Intelligent Multimedia Databases for Medicine

- HIS, CIS
- HL7 (Health Level 7)
- DICOM (Digital Imaging and Communications in Medicine)
- PACS (Picture archiving and communication systems)
- Electronic health record (EHR) / Electronic medical record (EMR)
- What are intelligent multimedia-databases in medicine
Why intelligent multidatabases for medicine

- Images are kept with patients record stored by unique identifiers
- Browse and navigate their way through collection of multimedia objects such as digital images
- “How does my patient's tumor look compared to other similar cases”
Nasen- und Polypen

Makroskopisch
Bereits in der Nase breitete sich ein 1-1,5 cm dickes Stroma, das in der Nasenhöhle lag. An der Nasenhöhle anhaftet der ganze Bulbus mit ein 1,5 cm dickes Stroma. Auch an der Rachenm.-Nasenpolypenartig im Atmen. 

Pathologisch
Polypenarten können sich unterhalb des Polypen- und Polypenartig im Rachenm.
**HIS, CIS**

- A hospital information system (HIS), variously also called clinical information system (CIS) is a comprehensive, integrated information system designed to manage the administrative, financial and clinical aspects of a hospital.
- This encompasses **paper-based** information processing as well as data processing machines.

- It can be composed of one or few software components with specialty specific extensions as well as of a large variety of sub-systems in medical specialties (e.g. Laboratory Information System, Radiology Information System).
- Example: SAP
CISs are sometimes separated from HISs
- CIS: concentrate on patient- and clinical state- related data (electronic patient record)
- HIS: whereas the latter keeps track of administrative issues
Health Level 7

- http://www.hl7.org
- “HL7” refers to Health Level Seven, Inc., an all-volunteer, not-for-profit organization involved in development of international healthcare standards
- Founded in 1987 to produce a standard for hospital information systems, HL7 is currently the selected standard for the interfacing of clinical data in most institutions
Background: HL7 Mission Statement (adopted 7/97)

- "To provide standards for the exchange, management and integration of data that supports clinical patient care ... Specifically, to create flexible, cost effective … standards … for interoperability between healthcare information systems."

- The standards, which support clinical practice and the management, delivery, and evaluation of health services, are the most commonly used in the world

- Hospitals typically have many different computer systems used for everything from billing records to patient tracking
- All of these systems must communicate with each other (a.k.a. "interface") when they receive new information
- HL7 is a standard by which various healthcare systems can communicate with each other
HL7

- Exchange and interoperability of electronic health records
- Without data standards, healthcare organizations could not readily share clinical information
- Theoretically, this ability to exchange information should help to minimize the tendency for medical care to be so geographically isolated and highly variable.

HL7

- Standardization of knowledge representation
- Specification of components for context management (known as CCOW)
- Support for healthcare data interchange using object request brokers standardization of XML document structures specification of robust vocabulary definitions for use in clinical messages and documents
- Functional specifications for an electronic health record
- Work in the area of security, privacy, confidentiality, and accountability.
HL7's Patient Record Architecture in (message standard) version 3.0 allows for a common format for exchanging a patient's medical record between different hospital systems or even different hospitals. This HL7 standard has come to serve as a foundation for the universal electronic medical record.

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**HL7**

- Health Level 7
- Sophisticated object model
- Currently text based messaging
- Used by most hospitals, implementations vary
- HL7 V3 will include XML serialization
- Active in XML activities e.g. XML schema datatypes
Healthcare Schema

Healthcare datatypes

- `<person>`
  - `<person.name>`
    - `<family>Jones</family>`
    - `<given>Susan</given>`
    - `<given>Samantha</given>`
    - `<suffix>Jr.</suffix>`
    - `<prefix>Ms.</prefix>`
  - `</person.name>`
  - `<id type="SSN">000-11-2233</id>`
Healthcare datatypes

- `<patient>`
  - `<person.name>` ...
  - `<id authority="New England Medical Center">000112233</id>`
- `</patient>`
- `<provider>`
  - `<person.name>`<family>Smith</family><given>Amanda</given><prefix>Dr.</prefix></person.name`
- `</provider>`

Document Attribute Example

```
<author>
  <time value="20030106"> </time>
  <assignedEntity>
    <id extension="PH00017" root="2.16.840.1.113883.3.933"> </id>
    <representedOrganization>
      <name>Midwestern Pharmaceuticals</name>
      <addr>Metropolis, IN 46285, USA</addr>
    </representedOrganization>
  </assignedEntity>
</author>
```

Identifying the package insert source company
DICOM

- Digital Imaging and Communications in Medicine (DICOM) is a comprehensive set of standards for handling, storing, printing, and transmitting information in medical imaging.

- It includes a file format definition and a network communications protocol.
- The communication protocol is an application protocol that uses TCP/IP to communicate between systems.
- DICOM files can be exchanged between two entities that are capable of receiving image and patient data in DICOM format.
DICOM enables the integration of scanners, servers, workstations, printers, and network hardware from multiple vendors into a picture archiving and communication system.

The different machines, servers, and workstations come with DICOM conformance statements which clearly state the DICOM classes they support. DICOM has been widely adopted by hospitals and is making inroads in smaller applications like dentists' and doctors' offices.

Format

DICOM differs from other data formats in that it groups information together into a data set.

That is, an X-Ray of your chest actually contains your patient ID within it, so that the image is never mistakenly separated from your information.
A DICOM data object consists of a number of attributes, containing such items as name, ID etc, and also one special attribute containing the image pixel data (i.e. logically, the main object has no "header" as such - merely a list of attributes, including the pixel data).

A single DICOM object can only contain one image, but that image may have multiple "frames", allowing storage of cine loops or other multi-frame data.

Image data can be compressed using a variety of standards, including JPEG, JPEG Lossless, JPEG 2000, and Run-length encoding (RLE).
Store
- The DICOM Store service is used to send images or other persistent objects (structured reports, etc.) to a picture archiving server or workstation

Query/Retrieve
- This enables a workstation to find lists of, and then retrieve, images or other such objects from a picture archiving server

Modality Worklist
- This enables a piece of imaging equipment (a modality) to obtain details of patients and scheduled examinations electronically, avoiding the need to type such information multiple times (and also the mistakes caused by retyping)

Modality Performed Procedure Step
- A complementary service to Modality Worklist, this enables the modality to send a report about a performed examination including data about the images acquired, dose delivered, etc.
Modalities in DICOM

Examples of Modalities supported in DICOM are:

- **AS** = Angioscopy
- **BI** = Biomagnetic Imaging
- **CP** = Colposcopy
- **MR** = Magnetic Resonance
- **US** = Ultrasound
- **VF** = Videofluorography (retired)
- **XA** = X-Ray Angiography
PACS

- Picture archiving and communication systems (PACS) are computers or networks dedicated to the storage, retrieval, distribution and presentation of images.
- Full PACS handle images from various modalities, such as ultrasonography, magnetic resonance imaging, positron emission tomography, computed tomography, endoscopy, mammography and radiography (plain X-rays).
PACS replaces hard-copy based means of managing medical images, such as film archives. It expands on the possibilities of such conventional systems by providing capabilities of off-site viewing and reporting (distance education, tele-diagnosis). Additionally, it enables practitioners at various physical locations to access the same information simultaneously, (teleradiology).

With the decreasing price of digital storage, PACS systems provide a growing cost and space advantage over film archives. The same image following contrast adjustment, sharpening and measurement tags added by the system.
The most difficult area for PACS systems is interpreting the DICOM image format

DICOM slightly variably implemented between different radiology equipment vendors

The ability to point the tags in the DICOM format coming from vendors equipment to useable titles in a PACS is a feature common to most vendors and software offerings

Typically a PACS network consists of a central server which stores a database containing the images

This server is connected to one or more clients via a LAN or a WAN which provide or utilize the images

Web-based PACS utilize the Internet as their means of communication, usually via VPN (Virtual Private Network) or SSL (Secure Sockets Layer)
A full PACS system should provide a single point of access for images and their associated data (i.e. it should support multiple modalities). It should also interface with existing hospital information systems: hospital information system (HIS) and radiology information system (RIS).
Siemens

PACS

- Siemens
- Philips
- GE
Electronic Patient Record

Electronic health record (EHR)/Electronic medical record (EMR)

- A personal medical record in digital format
- An EHR is typically accessed on a computer or over a network
- An EHR almost always includes information relating to the current and historical health, medical conditions and medical tests of its subject
  - The ideal EHR system, as of 2006, has not been implemented by any software or other vendor
A multimedia database for electronic patient records

- Access over internet (VPN)

- A trust center (database), manage the rights to access certain data

- Smartcards, pin number
Workflows

- Through existing radiological PACS system images are distributed by digital medical record to the entire hospital by a platform supporting DICOM and DICOM-XML formats.

- Traditional workflows often mimic workflows involving film and paper, the new generic workflow engine offer wireless access and enterprise wide data distribution.

Semantic Workflow / XPS
What are intelligent multimedia-databases in medicine?

- Allow new access of data
  - **Query by images:**
    - Find the most similar image to the presented image
    - Find images which may indicate an illness
What are intelligent multimedia-databases in medicine?

- Allow new access of data
  - Query by films
    - Find the most similar filmed operation to the present one

What are intelligent multimedia-databases in medicine?

- Allow easier and more natural data storage
  - No masks or frames
  - Instead free texts with images and films
What are intelligent multimedia-databases in medicine?

- Allows the representation of diagnostic and organization knowledge
- Medical workflows

http://www.sim.hcuge.ch/medgift/
medGIFT – Example:

Query image

Emphysem

Macro nodules

Emphysem

Micro nodules
The dataset was composed of 12,000 gray X-ray images (size 256x256).
The images came from 116 different categories (different views of x-rayed body parts),
belonging to persons of different genders, various ages and different diseases.

Data-set for experimental tests purposes to TM Deserno, Dept. of Medical Informatics, RWTH Aachen, Germany

### CBIR search

- **Histogram Based**
  - Fast
  - Not very effective in finding similar image

- **List Matching**
  - Slow
  - Effective in finding similar image
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- **Histogram Based**
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- **Hierarchical Subspace method**
  - Fast
  - Effective in finding similar image
Mean retrieval time of 26 medical images out of 12,000

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<th>method</th>
<th>comparisons</th>
<th>time</th>
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<td>786,432,000</td>
<td>130.1 sec</td>
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<tr>
<td>subspace tree</td>
<td>3,322,536</td>
<td>1.2 sec</td>
</tr>
</tbody>
</table>

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