming Player is an IIS Media service extension enables adaptive streaming of media to Silver light and other clients over HTTP Smooth is used.

4.2. Suspected endometrial malignancy diagnosis

A collection of 20 samples for diagnosis hysteroscopy case was gathered by taking a video from the camera control unit (CCU) of the endoscopy using IEEE1394 as a high transfer cable that shift the video into the computer to and record it as a reference video. After that the transcoding technique was applied to transmit the live source video over the network. The video streaming is tested by comparing each live source video with the reference one that already recorded at the beginning.

(a) (b)

Figure 3. Suspected endometrial malignancy

Figure. 3 image (a) Suspected Endometrial Malignancy before transmission, image (b) Suspected Endometrial Malignancy after transmission with encoder parameter Encoding parameter, Buffer window =3, Frame rate=30, key frame interval=5, Bit rate =1500 video complexity = 0.

The quality of transmitted moving video had no frame loss with the rate 30 per second. The sound was also clear and the time delay was less than 0.3 sec.

5. Conclusion

Endoscopy plays an important role in diagnostic, treatment health. However, access to endoscopy is limited in many rural areas throughout the world. Training non-physician personal to perform diagnostic endoscopy and to transmit images to a central hospital, where experienced endoscopists can review the procedures, may improve the health for patients in remote areas.

The tele-endoscopy can use as an important tool in endoscopy workshop by which it link between too many consultant with different place at the same time ,so it can use as learning tool also.

Our paper has demonstrated the feasibility of tele-endoscopy. We conduct medical network with high-quality video transmission over internet protocol using smooth video streaming method. It is easy to perform, reliable, and also economical. Thus, it will be a promising technique in remote endoscopy in the future.

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning (No.2013R1A2A2A01068923).

6. References

[1] Arya, A. V., and Yan, B. M., “Ultra high magnification endoscopy: Is seeing really believing?” *World journal of gastrointestinal endoscopy*, Vol.4(10), 2012, pp.462-471.

[2] Westebring–Van Der Putten, E. P., Goossens, R. H. M., Jakimowicz, J. J., and Dankelman, J., “Haptics in minimally invasive surgery--a review”, *Minimally Invasive Therapy & Allied Technologies*, Vol.17(1), 2008, pp.3-16.

[3] Dakins D. R., and Jones E. “Cream of the crop: 10 outstanding telemedicine programs.”, *Telemed Telehealth Networks*, Vol.2(11), 1996, pp.37-41.

[4] Craig J., and Patterson V. “Introduction to the practice of telemedicine.”, *Journal of Telemedicine and Telecare*, Vol.11(1), 2005, pp.3–9.

[5] Einthoven W. “Le télécardiogramme.”, *Archives Internationales den Physiologie*, Vol.4, 1906, pp.132–164.

[6] Currell, R., Urquhart, C., Wainwright, P., and Lewis, R., “Telemedicine versus face to face patient care: effects on professional practice and health care outcomes.” *Cochrane Database of Systematic Reviews*, Vol.2(2), 2000.

[7] M. Ezzeldin A. Bashir, D. G. Lee, M. Li, J. W. Bae, H. S. Shon, M. C. Cho, and K. H. Ryu, “Trigger Learning and ECG Parameter Tuning for Real-Time Cardiac Clinical Information System”, *IEEE Transactions on Information Technology In Biomedicine 2012*, Vol.16(4), 2012, pp.561-571.

[8] M. Ezzeldin A. Bashir, Shon H. S., Lee D. G., Kim H., and Ryu K. H., ”Real-Time Automated Cardiac Health Monitoring by Combination of Active Learning and Adaptive Feature Selection”, *KSII Transactions on Internet and Information Systems.*, Vol.7(1), 2013, pp.99-118.

[9] Wootton, R., Jebamani, L. S., and Dow, S. A., “E-health and the Universitas 21 organization: 2. Telemedicine and underserved populations.”, *Journal of Telemedicine and Telecare*, Vol.11(5), 2005, pp.14-22.

[10] Rabenstein T, Maiss J, Naegele-Jackson S, Liebl K, Hengstenberg T, Radespiel-Tröger M, Holleczek P, Hahn EG, and Sackmann M, ”Tele-endoscopy: influence of data compression, bandwidth and simulated impairments on the usability of real-time digital video endoscopy transmissions for medical diagnoses.”, *Endoscopy*, Vol.34(9), 2002, pp.17-30.

[11] Wildi, S. M., Kim, C. Y., Glenn, T. F., Mackey, H. A., Viator, G. E., Wallace, M. B., and Hawes, R. H., ”Tele-endoscopy: a way to provide diagnostic quality for remote populations”, *Gastrointestinal endoscopy*, 2004, Vol.59(1), pp.38-43.

[12] Hahm J.S., Shimizu S., Nakashima N., Byun T.J., Lee H.L, Choi H.S., Ko Y., Lee K.G., Kim S.I., Kim T.E., Yun J., Park Y.J.,.”Telemedicine with digital video transport system”, *The Korean journal of gastroenterology= Taehan Sohwagi Hakhoe chi*, Vol43(6), 2004, pp.370-375

[13] Antonious P., Lestas M., Pitsillides A., Vassiliou V., “Adaptive Methods for the Transmission of Video Streams in Wireless Networks”, *Final WP report (M18)*, 2011.