SIV 864: Special Module on Multimedia Applications

Telemedicine

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Definition

**Telehealth**

- At a distance
- Preventive and promotive
The earliest attempts....

THE FIRST WIRELESS INFORMATION TRANSMISSION
The first modern attempts...
The next milestone...
The Internet changed everything...
The Physician of 2020?

"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."
The Physician of 2020!

- Electronic Medical Record
- Telemedicine
- Digital Imaging
- Treatment protocols
- Lab tests
- Decision Support
- Patient Monitoring
- Robotic Surgery
- Computer-based teaching
- Simulators
"Building Bridges"

Medical Needs → Applications → Technical Solutions

Speak the same "language"
Understand each other
Work together
The coming together of ...

- Physicians
- Computer professionals
- Governments
- Voluntary organizations
- Industry
- Engineers
- Graphic designers
- Education experts
Types

Synchronous

- Real-time

Asynchronous

- Store & Forward
Synchronous Telemedicine

- Real-time
- Requires both parties to be present at the same time
- Telephone consultation
- Videoconference
- Extendable peripheral devices (tele-stethoscope, tele-otoscope)
- High bandwidth utilization
Synchronous Telemedicine (2)

- Client-server or peer-to-peer architecture
- May be recorded or not
- Phone lines / ISDN / Satellite / Broadband

Diagram showing the components of a synchronous telemedicine system, including A/V in, A/V out, Computer Codec, and Telecomm link.
Asynchronous Telemedicine

- Store and Forward
- Does not require both parties to be present at same time
- Capture text / audio / image / bio-signal data
- Requires some form of electronic medical record (EMR)
- Low bandwidth utilization
Asynchronous Telemedicine (2)

- Postal system / Letter / Fax / Email
- Network connectivity
- Databases
- Scheduling of offline activity
Standards

Medical Standards
- International Classification of Disease
- Clinical Procedural Terminology
- Unified Language of Medical Sciences

Technical Standards
- Accredited Standards Committee (ASC) X12N
- Digital Imaging and Communications in Medicine HL7
- International Telecommunications Union H.320
- Association for Advancement of Medical Instrumentation
Non technological issues

Medical Issues
- Security and Privacy
- Clinical Quality Assurance
- Education and Training

Implementation Issues
- Business models / reimbursements
- Portability and Inter-communicability
- Reliability / Technology support
- Scalability
Case Study
Healthcare Scenario in India

- India spends <1% GDP on health
- Urban/Rural mismatch of health professionals and population
- >70% rural population
- Most lack access to basic health facilities
Telemedicine in India

- Aravind Hospitals – Teleophthalmology Network
- Apollo Hospitals – Aragonda Project
- OTRI (Online Telemedicine Research Institute)
- Asia Heart Foundation
- OncoNet (Kerala)
- Common Service Centers e-governance
Telemedicine in India

- VSAT based (ISRO)
- Broadband based (BSNL)
- High cost (setup and maintenance)
- High technical expertise
- Low bandwidth
- Limited scalability
Continuing challenges

- Remotest of remote
- No connectivity
- Limited infrastructure
- “Bottom of Pyramid” (<$1 per day)
- Landless farmers, illiterate
Criteria

- Inexpensive and low maintenance
- Easy and quick to setup
- Robust and durable
- Minimal new technology usage and skills requirement
- User-friendly, able to cope with infrastructure
- Support large datasets and scalable
Our proposed solution

- Asynchronous (Store & Forward)
- Delay tolerant network (DTN)
- Large datasets
- Several unique features
- Highly scalable
Application overview

- X-ray Digitization equipment
- Primary Health-care Centre (rural)
- Kiosk
- Doctor viewing X-ray
- Kiosk-PC
- Bus
- Proxy

Srivastava / SIV864 / School of IT / Nov 2008
Case Flow 1

Primary Healthcare Centre (Rural)

- Health Care Worker
  - DICOM
  - Radiology Equipment

New Case Submission Path

Internet Region

- D1 (Neuro)
- D2 (Pediatrics)
- D3 (Ortho)
- D4 (Ortho)

Reply from Doctor
Case Flow 2
Design Overview

DICOM Interfacing

Automatic Case
- Allocation
- Forwarding
- Consolidation

Application
- IP Stack
- Wired
- Kiosk-PC

Application
- IP Stack
- DTN
- TCP/IP
- Wired
- Wireless
- Kiosk
- Bus
- Gateway
- Proxy
- Doctor

DICOM Interfacing

DTN – Communication Infrastructure
Design Overview

Automatic Case
- Allocation
- Forwarding
- Consolidation

Application | Application | Application | Application
------------|-------------|-------------|-------------
IP Stack    | IP Stack    | DTN         | DTN         
            | TCP/IP      | TCP/IP      | TCP/IP      
Wired       | Wired       | Wireless    | Wireless    
            |             |             | Wired       
Kiosk-PC    | Kiosk       | Bus         | Gateway     
            |             |             |             
            |             |             | Proxy       
            |             |             | Doctor      

DICOM Viewer
DCMTK
Creator
Decomposer
GUI
Design Overview
Automatic Case Allocation

- Physician database at proxy
  - Doctor’s Name, Specialty, Location, ID, IP, email address

- Case specifies only specialty

- Based on specialty and availability, allocation done
  - Any allocation algorithm can be implemented now
Automatic Case Consolidation

- Unique Case ID assigned to a case at creation
- One consolidated file per case ID maintained at the proxy
- Consolidated file can be retrieved from any location
Implementation Details

- Components
  - Hardware
  - Software
- Databases
- Application level routing
- Screenshots
## Hardware Components

<table>
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Software Components

Debian OS dtnd, dcmtk toolkit, dhcp, nfs
Creator, Decomposer (java modules)

Debian OS dtnd

Debian OS dtnd

Debian OS dtnd, dcmtk toolkit, dhcp, nfs
Creator, Decomposer (java modules)

Linux OS Apache 2.2, PHP 5.2.6
Receiver, Sender (java modules)
Case ID: 7007112950

Consultation Note
From XYZ

RV following treatment for fx of the left wrist. Cast will be removed next week. With physical therapy, the range of motion shall increase. PLAN: Continue whirlpool and ROM exercises for 4 more weeks.

Attached Files
1. IMG1

Consultation Note
From KioskB.regionA.IITD.kiosknet.org

Doctor, what measures need to be further taken with regards to the wrist injury I sustained. The cast has been there for 5 weeks now. Regards, Patient ABC

Attached Files
1. IMG2
2. par.jpg

Add Reply

Attach files
Results

- 1 GB data bidirectional transfer
- Measured time for link detection and transfer time
  - Time to link detection: Worst case – 10 mins
  - Throughput: 1 MBPS
Future Work

- SMS integration
- Call allocation methods
- Enable querying
- Security and privacy
- Utility based routing
Summary

- Rapidly evolving field
- Many needs and many solutions
- Success is not dependant on technology alone
Summary

“My team has created a very innovative solution, but we’re still looking for a problem to go with it.”
Thank You!