DeskCAT™
Multi-slice optical CT scanner

KEY FEATURES
✦ Teach principles of medical imaging
✦ Safe, accessible and portable
✦ Optical in place of X-ray imaging
✦ Perform real-time quantitative CT scans in the lab and classroom
✦ Hands-on, intuitive, and interactive
✦ Fully integrated CT Scanner includes phantoms, software and student lab exercises
✦ Image acquisition, 3D reconstruction and display
✦ Enables simulation of imaging artifacts

DeskCAT™ is a state-of-the-art optical CT scanner designed to demonstrate the principles of medical imaging in an educational setting. Each scanner comes with software and lab exercises developed by Modus Medical Devices Inc. in collaboration with imaging and educational experts from the London Regional Cancer Program and Western University.*

The DeskCAT™ scanner weighs 10 kg and measures 63 cm long, 23 cm wide and 33 cm high. It uses cone beam geometry, a CMOS camera and an LED light source. Phantom materials are translucent and rotate 360 degrees when attached to the rotary stage. The scanner connects to a computer (not included) and integrates with the DeskCAT™ software and lab exercises.

The DeskCAT™ scanner makes it safe and easy for students to learn about imaging and image reconstruction without the use of potentially harmful X-rays.

A) Camera View window displays the live projection images of the scanned phantom inside the aquarium.

B) Centre Slice Sinogram window displays the central sinogram of the scan and is updated for each projection angle during a scan.

C) Centre Slice Reconstruction window displays the reconstructed central slice and updates in real time for each projection angle as scanning and reconstruction progress.

D) 3D Reconstruction View window allows the student to observe and analyze the reconstructed images interactively in 3D.

BEGINNER LAB EXERCISES

Lab 0: Introduction to DeskCAT™
In this lab, students will scan a simple 3D object (i.e., a mouse phantom) to become familiar with the DeskCAT™ scanner procedures and software interface. This will help students become oriented with the operations of a CT scanner and associated software for data capture, image reconstruction, and 3D image display.

This exercise will introduce the students to the user interface of the DeskCAT™ scanner, explain the concept of a reference versus data scan, and allow them to explore the different navigational and visualization tools that the software offers for both 2D projections and 3D reconstructions.

Lab 1: Introduction to Medical Imaging – 3D Localization
In this lab, students will make geometric measurements of the 3D positions of fiducial markers embedded in a cylindrical phantom. Measurements are made from 2 orthogonal radiographic (camera) projections, as well as from a CT reconstructed 3D image. Students can compare and contrast the two imaging modalities with calculations of coordinates by each approach. By the end of the lab, students should find that the marker positions are in close agreement using an orthogonal pair of 2D radiographic images and the full 3D CT image.

This exercise will further introduce the students to the user interface of the DeskCAT™ scanner. Students will determine the geometric positions of fiducial markers in 3D space, and will also learn how to adjust window and level to improve visibility of targets in an image.

Lab 2: System Linearity
In this lab, students will perform an experiment to assess the linearity of the DeskCAT™ scanner performance. Students are given a water-filled jar and concentrated black dye solution. They must acquire a data-set of scans with increasing optical attenuation coefficients. By the end of the lab, students should observe a linear trend and accurate reconstructions to within 10%, with results depending on the concentration of the dye. Students must identify sources of error and offer suggestions to reduce the experimental error.

This exercise will illustrate the importance of an imaging system’s linearity on its suitability as a quantitative tool.

Lab 3: Spatial Resolution and Modulation Transfer Function (MTF)
In this lab, the student will assess the spatial resolution of the DeskCAT™ scanner at 2 levels: The spatial resolution of a single 2D projection radiographic image, and the spatial resolution of a 3D CT reconstructed image. Students will acquire images of a test bar pattern with a series of “picket fence” line thicknesses. By measuring the contrast of line pairs, students plot pixel intensity (or modulation) vs. spatial frequency to estimate the shape of the modulation transfer function (MTF).

This exercise will introduce students to the concept of MTF, its practical implications and demonstrate one method of measuring it.
INTERMEDIATE LAB EXERCISES

Lab 4: Edge Response, Point Spread Function and MTF
In this lab, students will apply a more mathematical technique to determine the modulation transfer function and compare results with the methods used in Lab #3. Students will use a step-edge phantom to measure pixel profiles across the contrasted edge. Using Fourier transform methods, students will calculate and plot the MTF for the radiographic and CT images. By the end of the lab, students will be able to compare the results for on-axis and off-axis slice locations in the 3D image with the previous results obtained from Lab #3.

This exercise will help students learn how to use Fourier methods to determine the image resolution limits of a CT scanner. To facilitate implementation of this lab, MATLAB® code is provided to analyze the edge response curve and perform the necessary Fourier transforms.

Lab 5: Contrast to Noise Ratio
In this lab, students will learn the importance of contrast and noise as it is observed in low-dose imaging. A lower dose image of a finger phantom containing several small pins of different opacity is simulated by adding Gaussian noise to the projection images in sinogram space. By the end of the lab, students should observe that for high noise (i.e. low dose) conditions, the ability to resolve low contrast pins is progressively impaired as noise is increased. This is an important topic in view of the “Image Gently” (www.pedrad.org) approach used in medical diagnostic imaging.

This exercise will help students understand the compromise between what is necessary to achieve visualization of low contrast targets and level of radiation exposure.

Lab 6: Image Artifacts due to Faulty Detectors and Missing Projections
In this lab, students will learn that CT images are not a perfect rendition of the object scanned. In a real CT scanner, the transmission of X-rays is measured by real detectors with inherent noise and possible faults. Students will manipulate the DeskCAT™ software to remove user-selected camera pixels, including entire rows or columns of pixels (i.e. corrupt radiograph and sinogram). In addition, angular projections can be eliminated from the sinogram. Students will observe a variety of artifacts (e.g. rings, spokes) in the reconstructed CT images and are asked to offer explanations.

<table>
<thead>
<tr>
<th>Resolution Setting</th>
<th>Voxel Size (mm)</th>
<th>Reconstructed Image Size (MB)</th>
<th>Acquisition &amp; Reconstruction Time (min)*</th>
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<tbody>
<tr>
<td>Low</td>
<td>2</td>
<td>0.25</td>
<td>&lt;1</td>
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<tr>
<td>Medium</td>
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<tr>
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<tr>
<td>Very High</td>
<td>0.25</td>
<td>128</td>
<td>3</td>
</tr>
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</table>

* x64 Windows 7 8GB RAM 2 Core @2.66GHz

ADVANCED LAB EXERCISES
(available as a package, Fall 2012)

Lab 7: Cone Beam vs. Fan Beam CT
Lab 8: SPECT Imaging (Nuclear Medicine)
Lab 9: Dual Energy CT
A safe way to learn about Medical Imaging

**DELIVERABLES**
- Scanner
- Phantoms
- Empty Jars (3)
- Food Coloring (Dye)
- Syringes (20mL and 5mL)
- Cables
- Power Supply

**DOCUMENTATION**
- Software CD
- User’s Guide
- Student Lab Exercises

**ORDERING INFORMATION**

100-2020 DeskCAT™ Optical CT System, includes:
- Scanner with Rotary Stage and Jar Clamp
- Software CD & Documentation
- Phantoms:  • Fiducial,  • Resolution  • Blank Silicone
- Empty Jars (3)
- Food Coloring (Dye)
- Syringes (20mL and 5mL)
- Labs 1, 2 & 3
- Cables:  • USB-A to USB- mini B  • USB-A to USB-B
- Power Supply (Elpac Power Systems 50W switching power adapter model FW C5024F: 110 - 240 V~, 50 - 60 Hz, 1.0A; Unit input: 24Vdc, 2.1A.)
- Auxiliary Power Cable (3.5mm audio connector)

**ADDITIONAL ORDERING INFORMATION**

500-2100 Labs 4, 5 & 6
500-2105 Labs 7, 8 & 9 (available Fall 2012)

**SPECIFICATIONS**
- Dimensions: 63cm x 23cm x 33cm (25” x 9” x 13”)
- Weight: 10kg (22lbs)

**MINIMUM TECHNICAL REQUIREMENTS**
- Standard desktop or laptop PC with Windows 7/ Vista (recommended x64), or XP
- 1 GB RAM
- .NET framework 3.5
- 2 USB ports

**CONTACT INFORMATION**
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