Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
25OCT2001	N/A	-

Title and Subtitle Asynchronous Transfer Mode, Computer Aided Detection: Teleradiology	**Contract Number**
	Grant Number
	Program Element Number
Author(s)	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Department of Computer Science, HCC/YB, FL	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) US Army Research, Development & Standardization Group (UK) PSC 802 Box 15 FPO AE 09499-1500	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)

Distribution/Availability Statement
Approved for public release, distribution unlimited

Supplementary Notes
Papers from the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, October 25-28, 2001, held in Istanbul, Turkey. See also ADM001351 for entire conference on cd-rom.

Abstract

Subject Terms

Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU

Number of Pages
3

ASYNCHRONOUS TRANSFER MODE, COMPUTER AIDED DETECTION: TELERADIOLOGY

Ehsan Sheybani
Department of Computer Science, HCC/YB, FL, US

Abstract- **A fiber-optic network derived by a set of ATM (asynchronous transfer mode) switches in association with CAD (computer aided diagnosis/detection) algorithms has been set up as the first prototype of on-line, real-time cancer detection/diagnostic system. Expanding diagnostics and treatment beyond the local level will bring better health care to a wider range of people at a reduced cost. This work describes the Asynchronous Transfer Mode (ATM) Teleradiology Network (ATMTN) and the high-speed fiber backbone architecture as a new technology that offers real-time, on-line , more accurate screening, detection and diagnosis of breast cancer with less need for invasive treatment. ATMTN is a fully automatic, robust and high-speed network integrated with DICOM standards, and IP protocols and associated with Computer Assisted Detection/Diagnostic (CAD) methods for digital mammography.**
Keywords - **CAD, ATM, telemammography, cancer.**

I. INTRODUCTION

One of the goals of the National Cancer Institute (NCI) cancer control program to reach more than 80% of the eligible women in mammography screening by the year 2000 has not been fully realized and yet remains as a challenge. That is primarily due to 1) the fact that examination process is a complex and lengthy one and 2) it is not available to the majority of women who live in remote and urban sites. This problem can be solved using advanced networking technologies and signal processing algorithms. On one hand, software modules can help detect, with high precision, true negatives (TN), while marking true positives (TP) for further investigation. Since TNs are the majority of examinations on a randomly selected population, this first step reduces the load on radiologists by a tremendous amount. On the other hand, high-speed networking equipment can accelerate the required clinic-lab connection and make detection, segmentation and image enhancement algorithms readily available to the radiologists. This work presents the results of such association.

II. METHODOLOGY

This research describes the Asynchronous Transfer Mode (ATM) Telemammography Network (ATMTN) connected via a high-speed fiber backbone architecture for real-time, on-line screening, detection and diagnosis of breast cancer. ATMTN is a high-speed network integrated with associated automatic robust Computer Assisted Diagnostic (CAD) [1-4] methods for mass detection. This telemammography system for remote computer-aided breast cancer detection and diagnosis has the advantage of better reach of women for cancer screening and at the same time provides the diagnosis with higher efficiency, better accuracy, and lower cost. The work addresses key problems in the development of the infrastructure and algorithm design for the telemammography scheme. The research plan to achieve our goals involved: (1) Networking stations for telemammography by means of ATMTN fiber connection to demonstrate, evaluate, and validate technologies and methods for delivering mammography screening services via high-speed (OC-3=155Mbps and OC-12=622Mbps) fiber-optic links, performing real-time network-transmitted, high-resolution mammograms for immediate diagnosis [5]. (2) Development of object-oriented compression methods [6,7] as a cost-effective means for storage, retrieval, and transmission of digital mammograms as required for telemammography. (3) Optimization of detection algorithms for identification of normal images in different resolutions to increase the speed and reduce the cost of telemammography and (4) Development of an integrated ATMTN with adaptive CAD methods that is robust for large image databases and input source. The impact of this project is expected to be significant and will provide a way for centralized and remote detection and diagnosis of breast cancer by using a high-speed network of interconnected screening centers with the aid of CAD techniques.

III. RESULTS

The telemammography system transports a combination of image (digital mammograms), video, audio, and data through the networking environment among hospitals, clinics, and remote locations at a distance. The ATMTN telemammography system reduces the film cost, patient transports and travel to the expert mammographers and radiologists. The quality of health care is improved through faster and better diagnosis as remote experts can be consulted for complicated cases. Another advantage is the reduction of costs through resource sharing of expensive equipment and personnel (mammographers and radiologists). The system supports several telemedicine and consultation functions to collaboratively transfer, manipulate, and view images, image sequences, video, audio, and data.

A. Significance

One of the key components of the high-speed network is the use of compression algorithms in transmission of images. The association of digital computer aided diagnosis (CAD) has been proposed for remote breast cancer screening, because the response characteristics of this detector has

proved to be better, less costly, faster, and even more accurate than use of conventional direct X-ray screening. Softcopy reading using a computer monitor is important for centralized diagnosis and may be better than reading films on a light box if appropriately optimized. CAD improves both sensitivity and specificity of breast cancer detection and more importantly, reduces the variability of reading mammograms on a computer monitor (or on film/light box).

Asynchronous Transfer Mode Telemammography Network (ATMTN) architecture proposes a very novel approach for telemammography in association with CAD algorithms, namely, a CAD method that allows for compression, detection, and diagnosis of masses and finally transmission of the digital image from different sensors. The associated CAD techniques improve the performance of the network by filtering out the normal images, reducing the size of the image data files for transmission, and screening images for microcalcifications. The impact of this work is very broad and will provide the ability for centralized and remote diagnosis of mammograms by creating a high-speed network of screening centers that are interconnected through a high-speed fiber-optic telecommunication network architecture.

B. Performance

The ultimate goal of ATMTN to accept, store, display, and communicate images and associated information via a fiber-optic network was met. DIN-PACS contains four major functional subsystems: Acquisition, Display, Database and Communication. The organization and integration of components within the system supports a logically unified view of all exams and associated information across multiple domains. A user can access any examination stored on-line in the system from any display workstation integral to the system at any time without knowledge of where the images and related data are physically stored. ATMTN is designed to provide for an open architecture, standards-based digital imaging network, picture archiving and communication system using DICOM 3.0 and HL-7 (v2.4)(as a minimum) that is reliable and scaleable to deliver technical, clinical functionality and performance. Being robust and designed open, ATMTN has the potential to become the "Base System" of Teleradiology and a model for other clinical diagnostic information technology systems.

IV. Discussion

Telemammography over a fiber-connected ATM network can provide significant cost saving and greatly improved health care services in many of the under-served areas. Although the telemedicine workstation exhibited its high performance and programmability, we found from the experiment that a tighter integration of the multimedia capability with the networking component should be one of the mostly desired improvements for the telemedicine system to become applicable in routine clinical environments and to bring ATMTN prototype closer to a "commercializable" product. This should be followed by improvements in some of the key technologies requiring additional development beyond what is currently available in order to make future high-speed networks sufficiently fast, efficient, and cost-effective enough to make widespread commercial deployment possible.

V. Conclusion

Research results indicate that the unique setup of ATMTN, that is the employment of the optimized CAD methods, object-oriented compression scheme, DICOM compatibility, and high-speed transmission of image/data/voice/video over a private ATM-switched network will contribute to the field of telemedicine and teleradiology in the following ways [8,9]:

- The proposed (ATMTN) was used to demonstrate, evaluate, and validate technologies and methods for delivering mammography screening services via high-speed (155Mbps/622 Mbps) fiber-optic links, performing "real-time" network-transmitted, high-resolution mammograms for immediate diagnosis.

- The associated adaptive CAD method developed for classification of normals will still identify more than 50% of all the negative mammograms with respect to calcifications after transmission. This will have a substantial effect on one of the main bottlenecks of radiology, namely radiologist performance. It will additionally help reduce traffic load on the network by at least 50%.

- The associated object-oriented image compression method will provide a cost-effective means for storage, retrieval, and transmission of digital mammograms, required for the telemammography.

- The DICOM implementation in this work does not need a database to support different fields of the image files (i.e. image, thumbnail, patient information, trailer, etc.). This makes it faster and easier to use. The algorithm presented will convert to and from DICOM standard and will write the fields on fly while reconstructing the image file.

- The systematic optimization of ATMTN will result in overall improvement in performance, as confirmed by FROC and ROC analysis of CAD algorithm.

- The final optimized ATMTN, when used as a second opinion strategy, will improve the breast cancer detection and diagnosis performance and speed for

experienced mammographers, as verified by using ROC analysis.

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