X-Ray Lab & Imaging

Currents

Quarterly Publication of the American Association of Dental Maxillofacial Radiographic Technicians **Winter 2004**

Cone Beam Computed Tomography in Dentomaxillofacial Imaging

By:Predrag Sukovic

Various imaging modalities have been used in the dentomaxillofacial fields over the past few decades, none of them with entirely satisfactory results. This is particularly true for more demanding imaging tasks, such as implant planning, temporomandibular joint imaging, detection of facial fractures, lesions and diseases of soft tissue in the head and neck, and reconstructive facial surgery.

In particular, the use of dental implants is becoming the treatment of choice for the replacement of missing teeth. The successful outcome of a dental implant—the osseointegration of the implant—is heavily dependent on precise presurgical planning. Since the functional load on implants can be high, it is important that the implant be placed in a position where it can contact cortical bone and at an angle where the forces are as perpendicular as possible. Selection of the appropriate size and inclination of the implant in both a bucco-lingual and mesio-distal direction requires precise knowledge of the anatomy of the proposed site, including its dimension in all planes, the presence of knife-edge ridges and undercuts, as well as the location of anatomic structures, such as the nasal fossae, the maxillary sinus, and the mandibular canal. An evaluation of the thickness of the cortical bone and the density of the medullary bone is also critical to the success of the implant.

Commonly used dentomaxillofacial imaging modalities, such as periapical radiography, panoramic radiography, and conventional tomography produce only two dimensional and/or distorted images. As a result, a number of practitioners have resorted to outsourcing CT scans for implant planning and other demanding imaging tasks.

Cone Beam Continued on page 10

Predrag Sukovic
President Xoran Technologies
Ann Arbor Michigan, USA

Inside This Issue

President's Message

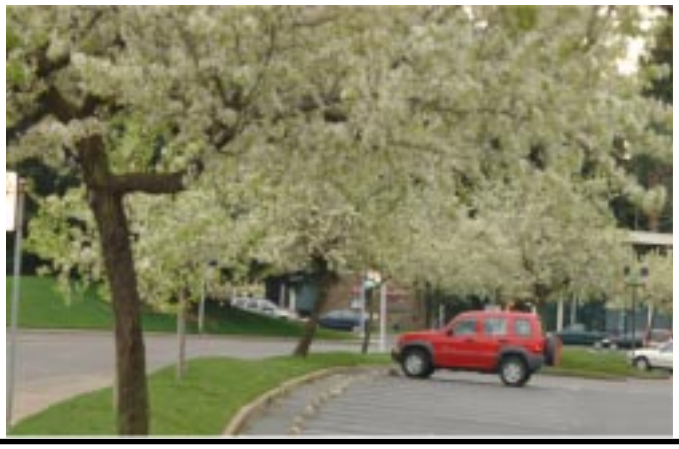
Craig Dial

It is only the second week of February, but here in California the weather is already beginning to change toward spring. I sometimes walk around the neighborhood of the lab during my lunch hour, and just this week I have begun to notice the changes this warmer weather brings. As I walk, I see a multitude of trees beginning to bud out, with their swelled-up tips ready to burst out a display of flowers and leaves. As I look down I notice plants and shrubs that are coming out of their deep sleep, ready to welcome the sun. Although it is technically winter, I know that many people around me can feel, smell and taste the spring in the air, and this has had an invigorating effect on me, and the people around me.

When we experience this phenomenon, we call it spring fever; with delight it comes over us, awakening our senses with rejuvenation. We feel good to be alive, and it excites our mind and body to move onward with our current projects, future plans, and projected goals. Just like the plants and animals that welcome this time of year, we too welcome this change; because change motivates us toward our ambitions and dreams.

Your part of the county (or world) may not be experiencing spring fever in the air, trees, or in your colleagues yet, but you can carry that rejuvenating spring in your step, in your voice, and in your heart. Think about coming out of this winter hibernation today, and commit yourself into an innovative view of life. You will be glad you did.

In front of DDI Sacramento (above), across the street (below)



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Editors View

Camille Mayorga

With a new year ahead of us, we have the opportunity to refresh our ideas and weed out any habits that are not serving us. Now is a good time to re-evaluate the way we think about our lives, our jobs, and the way we perceive the world. It is a great time to let go of any negative thought patterns we have incorporated into our daily routines that we are not even aware of at any given moment. We truly are "given moments" and we should treasure them and make them work for us. Time to start anew.

Sometimes we just need to update our "current" way of thinking, take a hard look at our "mind-chatter" and eliminate any negative thoughts we send ourselves. Afterall, our minds are listening when we tell ourselves that we can't remember names or where we put our car keys or that important piece of paper. Our mind is also listening when we tell ourselves we can never find a good parking place, or that we are always running late. Instead, fill your mind with positive thoughts and energy. Positive thoughts create around yourself an atmosphere favorable to the development of positive outcomes. "A man is what he thinks about all day long", famous words by Ralph Waldo Emerson, clearly states the power of the mind.

In keeping with fresh "current" thinking, the editorial staff here at *Currents* newsletter is committed to bringing you the most "current" in dental equipment news, software, products and events. We hope you enjoy this issue and are inspired to do some mental spring-cleaning.

News and Trends

Other Dental Radiology Meetings

2004 American Association of Oral Maxillofacial Radiology Annual Session Nov. 3-7 Denver Colorado www.aaomr.org
2004 European Congress of DentoMaxillofacial Radiology March 5-8, Malmo, Sweden www.od.mah.se/eadmfr
2004 World Confrence of Oral Impantology, March 5-8, Honolulu, Hawaii, www.wcoi6.com
2005 International Congress of Dentomaxillofacial Radiology May 28th-June 1 Cape Town, South Africa, www.iadmfr.org

MALMÖ UNIVERSITY

World Congress of Oral Implantology 6
March 5-8, 2004
Honolulu, Hawaii, U.S.A.

2005 IADMFR Cape Town

New Feature on AADMRT.com

The public half of the ad rotator is complete and working on the AADMRT website (www.aadmrt.com). Instead of the long list of ads that has been accumulating over the past few months, the user is now presented with a random selection of three ads from the "pool" of advertising on the server. This selection changes with every page load (you can hit "refresh" a couple of times to see this). We can also prepare a report to the advertisers showing how many hits they have received through the AADMRT web site. The reports show day, month and yearly activity. This in turn can be very helpful for future and current advertisers with the AADMRT.

Ad		Views	Clicks	Click %
Aperio	Past Day:	21	0	0.00 %
	Past Week:	276	1	0.36 %
	Past Month:	652	7	1.07 %
	Past Year:	652	7	1.07 %
	Total:	652	7	1.07 %
CDS	Past Day:	31	0	0.00 %
	Past Week:	395	0	0.00 %
	Past Month:	760	2	0.26 %
	Past Year:	760	2	0.26 %
	Total:	760	2	0.26 %
Dolphin Imaging	Past Day:	31	0	0.00 %
	Past Week:	377	0	0.00 %
	Past Month:	730	3	0.41 %
	Past Year:	730	3	0.41 %
	Total:	730	3	0.41 %
Hitachi	Past Day:	26	0	0.00 %
	Past Week:	339	4	1.18 %
	Past Month:	729	5	0.69 %
	Past Year:	729	5	0.69 %
	Total:	729	5	0.69 %
Instrumentarium	Past Day:	34	0	0.00 %
	Past Week:	383	1	0.26 %
	Past Month:	762	2	0.26 %
	Past Year:	762	2	0.26 %
	Total:	762	2	0.26 %
Imaging Science	Past Day:	35	0	0.00 %
	Past Week:	381	1	0.26 %
	Past Month:	763	3	0.39 %
	Past Year:	763	3	0.39 %
	Total:	763	3	0.39 %
MME Consulting	Past Day:	35	0	0.00 %
	Past Week:	356	1	0.28 %
	Past Month:	742	9	1.21 %
	Past Year:	742	9	1.21 %
	Total:	742	9	1.21 %

Spring Conference Nearly Sold Out

The 2004 spring meeting to be held in Costa Mesa, CA has very little seating left and we have outgrown our original room. We have worked with the hotel to have available to us a larger room so we can accomodate the high demands for this meeting, but if you plan on attending, you should sign up soon. This will be a sold out conference, and we will not be able to expand rooms again. Please see the insert in this publication for registration information, or go to www.aadmrt.com and click on future events.

ORAD List

For those that want to discuss oral radiology, you may want to register on the Oral Radiology Discussion Group. This discussion group was started by Dr. Stuart White (Dental Radiologist, UCLA), and the topics include areas of interest in oral and maxillofacial radiology. If you are interested in subscribing, please log on to: http://lists.ucla.edu/cgi-bin/mailman/listinfo/oradlist

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News and Trends

Imaging Prior to Implant Placement Suggested

Recent evidence has suggested that the use of radiographic images prior to implant placement can be beneficial, but until recently, there has been very little evidence supporting this. An article in the *Journal of the Massachusetts Dental Society* cites that a study showing that the use of tomography for pre-implant placement revealed an 87% agreement between the implant dimensions verified by the tomography, and the implant dimensions used in actual surgery. Without the use of tomography, there was only a 30% agreement between the implant dimensions, and those used during surgery. The results indicate that advanced imaging like tomography makes a positive difference in treatment planning for implants, it is cost effective, and has a significant dose reduction compared to spiral CT.

Fall Conference- Salt Lake City, Utah

Make plans now to attend the annual fall conference this September 23rd-25th. The conference will be held in beautiful Salt Lake City Utah, surrounded by the picturesque Wasatch Mountains. This meeting will be held at the Park City Marriott located on historic Main Street. This conference will provide you with 12 CE credits and promises to be an interesting and informative session. Please see the advertisement for this meeting on page 8, or go to our website and click on future events for more specific details: www.aadmrt.com

KODAK Digital Camera, Film Packets Earn Top *DentalTown* Awards

ROCHESTER, N.Y., December 10—Two flagship products offered by Kodak's dental systems group have been voted by members of the *DentalTown* online community to win the 2003 Townie Choice Awards.

KODAK INSIGHT Intraoral Dental Film in SURESOFT Packets won the top award in the x-ray film category. In the extraoral camera category, the KODAK DX4900 Dental Digital Camera won the top award. Townie Choice Awards are selected by vote, open to the *DentalTown* online communities' 29,000 members.

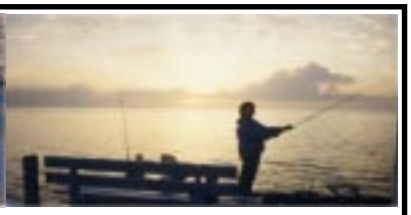
SURESOFT Packets
KODAK SURESOFT Packets feature a comfort edge that helps protect patients from the discomfort that can sometimes occur from the edge of a dental x-ray film packet. They are available with new KODAK INSIGHT Intraoral Dental Film, an F-speed film, which allows dental professionals to reduce radiation dosage for patients up to 60 percent compared with D-speed films.

DX4900 Camera Kit
The KODAK DX4900 Dental Digital Camera Kit is designed to provide dentists with an easy, cost-effective way to create high-quality prints of dental images, including clinical views of teeth as well as patient portraits.

For more information on these or any other KODAK dental products, call 800-933-8031, visit Kodak's Health Imaging Dental Systems Group website at: www.kodak.com/go/dental.

Spotlight Lab

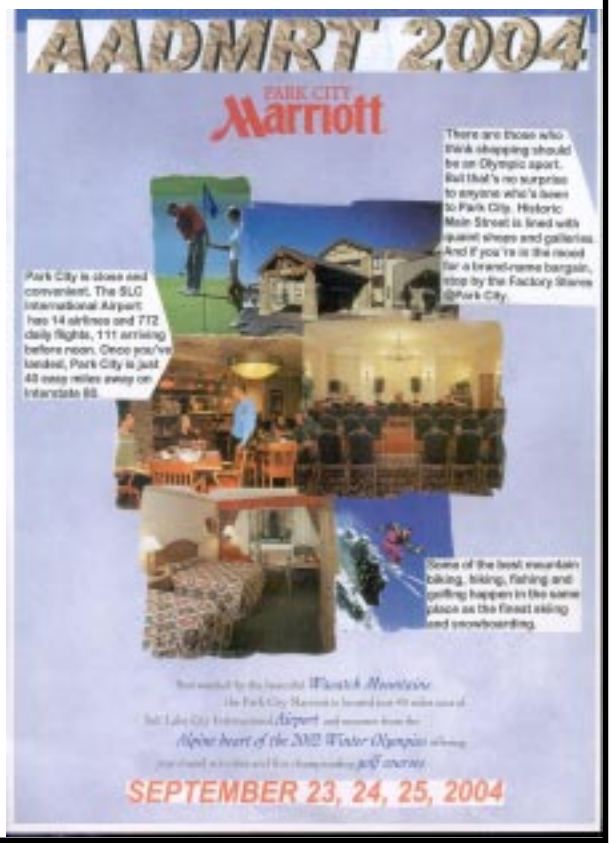
Submitted by: ***Betty Walls, R.T.***
Wilson Radiographic Center of Austin
Austin, Texas



I have been a Radiographic Technologist since 1967. I worked in hospital settings and family practice clinics for 10 years. Then in 1977 my love of the outdoors and whitewater canoe racing took me on a different path. I became the first River Outfitter in Texas. I led whitewater rafting trips in Texas, The Big Bend of Texas, and Mexico as well as renting canoes and rafts on the Guadalupe River. In 1987 I became involved in the politics of saving Texas Rivers and was instrumental in creating the first River District in Texas. In 1992 I sold my river companies and moved to Austin. I assumed I would get a job with Texas Parks and Wild Life, but there were 800 applicants for one position so after 6 months of being told I was over qualified for most outdoor recreation jobs or environmental positions I looked at going back into the medical field. I was hired by a hospital that turned out to be the trauma center for 14 counties. So after being out of the field for 15 years I quickly got back up to speed. It didn't take long to realize trauma centers were not as exciting as they were when I was young. Luckily I saw an ad for Wilson Radiographic Center and wondered what do they do?

Betty & Jeanette

Wilson Radiographic Center of Austin was the first commercial dental lab to open in Texas. Now there are four Wilson Labs in Houston, one in Dallas, and one in Plano, Texas. I was hired in 1992 and have gained much of my new skills in dental radiology by attending AADMRT conferences. We have a referral base of 40 orthodontist and some 60 general dentists. I act as chief technician and office manager and have cross-trained our receptionist Jeanette Hembrough to take radiographs and photos. She has completed the state dental x ray certification program and really enjoys the two roles she fills. Our team is small but we work great together. We have a dental assistant temp. who comes in to help during the summer when are schedule is the heaviest. We have the Instrumentarium Pan Machine and a Quint Sectograph, old but still the workhorse of the industry in my opinion. We also utilize the Dolphin Imaging system for our intra-oral photos.



I really enjoy this job and the interaction with children in particular. One of my most memorable moments was when I was working on a child and asked her to smile for the photos. She was only 8 years old but she said "my mom told me not to smile with my teeth showing because they are ugly." I felt so sorry that she felt that way but I knew when she finished her orthodontic treatment she would have a great smile. Knowing that we contribute to having that happen makes me feel really good. I also appreciate the support and training that AADMRT provides and how the other labs share their knowledge with us when we attend conferences. And for fun I still go whitewater rafting and saltwater fishing.

Table 1

Comparison of Maxillofacial CBVT Devices

Parameters	Newtom 9000	Newtom Plus	3DX Accuitomo	ISI/CAT	Hitachi MercuRay	MedicalCT
X-ray beam	cone	cone	cone	cone	cone	fan
Sensor detector	area	area	area	area	area	linear
	image intensifier CCD	image intensifier CCD	image intensifier CCD	amorphous silicon flat-panel detector	image intensifier CCD	Solid state or gas
Grayscale	8 bit	12 bit	8 bit	12 bit	12 bit	12 bit
Voxel size (mm^3)	0.265	0.07-0.20 (variable)	0.125	0.4 typical 0.2 minimum	0.1	0.3[16]
X-ray source			direct current	direct current		
anode	fixed	fixed	fixed	fixed	fixed	rotating
kVp range	110 (fixed)	110 (max)	60-80	120	70-100	110-140
mA	10 15 max		1-10	1-3	to 15 max	80-300
Image acquisition	panoramic type	panoramic type	panoramic type	panoramic type	panoramic type	axial slices
	single 360°	single 360°	single 360°	single 360°	single 360°	multiple 360°
	rotations	rotations	rotations	rotations	rotations	rotations
Patient position	supine	supine	seated	seated	seated	supine
Image area	maxillofacial	maxillofacial	maxillofacial	maxillofacial	maxillofacial	entire body
Dimensions (cm)	13x13 (height x diameter)	22x25 (height x diameter)	3.0x4.0 (height x diameter)	2 versions 11x17 17x17 (height x diameter)	D mode 5.12 P mode 11.7 C mode 15.0 (height only)	varies/exam
Imaging session (sec)	75	30 or less	17	40 or less	9.6	varies/exam
Effective dose* (max & mand) mSv	.04-.05[15]	.01-.02	.0074	not available	not available	.289 low[17] .723 high[17]
Auto exposure control	smart scan yes	smart scan yes	no	not reported	not reported	no
Commercially available	yes	end of 2003/early 2004	yes	projected 2004	not reported	yes

*Effective dose as reported is provided from the manufacturer and is not truly comparable to other devices due to variable such as different size of imaging volumes and operational settings of the devices.

Cone Beam Continued from Page 1

Principles and Brief History of X-ray Computed Tomography

CT scanners consist of an X-ray source and detector mounted on a rotating gantry (Fig. 2). During one rotation of the gantry, the detector detects the flux, I, of X-rays that have passed through the patient. The attenuation of monochromatic X-rays in homogenous objects is governed by: $I = I_0 \exp(-\mu x)$, where I_0 is the X-ray intensity without the object, x is the length of the X-ray path through the object, and μ is the linear attenuation coefficient of the material at the X-ray energy employed. For inhomogeneous objects, like the human body, the attenuation of X-rays consequently can be described by: $I = I_0 \exp(-\int \mu(x)dx)$. By taking the logarithm of the flux $-\log(I / I_0)$ one obtains line integrals of the linear attenuation coefficients. These integrals constitute so-called "raw data" that are then fed into an image reconstruction method that generates cross-sectional images whose pixel values correspond to linear attenuation coefficients. The theoretical background for tomographic image reconstruction was laid out in 1917 when Radon established that a 3D object can be reconstructed from an infinite set of 2D projections obtained at varying angles around the object.

The resulting attenuation coefficients are usually expressed with reference to water, and are given in Hounsfield units (HU):

$$HU_{patient} = 1000 \times \frac{\mu_{patient} - \mu_{water}}{\mu_{water}}$$

The first CT scanner was developed in 1967 by Sir. Godfrey N. Hounsfield, an engineer at EMI. Since then, CT technology rapidly underwent four developmental generations. The first generation of CT scanners used a single detector element to capture a beam of X-rays, corresponding to the integral of linear attenuation coefficients along a single line. It then translated horizontally to acquire the next line integral. After acquiring all the line integrals for a given position of the X-ray source, both the detector and source rotated one degree—a design known as the "translate-rotate" or "pencil-beam" scanner. Hounsfield's unit belonged to this generation, as did the first commercial CT scanners introduced in 1972. Interestingly, these first generation CT scanners were designed to scan the head only.

Figure 1: MiniCAT/I-CAT scanner developed by Xoran Technologies, Inc. and Imaging Sciences, Inc.

A second generation of CT systems was introduced in 1975. These systems, also known as "hybrid" machines, used more than one detector and used small fan-beam, as opposed to pencil-beam, scanning. Like the first generation of CT scanners, these scanners also used a translate-rotate design, and were for the most part head-only scanners. While the first iterations of full body CT scanners also incorporated the translate-rotate design, image quality was poor due to patient motion artifacts caused by the significant amount of time required to take the scan.

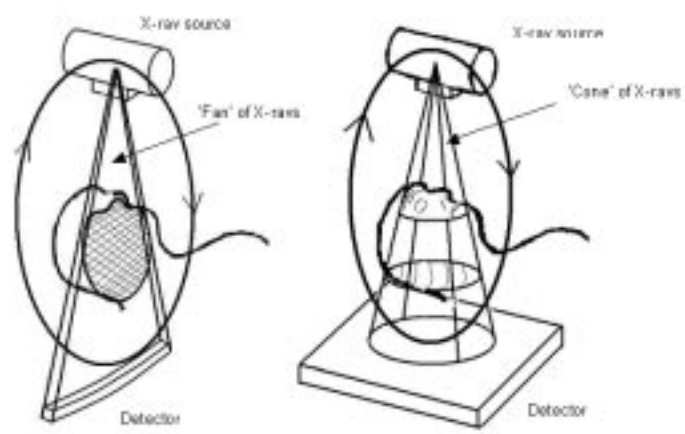


Figure 2: Principles of conventional ('fan beam') CT (left) and cone beam CT (right)

Cone Beam Continued on page 12

Cone Beam Continued from page 12

Third generation CT scanners appeared in 1976 and are the systems most widely used today. These scanners use a large, arc-shaped detector that acquires an entire projection without the need for translation. This rotate-only design, frequently referred to as "fan-beam", utilizes the power of the X-ray tube much more efficiently than the previous generations.
Fourth generation scanners shortly followed third generation scanners, replacing the arc-shaped detector with an entire circle of detectors. In this design the X-ray tube rotates around the patient, while the detector stays stationary. Since these fourth generation scanners tend to be more expensive and suffer from higher levels of Compton scatter artifacts, most of the commercially available CT scanners today are third generation scanners.

After an initial period of rapid development, CT technology quickly became mature, and it was not until the early 1990s that CT research began anew. Recent advances in CT include multirow detectors and spiral scanning. Multirow scanning allows for the acquisition of several cross-sectional slices at the same time, reducing scanning times. Today's state-of-the-art scanners have 64 rows of detectors. Spiral (helical) scanning incorporates a moving table with the rotating X-ray tube, with the net effect that the X-ray tube describes a helical path around the patient.

Conventional CT scanners are large and expensive systems designed for full-body scanning at a high speed to minimize artifacts caused by movement of the heart, lungs, and bowels. They are not well-suited for dedicated dentomaxillofacial imaging, where cost considerations are important, space is often at a premium, and scanning requirements are limited to the head. The advent of cone beam CT (CBCT) technology has paved the way for the development of relatively small and inexpensive CT scanners dedicated for use in dentomaxillofacial imaging.

Principles and Brief History of Cone Beam Computed Tomography

Cone-beam CT scanners utilize a two dimensional detector (Fig. 2), which allows for a single rotation of the gantry to generate a scan of the entire region of interest, as compared to conventional CT scanners whose multiple "slices" must be stacked to obtain a complete image. In comparison with conventional fan-beam or spiral-scan geometries, cone-beam geometry has higher efficiency in X-ray use, inherent quickness in volumetric data acquisition, and potential for reducing the cost of CT. Conventional fan-beam scans are obtained by illuminating an object with a narrow, fan-shaped, beam of X-rays. The X-ray beam generated by the tube is focused to a fan-shaped beam by rejecting the photons outside the fan, resulting in a highly inefficient use of the X-ray photons. Further, the fan-beam approach requires reconstructing the object slice-by-slice and then stacking the slices to obtain a 3D representation of the object. Each individual slice requires a separate scan and separate 2D reconstruction. The cone beam technique, on the other hand, requires only a single scan to capture the entire object with a cone of X-rays. Thus, the time required to acquire a single cone-beam projection is the same as that required by a single fan-beam projection. But since it takes several fan beam scans to complete the imaging of a single object, the acquisition time for the fan beam tends to be much longer than with the cone beam. Although it may be possible to reduce the acquisition time of the fan beam method by using a higher power X-ray tube, this increases the cost and size of the scanner as well as the electric power consumption, thus making the design unsuitable for a compact scanner.

A number of groups have worked on developing task-specific CBCT scanners over the past two decades. Computed tomography angiography (CTA), in particular, has been an active area of investigation due to its lenient requirements for contrast resolution and strict requirements on spatial resolution - a natural fit for CBCT. The first CBCT scanner ever to be built was built for angiography among other tasks at Mayo in 1982 [1].

Cone beam continued on page 14

AADMRT COMMITTEE REPORTS

The AADMRT Board of Directors held it's meeting in Sacramento CA, on February 7th 2003; Merry Hampton, Executive Secretary, submits the general membership minutes.

The Board welcomes two new members: Kevin Fox, who will take over as Recruitment Chair, and Tracey Saucier, will take over the By-Laws. Craig Dial has agreed to stay on as President. Duane Perry will continue as Vice President.

From left to right: Jeannie Herriott, Tracey Saucier, Kathleen Cox, Duane Perry, Bart Webb, Kevin Fox, Craig Dial

Membership: 184 current members, 49 non-paid .New members in 2003: 53,
New members 2004: 4 , Labs in database:153
Nominating: needs three new members for 2005.
Website: Paypal is now available for credit card payments online for membership dues.
Bi-Laws: Board agreed to continue using the term "Technicians" vs. changing to "Technologist".
Continuing Education: currently have 7 students enrolled in our school.
2004 Fall Conference: Park City, Utah, September 23-25. Duane Perry Chairperson.
2005 Conference Sites: Spring -San Fransisco, CA; Fall -Phoenix, AZ
New Business: board agreed to place an advertisement in one or more of the National Dental Journals.

Continued from page 12

Fahrig et al [2] [3] have developed a CBCT system based on an image intensifier and C-arm for use in angiography. Wiesent [4] have also developed a C-arm plus image intensifier system for interventional angiography. Saint-Felix et al [5] developed a CTA CBCT system based on the gantry of a conventional CT scanner which reconstructs vasculature from a set of digitally subtracted angiography (DSA) images. Ning et al. have developed a CBCT angiography imager based on GE 8800 CT scanner with an image intensifier - CCD chain and later with a flat-panel detector [6] [7] [8]. Schueler et al. have developed a CBCT CTA scanner based on a biplanar C-arm system [9]. Kawata et al. also developed a CBCT CTA system [10].

Jaffray and Siewerdsen have developed a CBCT system for radiotherapy guidance based on an amorphous silicon (a-Si:H) flat-panel detector [11] [12, 13]. Cho et al. have also developed a CBCT system for radiotherapy applications [14]. Efforts are being made towards dedicated CBCT-based imaging systems for mammography [15].

Although CBCT has existed for over two decades, its true potential has not yet been fully tapped. Only recently has it become possible to develop CBCT clinical systems that are both inexpensive and small enough to be used in OR, medical offices, emergency rooms, and intensive care. Four technological and application-specific factors have converged to make this possible. First, compact and high-quality flat-panel detector arrays were developed. Second, the computer power necessary for cone-beam image reconstruction has become widely available and is relatively inexpensive. Third, x-ray tubes necessary for cone-beam scanning are orders-of-magnitude less expensive than those required for conventional CT. Fourth, by focusing on head/neck scanning only, one can eliminate the need for sub-second gantry rotation speeds that are needed for cardiac and thoracic imaging. This significantly reduces the complexity and cost of the gantry.

In short, cone beam CT is ideally suited for high quality and affordable CT scanning of the head and neck in dentomaxillofacial applications.

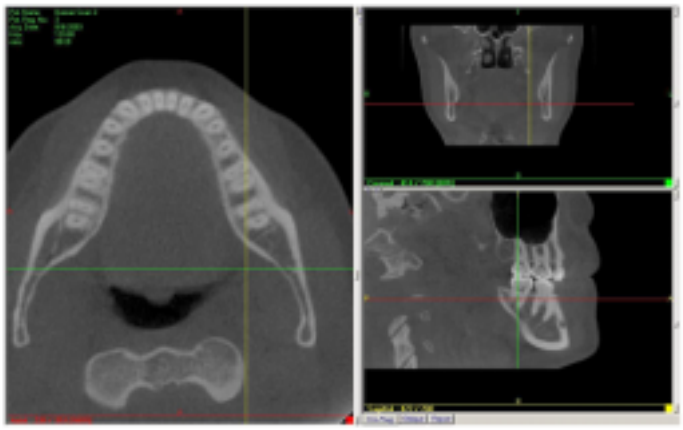


Figure 3: Axial, coronal, and sagittal slices of a maxillofacial scan obtained with MiniCAT™ / I-CAT.

This value of using cone beam CT for dedicated dentomaxillofacial imaging has been recognized by a number of researchers, and several commercial systems are available commercially from Quantitative Radiology ("NewTom 9000" [3]), Hitachi, J. Morita Co. [4,5], as well as from the collaboration of Xoran Technologies and Imaging sciences International (MiniCAT™ / I-CAT (formerly DentoCAT™" [6])

Continued on page 16

CB MercuRay™

Changing the face of dental imaging

Hitachi has taken its expertise in conebeam and CT technologies and applied it to the field of dentistry with the CB MercuRay. The result is an x-ray scanner with a 360º rotational sequence, enabling 2D images and 3D volume reconstructions for excellent planning and diagnostic support.

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Flat-Panel Detector based on Amorphous Silicon

The quality of the reconstructed CT image depends significantly on the quality of the data that is acquired during the scan. The characteristics of the two-dimensional detector used by a cone beam CT scanner affect therefore directly the quality of the CT scan.

MiniCAT™ scanner deploys a flat-panel detector constructed from hydrogenated amorphous silicon (aSi:H). These detectors are essentially self-scanned arrays of n-i-p photodiodes and thin-film transistors switches with a scintillator layer. Essentially the same underlying technology is used to construct flat-panel computer monitors and large-area document imagers. Flat-panel detectors are replacing film and image-intensifiers in conventional radiography and fluoroscopy applications.

The characteristics of aSi:H based flat panel detector arrays make them a much better choice for cone beam imaging than an alternative solution: image intensifier coupled with a CCD. Image intensifiers create geometric distortions that must be addressed when processing the data later in the software, while flat-panel detectors do not suffer from this problem. Also, flat panel detectors afford a greater dynamic range than that offered by the image intensifier + CCD camera approach.

Sample Images

Figures 3-6 illustrate the high spatial resolution that can be obtained with CBCT (MiniCAT™ / I-CAT) and compare it to that of conventional CT scanner.

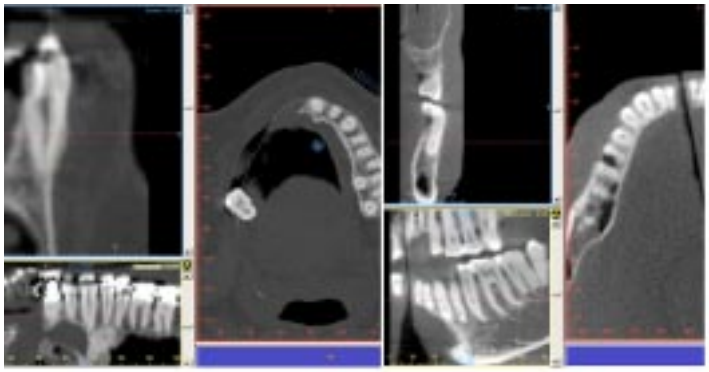

Figure 4 Comparison of a conventional CT scan (left) with a CBCT scan (right). Note the higher resolution along the z-axis for the CBCT scan.

Figure 6 3D renderings of a MiniCAT scan of a image guided sinus surgery phantom. The high isotropic spatial resolution makes it ideal for example for image-guided functional endoscopic sinus surgery.

Future of Cone Beam CT

Its high spatial resolution, smaller size and lower cost has made CBCT a natural fit dentomaxillofacial imaging. Those same attributes will drive the adoption of CT in other markets as well. Xoran Technologies is successfully marketing the MiniCAT™ scanner to otolaryngology offices for in-house imaging of the sinuses and temporal bone. In the future, integration of CBCT with image guided surgery systems for functional endoscopic sinus surgery is anticipated (a scan of an image guided surgery phantom is shown in Figure 0.) 3D intraoperative imaging devices based on CBCT are also in development.

At the other end of the spectrum, the 'big four' companies that manufacture conventional CT scanners are working on mating cone beam technique with the scanners from their product lines. Once accomplished, this would allow the physicians to 'freeze' the motion of the heart for cardiac imaging. The latest generation of conventional CT scanners has 64 slices and can cover 4 cm axially. It is anticipated that the need for sophisticated cardiac imaging tools will drive the introduction of truly cone beam helical scanners within several years.

conclusion on page 17

As CBCT scanning is finding more and more commercial applications in medicine, dentomaxillofacial radiology stands as the privileged field that has driven growth of this exciting technology out of the R&D infancy into the commercial maturity.

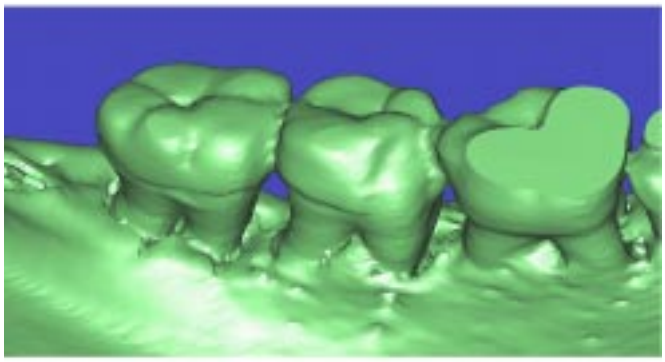

Figure 5 3D renderings of a high-resolution isotropic (voxel size 0.2 mm) scan of a dry mandible.

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