



Kodak Dental Systems

Emerging technologies and challenges in 3D radiology specialized applications

Toulouse, June 19th and 20th 2008

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Carestream Health

Company

- Carestream Health was formerly known as Kodak Health Group
- It was span off in 2007, and continues to manufacture products for the medical radiology field
- Revenue amounts to US \$ 2.5 billions
- The Dental branch sells products under the Kodak Dental Systems brand
- Research and Development employs around 200 people based on 7 R&D centers worldwide

Products



Intraoral x-ray detector

- Kodak Dental Systems products target a variety of different fields including:

- General dentistry,
- Oral and Maxillofacial surgery,
- Orthodontists,
- Maxillofacial radiology



X-ray film

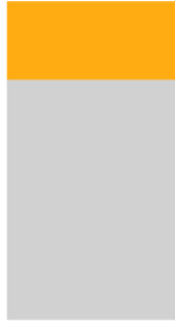
- Product line provides complete solution for image and patients management



Panoramic and cephalometry



Patient management



Example of new technology and new challenges Cone-beam CT

Cone-beam CT

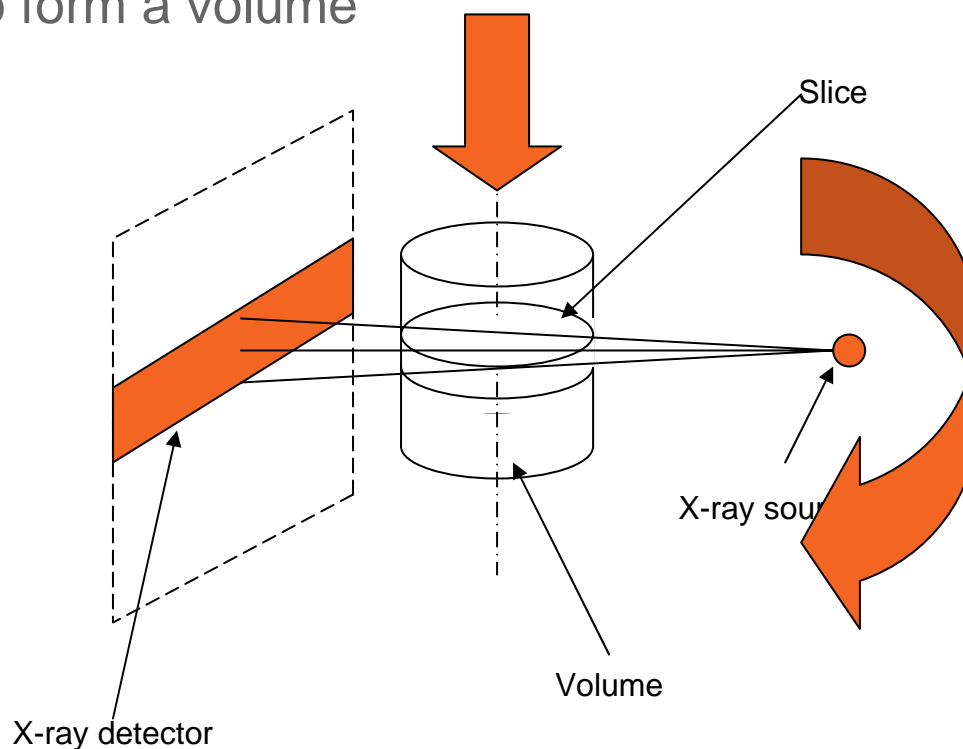
- Cone-Beam CT is an emerging technology that provides a 3D representation of the patient's hard and soft tissue
- Depending of the digital detector size, it can address different regions of interest, ranging from focused field-of-view to full field-of-view
- Like medical CT scanners, it is based on Johann Radon's concept of volume reconstruction based on a set of projections (1917)
- It however features a very advantageous image quality vs. dose ratio, especially if detector is kept small
- And its technology is affordable





Medical CT-scan Principles

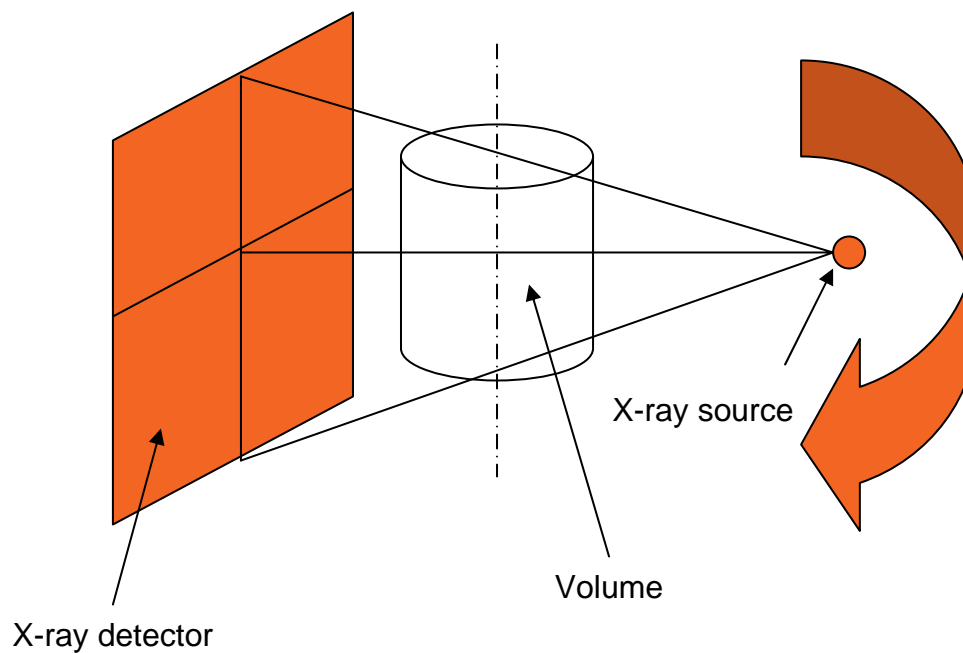
- As a detector that matches the volume size can't be built, acquisition follows a trajectory that spirals around the volume
- Slices of the volume are therefore acquired (up to 256 at a time) then recombined to form a volume





Cone-Beam CT Principles

- Cone-Beam CT is also based on the reconstruction of an x-ray volume from projections, but it involves a single rotation to acquire a series of projections



Data manipulation Flow

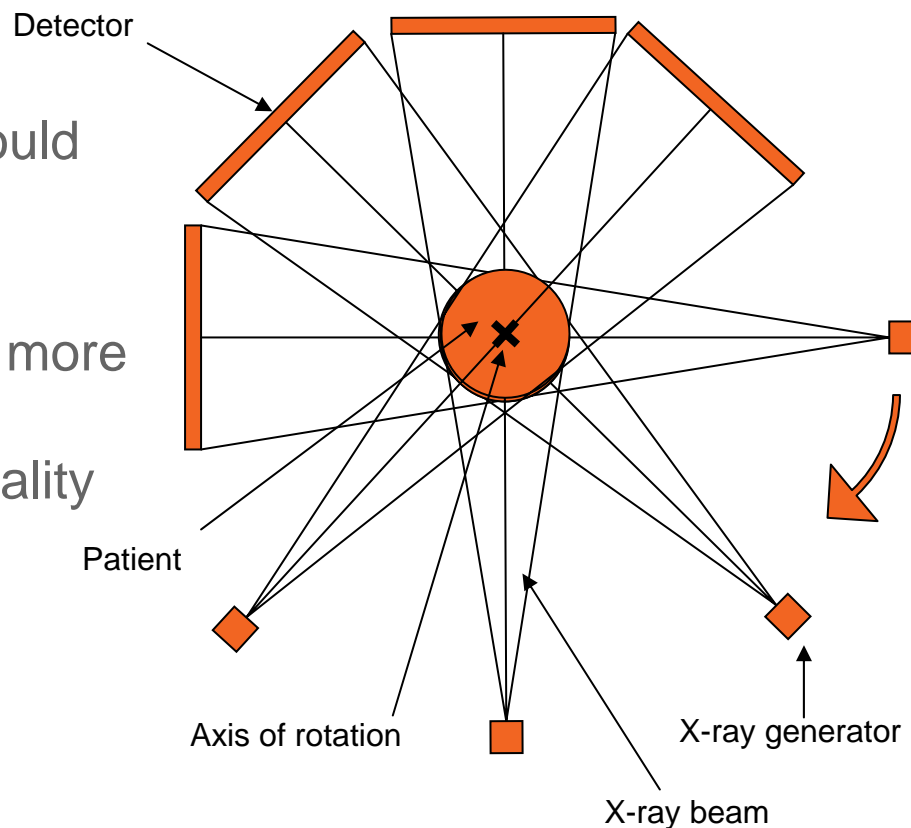


Cone-Beam CT acquisition is a three-step process

- Acquisition of a series of 2D radiographs
- Reconstruction of the x-ray volume
- Volume storage

Step 1 - Image Acquisition

- The minimum set of images should minimally cover a 180-degree perspective of the object.
- However, more projections and more angle coverage usually result in better volume reconstruction quality



Step 2 - Volume Reconstruction



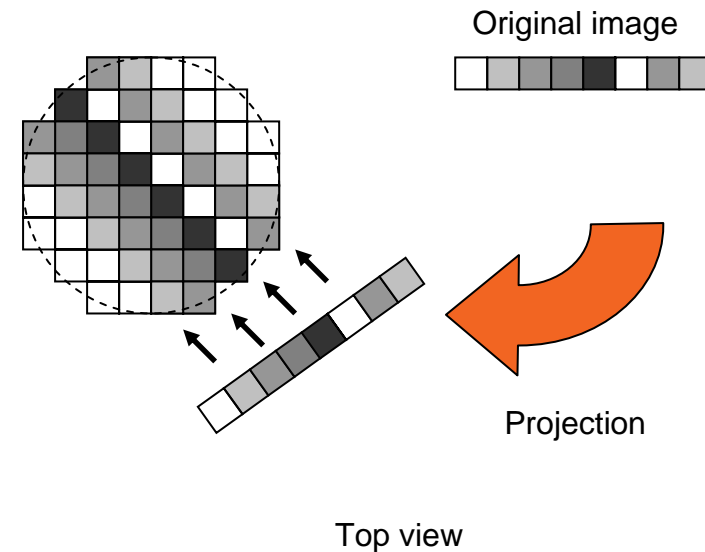
- Once all views are acquired, reconstruction can start
- There are several reconstruction methods, but the most popular one is the FDK algorithm (Feldkamp David Kemp)
- FDK is a two-step process that is applied to all images
 - High-frequency filtering
 - Retro-projection

Step 2 - Volume Reconstruction



Retro-projection principles :

- Start with empty volume
 - A volume is a 3D collection of 3D pixels referred to as voxels
- Project the first image through volume, with its correct angle of perspective
- Iterate process for all images
- Voxel values end-up being built-up by the summation of the different image pixel values, projected angle by angle



The resulting volume is a cylinder

Step 3 – Volume Storage



- Once volume is reconstructed, it is stored either as :
 - a collection of individual Dicom files, each containing a single layer, or
 - A single file containing multiple layers

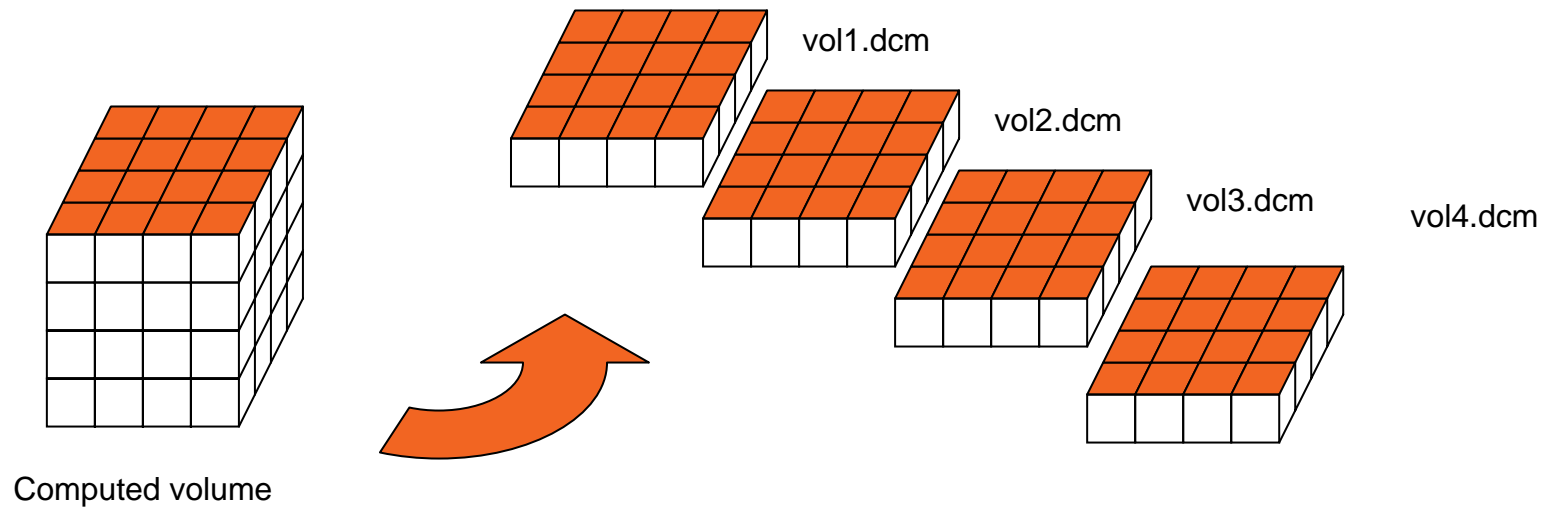
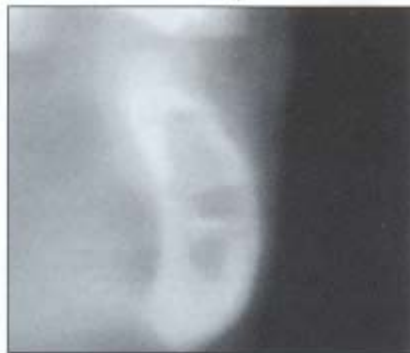


Image Comparison for Various Modalities



Linear tomography



Medical CT-scanner



Cone-beam CT

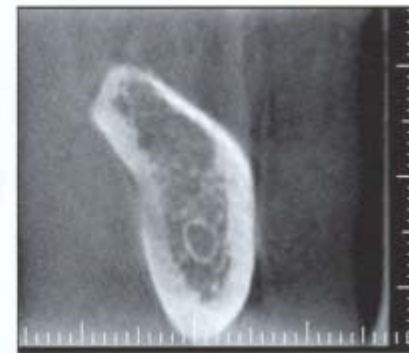


Figure 4 (left to right). Mandibular posterior alveolar bone in cross-section (coronal view). Linear tomogram – note magnification and poor resolution; Medical CT - note poor resolution - measurements are accurate and 1 to 1; Cone Beam CT - note excellent resolution - measurements are accurate and 1 to 1. Left and centre images are from the same patient.



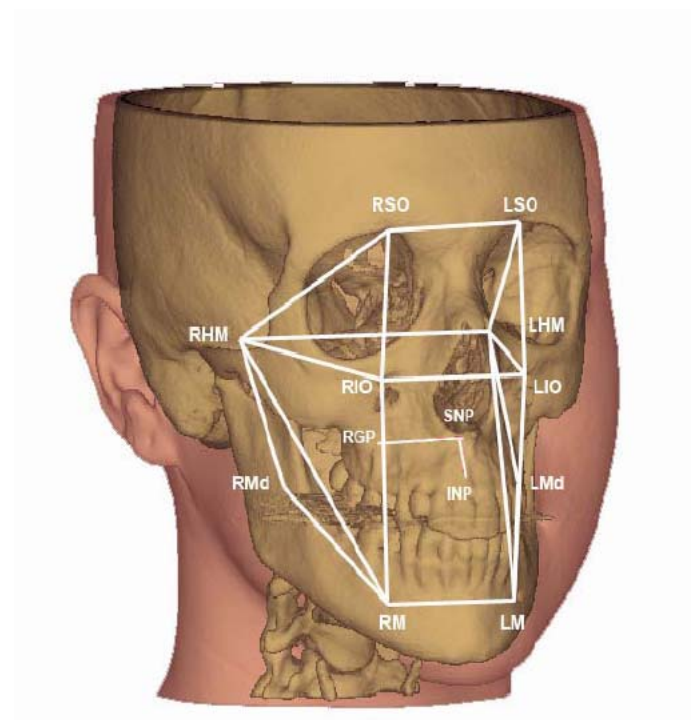
New Cone-beam CT challenges

- Because it is affordable, Cone-Beam CT provides information that was previously unavailable to certain professional categories
- It also provides information with a high level of detail
- Practitioners therefore deal with quantities of data that can be quite overwhelming, however science can help by:
 - Developing new tools to fully leverage 3D data
 - Highlighting certain types of information that can sometimes be difficult to spot in the midst of the rest of the data

Leveraging 3D information

Example of information that only 3D can provide:

- Dr Treil's biometry analysis



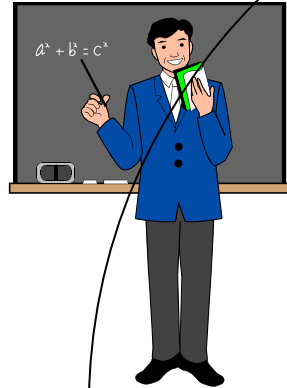
Highlighting information

Techniques such as CAD (based on artificial intelligence) and segmentation should help practitioners

- Quickly extract information (mandibular canal, airways...)
- Spot information that they may have otherwise overlooked (lesions...)

... But these areas are still subject to research

Conclusion



Research



Practitioners



Industry

Carestream Health

Kodak Dental Systems



Thank you !