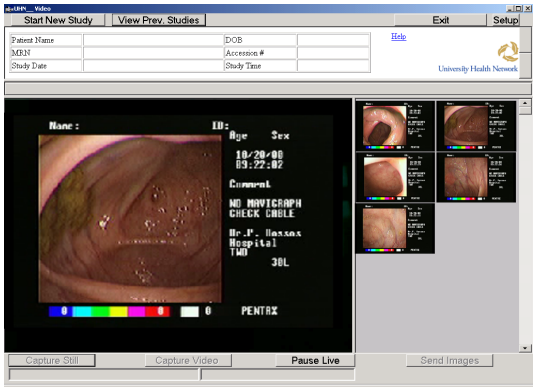
Development of a full-motion video capture, archive and review system for the documentation of GI endoscopy studies

JA Cafazzo MHSc PEng, PG Rossos MD FRCP(C), JKT Lam PEng, A Chagpar MHSc, WB Igharas HBSc, E Seto MSc, AC Easty PhD PEng CCE

Medical Device Informatics Group, Departments of Medicine and Medical Engineering,
Centre of Global eHealth Innovation, University Health Network, Toronto.
Faculty of Medicine and the Institute of Biomaterials and Biomedical Engineering, University of Toronto.

Introduction:

The documentation of endoscopic procedures has traditionally been limited to text-based narratives and descriptions of findings. The use of video printers and video tape recorders can greatly improve the comprehensiveness of the procedure record, but are ultimately impractical due to difficulty of storage and retrieval. Rex *et al* showed that full-motion video-taped procedures are superior to multiple still images in documentation of colonoscopy[1]. They also concluded that videotape is far more cumbersome to review than still hardcopy images. Digital video however, eliminates some of the impracticalities normally associated with the storage and review of full-motion videotape. Digital video, through the use of databases, networks and mass storage devices, can eliminate the need to physically store videotapes. The random access nature of digital video allows for quick access to point of interest when compared to the sequential access of videotape. Ultimately, integration into an electronic patient record (EPR) would necessitate the digitization of video for large-scale storage and distribution.



However, there is no obvious path in incorporating digital video as a medical imaging modality for the EPR. There are no standardized methods to acquire and manage digital medical video and there are no established parameters for the validation of its diagnostic quality.

Objective: Develop a digital endoscopic video system that integrates seamlessly into an existing EPR infrastructure.

Background:

Earlier work by the authors showed that endoscopic still images could be incorporated into a Picture Archiving and Communication System (PACS) using the well-established DICOM standard used in medical imaging informatics[2].

The evolution from still images to full-motion video is not easily facilitated by DICOM as it does not support interframe compression schemes which most digital video codecs use. As a result, DICOM can only typically facilitate the storage and retrieval of video segments that are of short duration (typically 10 seconds), since it can only accommodate digital video with a limited level of compression (intraframe only).

This does not permit the use of the PACS servers and storage for the use of digital video, and requires the creation of a parallel infrastructure. Much of this inefficiency can be overcome however, as will be discussed.

The choice of video codec amongst the dozens available required a careful consideration of the application in a hospital environment. The codec must produce video of sufficient quality such that diagnoses can be made, but also allow a level compression such that the data rate will not burden network and storage resources.

MPEG-1 was found to be flexible enough for the application and also benefited from its native integration into all major operating systems. A validation was performed to confirm that

diagnostic quality was achieved at an optimum data rate for storage and retrieval[3].

System Design and Implementation: The validation process has suggested that MPEG-1 video at data rates as low as 1.5 Mbps at a 352 by 240 pixel (NTSC - Source Input Format) resolution is of acceptable quality for the documentation of colonoscopy. Real-time encoding from the endoscope processor output was achieved using an Optibase[4] real-time MPEG-1 encoder card running on Windows 2000 PC platform. A custom HL-7 interface and LCD touch-screen are used to associate patient information with captured video. Capture start, stop and continue is initiated via footswitch. Voice annotation of the video can be achieved via a wireless headset microphone system as the video is captured. Still images can also be acquired as video is being captured, as the system uses independent video capture cards. The MPEG-1 digital video is then transferred over a 100 Mbps Ethernet network to a server for storage and later retrieval. The video is then reviewed through a web-based Active Server Page (ASP) application utilizing the Windows Media Player's MPEG-1 decoder. The web application facilitates secure login and query on a number of fields including medical record number (MRN), patient name, or physician.

Discussion:

At the 1.5 Mbps data rates described, the file size for captured and encoded video run about 12 Mbytes per minute. This is manageable for most modest networks and data archives. Although higher data rates would improve the perceived video quality, this level of compression produced results that were considered of good or excellent diagnostic quality in our study[2], while minimizing the impact on the networks and archives.

The problem of two separate data archives for each of the captures, still and full-motion, can be addressed by using a Storage Area Network (SAN) solution. The SAN can pool data types from a number of database sources into a common storage infrastructure, eliminating the inefficiencies of replicating services for each.

The user interface and access methods to the SAN however, remain distinct. This is clearly undesirable from a users perspective. This too can be addressed by using a standard clinical desktop application that can maintain patient-context when queries are made to each of the clinical database on the SAN. Multiple logins will be avoided through this method, with security and audit capabilities enhanced. Developed by Per-Se[5], this application links multiple clinical databases into one user interface, creating transparent access to the various data.

Results: Advances in computer hardware and network infrastructure have alleviated the storage and bandwidth limitations to archiving and retrieval of endoscopic digital video. Inexpensive commercially available components may be used to capture and compress digital endoscopic video from any source. With a file size of approximately 12 MB per minute, the storage requirements are not unlike that of typical digital chest radiograph studies or CT series.

Conclusions:

Voice-annotated digital video provides a more comprehensive endoscopic patient record. A standard protocol for the electronic management of medical digital video is necessary for interoperability of systems and simplified EPR integration. Through the appropriate development and evaluation of information technology to manage visual information, endoscopists will be able to improve patient care, teaching, and research.

References:

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[4] Optibase Ltd.7 Shenkar St., P.O.Box 2170, Herzlia, 46120 Israel.

[5] Per-Se Technologies, 2840 Mt. Wilkinson Parkway, Atlanta GA 30339, U.S.A.