

# **CD-ROM BASED DIGITAL FILM LIBRARY FOR RADIOGRAPHY STUDENTS**

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## **ABSTRACT**

The structure, organisation and use of digital (CD-ROM) radiography and medical imaging film library, based on an analog (film) collection, is described. The analog collection has been specialised for radiographic educational use in an undergraduate program, and includes relevant pathological appearance for traditional teaching using radiographic film and light boxes for review. The digital library has been produced for a broad medical and allied health professional educational application for use on either IBM-PC or Macintosh platforms with CD-ROM facilities.

Film libraries are an essential resource in any radiography teaching program. However, film is easily damaged, frequently lost and hard to keep in reasonable order, but relatively cheaply digitised and stored in a suitable file format for student access. This paper describes the development of a navigation program that allows students to access a range of digitised film images from general radiography, fluoroscopy, vascular imaging, mammography, computed tomography, magnetic resonance and ultrasound. Provision is made for storage and display of the original image, an annotated image indicating features that students should be able to identify and describe, and a screen with text that provides this information if required. The digital library is also readily enlarged.

## **KEYWORDS**

Teaching and learning, medical imaging, medical sciences

## **INTRODUCTION**

An extensive radiographic and medical imaging library has been established by the Department of Radiography and Medical Imaging of Monash University, Melbourne, Australia. This library has been compiled to provide important resources in the teaching of a new 4-year undergraduate program in Radiography & Medical Imaging. Funds to support its creation were provided by a strategic initiative fund (SIF) of the university.

The conventional radiograph, or x-ray, is only one of a variety of diagnostic images practitioners need to evaluate in today's health care setting. Accordingly, the film library has been configured to also include images generated by computed tomography (CT), ultrasound (US), magnetic resonance imaging (MRI) and digital vascular imaging (DVI) procedures. During 2001, the CT and MRI representation of various pathologies will be incorporated into the library.

The current radiographic section of the film library has been created using hard copy (analog) radiographic images collected from local clinical institutions. Person/confidential information has been removed and a large sample of these images subsequently digitised.

Images forming the medical imaging section (US, CT, MRI and DVI) are almost exclusively in soft format, being either harvested directly using transfer software or digitised from current original hard copies.

The analog (film) library has been created incorporating several innovations, which customises its application to education in radiography and medical imaging. Major components of the collections have direct and relevant application to the education of students in other health sciences, biomedical science and medical undergraduate education. The actual films are stored in specially colour coded and labelled film bags. This arrangement is physically large, occupying multiple shelves along one wall in a large classroom. The shelving is heavy duty in order to handle the weight. This room has long tables incorporating horizontal light-boxes for image review and a seating capacity of 40 students. After-hours access is provided for students to engage in private study. Students at all levels of the undergraduate program use this resource almost daily.

The advantage of soft copy image libraries in terms of storage space, running costs, ease of extension, is well established. Ensuring such libraries are available on suitable and robust storage devices, readable on readily available and relatively low cost personal computers, is an efficient and effective alternative to hard copy facilities. Suitable user friendly software is an important component to allow access to these complex image databases. Educationally the database must incorporate facilities to assist the student in understanding the images they are reviewing. To serve this request an integrated software and database solution has been created.

The library is currently being digitised and placed in a CD-ROM format in two versions for both student and staff use. It is anticipated that a future version, which is compatible with the world wide web (WWW), will be initially placed on a local server for multiple student use using locally networked computers. At a later stage this version will be mounted for access from remote sites outside the university.

The CD ROM image library is designed to facilitate the progressive development of skills in the interpretation of diagnostic images generated from by a variety of radiological and medical imaging modalities. Such a library presents many advantages to educators. Firstly, it provides students with a learning context that is free from the wider distractions of that are present in the clinical setting. Secondly, the software allows students to monitor the progression of their interpretational skills in respect to the recognition of anatomy and pathology. Unlike many of the commercial products available the Monash CD-ROM image library program provides clear and unambiguous guidance to students as they navigate their way through the various images.

The program's organisation allows images of the one region of the human body acquired from different modalities to be linked and readily accessed, and also comes with a simple data base arrangement for students or staff to add and remove the images. In this way it is suitable for a range of professional disciplines that rely on students' familiarisation with data that is readily put into image form.

## **THE RADIOGRAPHIC ANALOG FILM LIBRARY**

The starting point for the CD-ROM project was the radiographic analog film library. This analog library is colour coded (and this colour coding is carried across to the digital version) and composed principally in four sections encompassing:

- Normal Radiographic Anatomy (yellow), as displayed on plain and contrast radiographs [musculoskeletal system (including both paediatric and adult), digestive system, urinary tract, central nervous system].
- Radiographic Method (green), demonstrating radiographically acceptable projections.
- Radiographic Reject (red), designed to assist students to recognise unacceptable radiographic projections and learn how to correct them.
- Radiographic Pathology (blue), as demonstrated on plain and contrast radiographs. A key feature of this section is the provision of a rationale for the radiological diagnosis and, where appropriate, a discussion of the differential diagnosis

Within each of these sections the image library is further subdivided into body regions as:

- Head
- Neck
- Upper limb (including shoulder)
- Chest/Cardiovascular (including lungs, pleura, heart and great vessels)
- Abdomen
- Pelvis
- Lower limb
- Spine
- Major trauma involving multiple systems/areas
- Mobile radiography

These are then subdivided further; for example Head as Skull, Sinuses, Facial Bones, Mandible, and Nasal Bones.

In the radiographic pathology library a case-based approach is also adopted with a view eventually to maintaining the radiographs and case notes of a patient together under pathology and region. In this library the following headings for pathology has been generally adopted.

- Variation/Anomaly/Congenital
- Inflammation
- Neoplasm/Tumorous
- Trauma/Traumatic
- Metabolic/Endocrine/Toxic
- Other/Infections
- Vascular
- Neurological/Iatrogenic

These categories are generally consistent with those used in the American College of Radiologists (ACR) Index and have also been used in the construction of the digital library.

The analog radiographic library has been principally created by selecting relevant images in each of the categories described above. Such collections are common within hospitals and educational facilities. However, as noted above, ongoing maintenance and additions in these collections is onerous, costly and time consuming, and is partly the reason for moving to a digital collection.

In addition to this the equivalent film/digital images in the other modalities, US, CT, MRI and DVI, are being incorporated into the library under similar headings.

## **EDUCATIONAL OBJECTIVES**

A readily distributed, high quality repository of medical images is a valuable teaching resource to a wide range of academics and students in most departments and schools within a Faculty of Medicine, Nursing and Health Sciences. The initial target group for the CD-ROM digital library is the students enrolled in the Bachelor of Radiography & Medical Imaging. However, the production of the digital library was also constructed with other student groups in mind; specifically students in the MBBS course and the Bachelor of Biomedical Science.

The educational objectives for the digital library project were to:

- establish an extensive CD-ROM library of medical images to support the teaching of radiography, computed tomography, digital vascular imaging, ultrasound and magnetic resonance imaging,
- design and create a software display interface and database structure for the images which is intuitive to use, capable of expansion and expedites access to the required medical images by the student,
- allow a student to undertake self directed review and revision of an extensive collection of medical images relevant to the subject of study in a flexible learning manner,
- configure the software to be able to provide technical, anatomical or pathological information concerning an image when required by the student,
- facilitate the development of a student's radiological (medical imaging) recognition skills in both multi-planar and multi-modal representations of human anatomy and pathology.

The learning objectives for this project were clearly spelt out in the initial funding application to the university as follows: “At the conclusion of this Project students will be able to:

- view digitised radiographic and medical imaging mode images using a CD-ROM and PC system,
- select specific radiographic or other medical imaging mode images (US, CT, MRI, DVI) of selected anatomical regions under the following main categories: Radiographic Anatomy, Radiographic Method, Radiographic Reject, Radiographic Pathology (or medical imaging equivalent),
- review, in relation to each image, the explanatory text,
- export the images for use in, for example, reports (Word) and presentations (PowerPoint)”

The scope of the CD-ROM project was to include an image navigation system that allowed images to be viewed using the broad classification as for the analog (film) library), to include related annotated images and appropriate text. The system was also designed to allow new images to be readily added, old ones removed, and images to be magnified if necessary.

## **THE DIGITAL FILM LIBRARY DATABASE**

The initial set of images for the CD-ROM project was created by digitising the analog films using a *Luminsys 150* radiographic film digitizer. Each image was captured at high resolution with 8-bit or 16-bit depth directly using *Luminaccess* software as a plug-in to *Adobe Photoshop* software. Each digital image was stored in JPEG format with the contrast optimised for computer screen display. Long name convention was used to accurately identify each image in production, and increase optimisation and annotation prior to insertion into the database. An XML database was designed to logically contain each image, its annotated version and an accompanying text-based description.

The XML database is lifted directly from the SOLAR project (Wells et al, 1999), also further described in this conference. It has been found easy to use and change for inclusion of new images and text, and removal of unwanted images. A special mode of sequential display has been built into this database that links related images from the various modalities. It is also being developed to enable students to review the images from US, CT, MRI and DVI in a singular sequential form rather than in a sheet of up to 20 images.

## **CD-ROM DISPLAY SOFTWARE**

The display software is easy to learn and to use. Its use is intuitive, and has maintained some parity with image review facilities now becoming available with PACS technology in the clinical setting. It allows the student to select a body region then select images from one of the 4 main categories noted above; normal Anatomy, Method, Reject and Pathology.

The presentation of images, associated annotation and text is arranged to:

- form an adjunct to lectures and clinical experience, a guide, and a resource.
- be easy to learn and to manipulate
- have realistic parity with the function and feel of a radiographic display unit
- allow independent (even if restricted) control over image display factors
- provide instructional feedback
- be cost effective and easily updated.

The software then displays the image, free of annotation, that the student has selected. This simulates the real life situation where a radiographer/student is aware of the region to be examined and from clinical notes can formulate possible pathological appearances to match clinical observations. This can be verified with the annotations and text explanation if required. At this stage the image filename is also made visible on the screen. At any stage the image can be magnified and text and/or images can be printed or saved. Randomisation of image review has been incorporated into the display software for student self-testing. This situation is not unlike clinical practice where patients can present for image review of any part of the body in random order. A typical screen display is shown in Figure 1. Cases can be readily added to the library to supersede those present with better examples, or the database expanded to include those not already collected.

## **CONCLUDING COMMENTS**

A radiographic and medical imaging film library for educational use in both hard and soft copy has been described. The library has the following features.

- It uses a regional approach to radiographic and medical imaging procedures consistent with clinical requests for examination.
- It incorporates ACR pathology classification.
- It incorporates text to explain to the user key parts of a image (annotations, general description radiological reports etc).
- It provides a matched education system for undergraduate radiographers.
- It has a flexible structure to allow for future growth of the collection.

The creation of the dual library has involved collecting, sorting and independent verification of pathology, digitisation, reprocessing, creation of image review software and ongoing maintenance. Collection costs have been minimised with local hospitals allowing access to films being recovered after the legal period of storage has been exceeded.



**Figure 1:** Typical screen display of the CD-ROM project. The annotated image and text are seen in this example of a radiographic case involving a pathology of the upper limb (humerus).

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