

2D and 3D Medical Images for Anatomy Education using a cloud computing platform

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Outline

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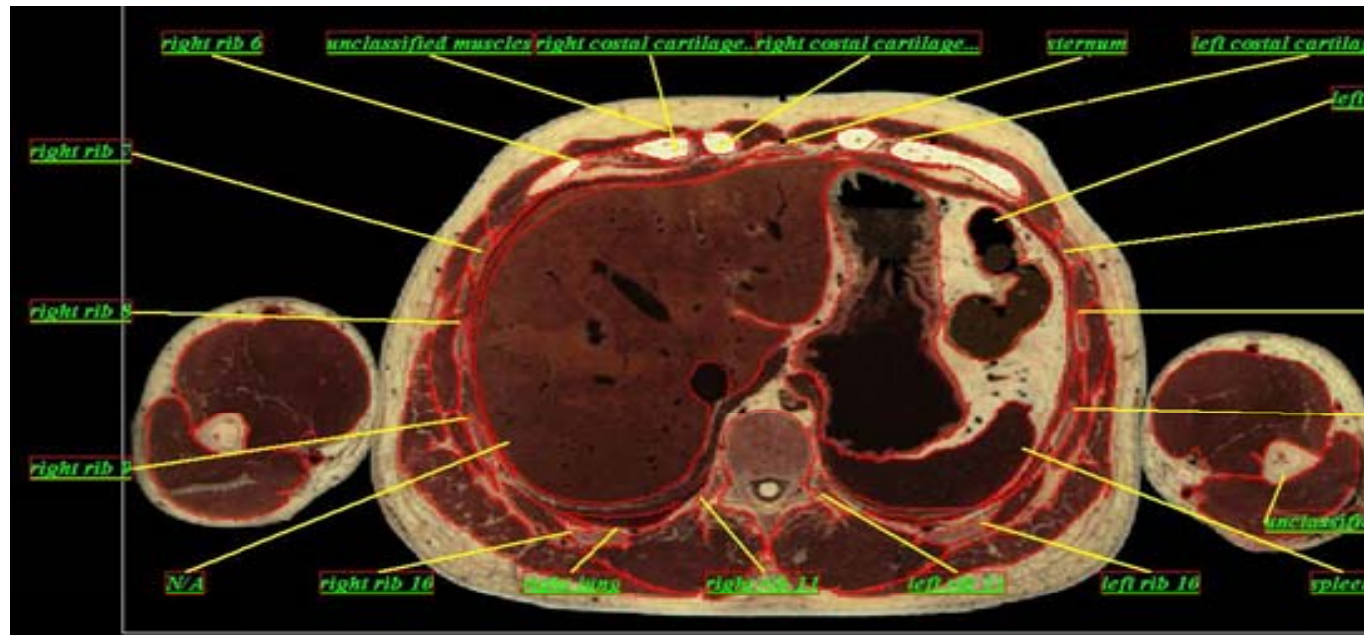
Introduction

Human anatomy is the basic scientific study for students in medical schools to learn.

- Name
- Shape
- Position
- Size
- Organ structures
- Functionality

The traditional way to learn anatomy

- Anatomical atlas book
 - Static 2D images
- Laboratory dissection



Introduction

- The difficulty of learning anatomy
 - There is **a huge amount of information** that students should understand and memorize – more than **one thousand of organs**.
 - The students still can **not visualize the internal structures** of a given organ.
 - It is still difficult for the students to visualize or imagine **the spatial relationship between various organs** since the organs might obscure each other.

related background

- The computerized 3D anatomical atlases can be used to create arbitrary views of the human anatomy, provide a “look and feel” close to real organs, and support an “interactive learning by doing” mechanism.
- The basic data we use
 - Anatomical cross-sectional image datasets
 - The Visible Human Project (VHP)

The Visible Human Project

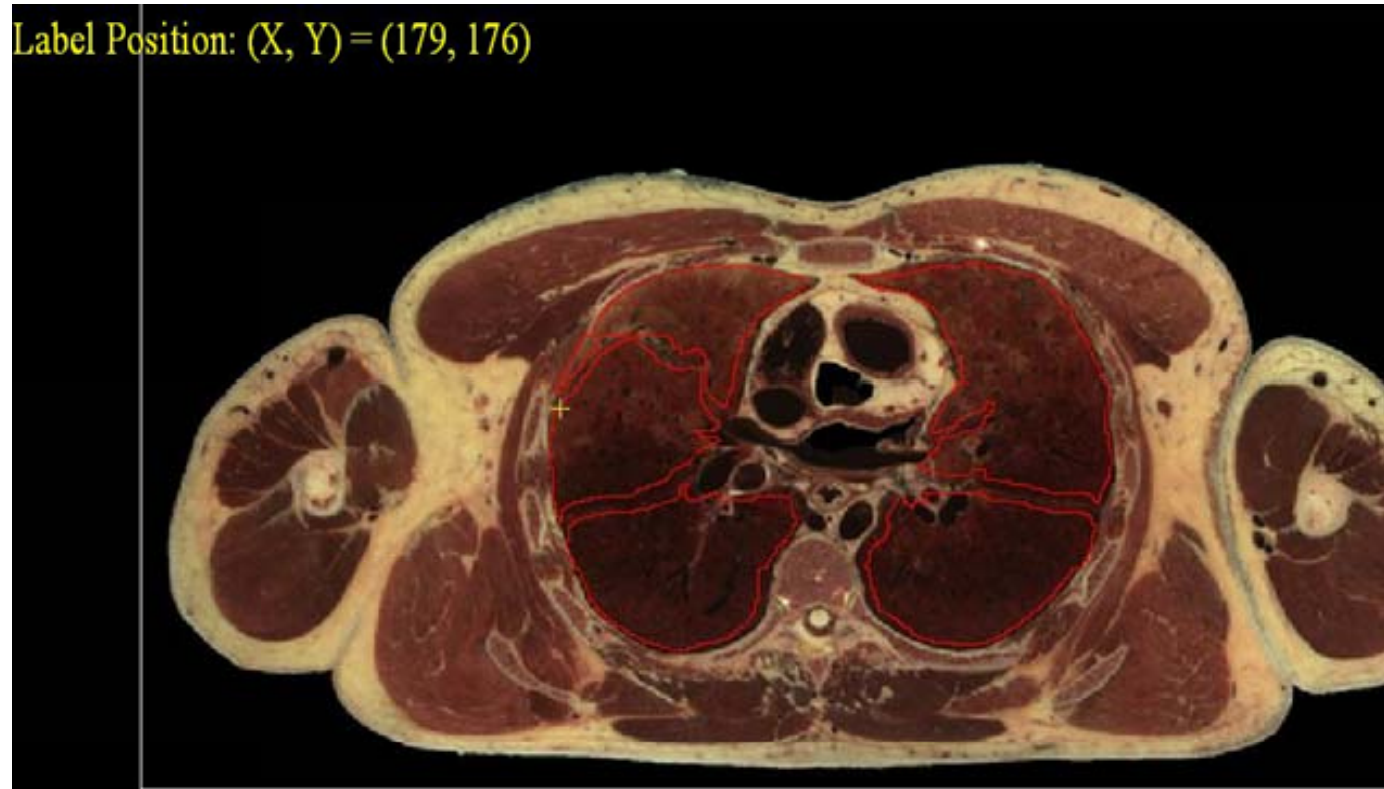
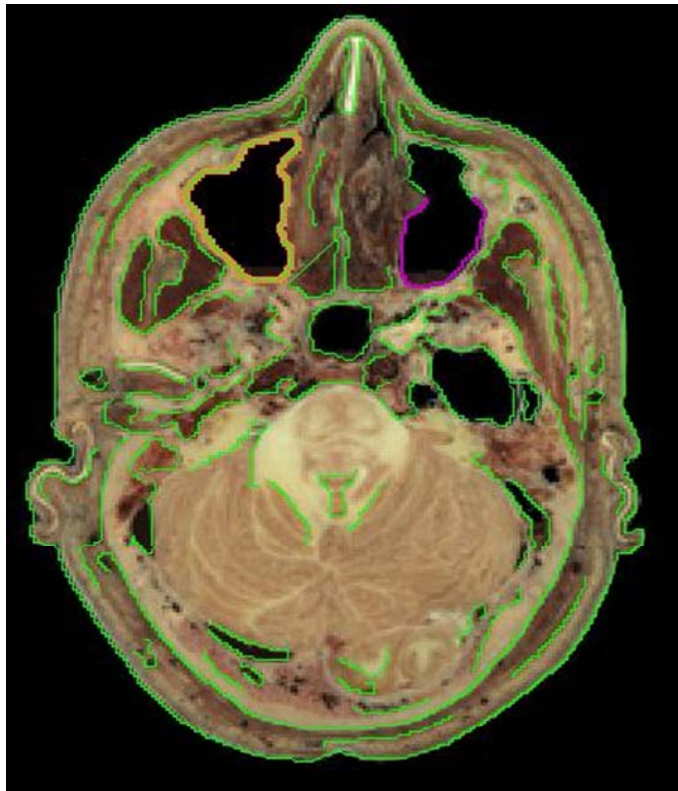
- The project is run by the **U.S. National Library of Medicine (NLM)** under the direction of Michael J. Ackerman.
- It is an **effort to create a detailed data set of cross-sectional photographs** of the human body
- **A male and a female cadaver were cut into thin slices** which were then photographed and digitized.

Data collection

- *Photographic cross-sections:*
Volume Dimensions: 1760 x 1024 x 1878
Pixel Dimensions: .33 mm x .33 mm x 1 mm
Pixel Depth: 24-bit (8-bits x RGB)
Volume Size: 9.5 GB

- *Computed Tomography (CT) – in frozen state:*
Volume Dimensions: 512 x 512 x 1878
Pixel Dimensions: variable x variable x 1 mm
Pixel Depth: 16-bit
Volume Size: 939 MB

The Visible Human Project

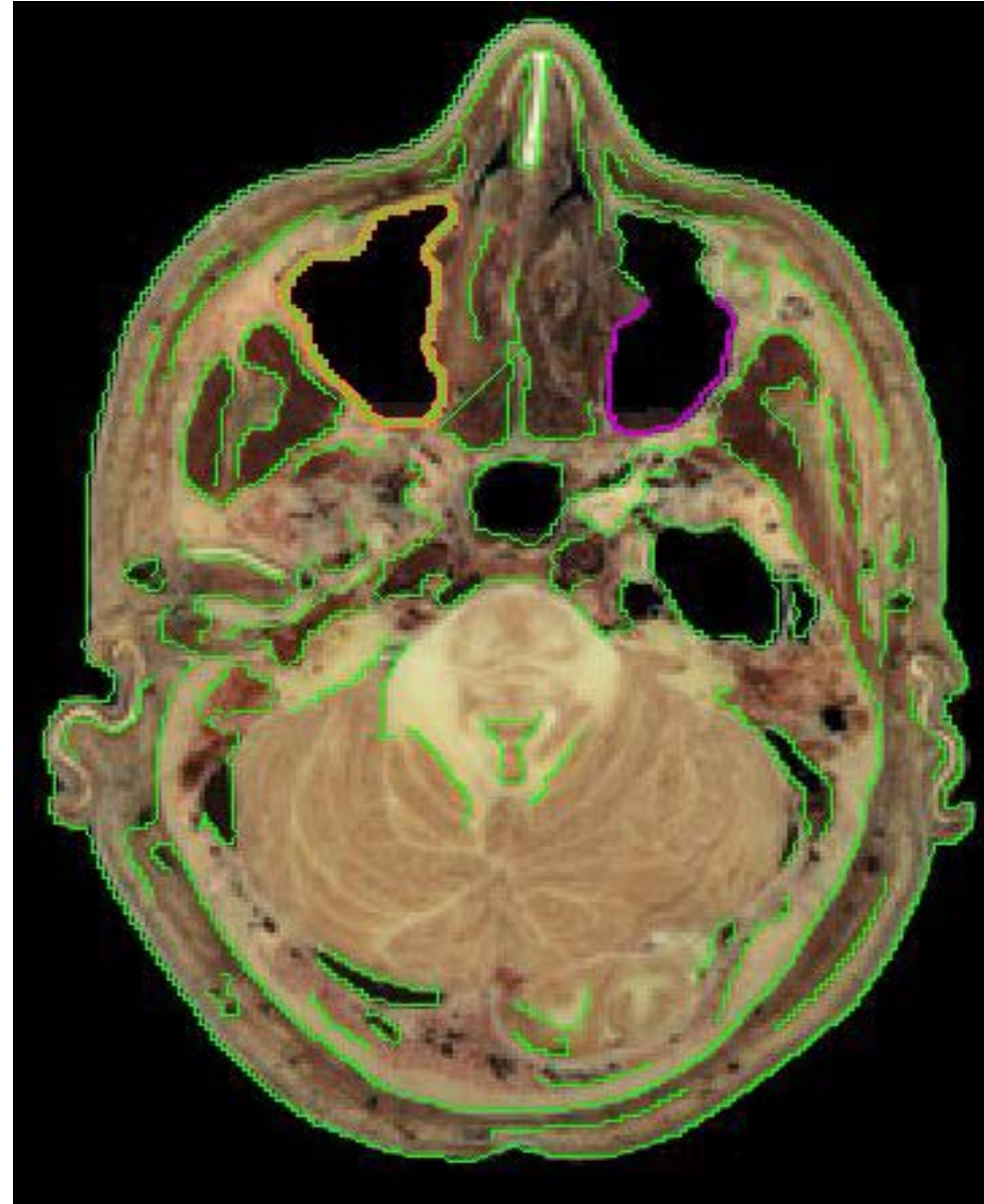


Organ Reconstruction process

2D object segmentation

- We have **developed a semi-automatic method** to automatically generate all the potential object edges.
- The **non-expert persons** can **easily and efficiently draw the contour of an organ** without carefully following the boundary of an organ

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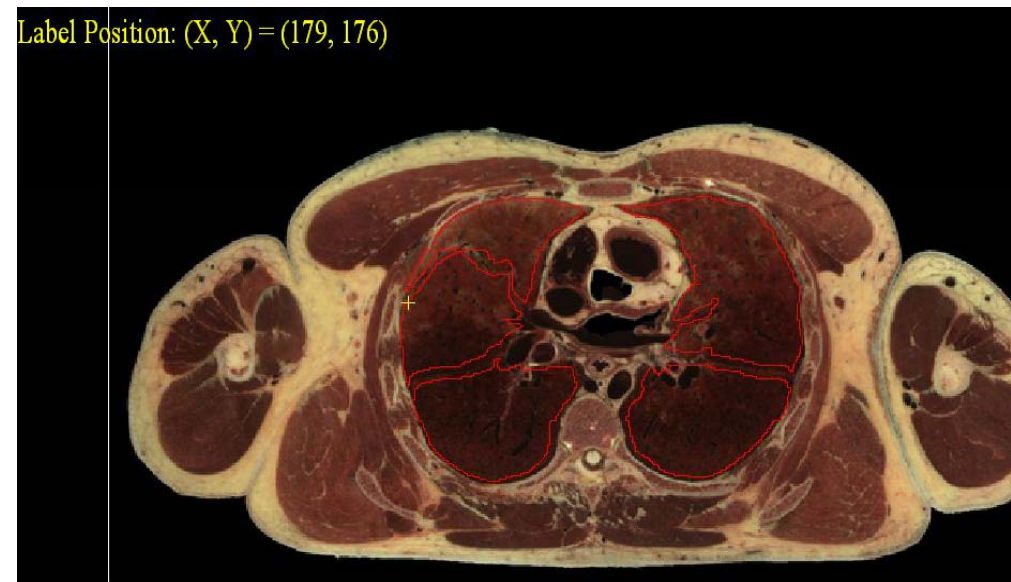
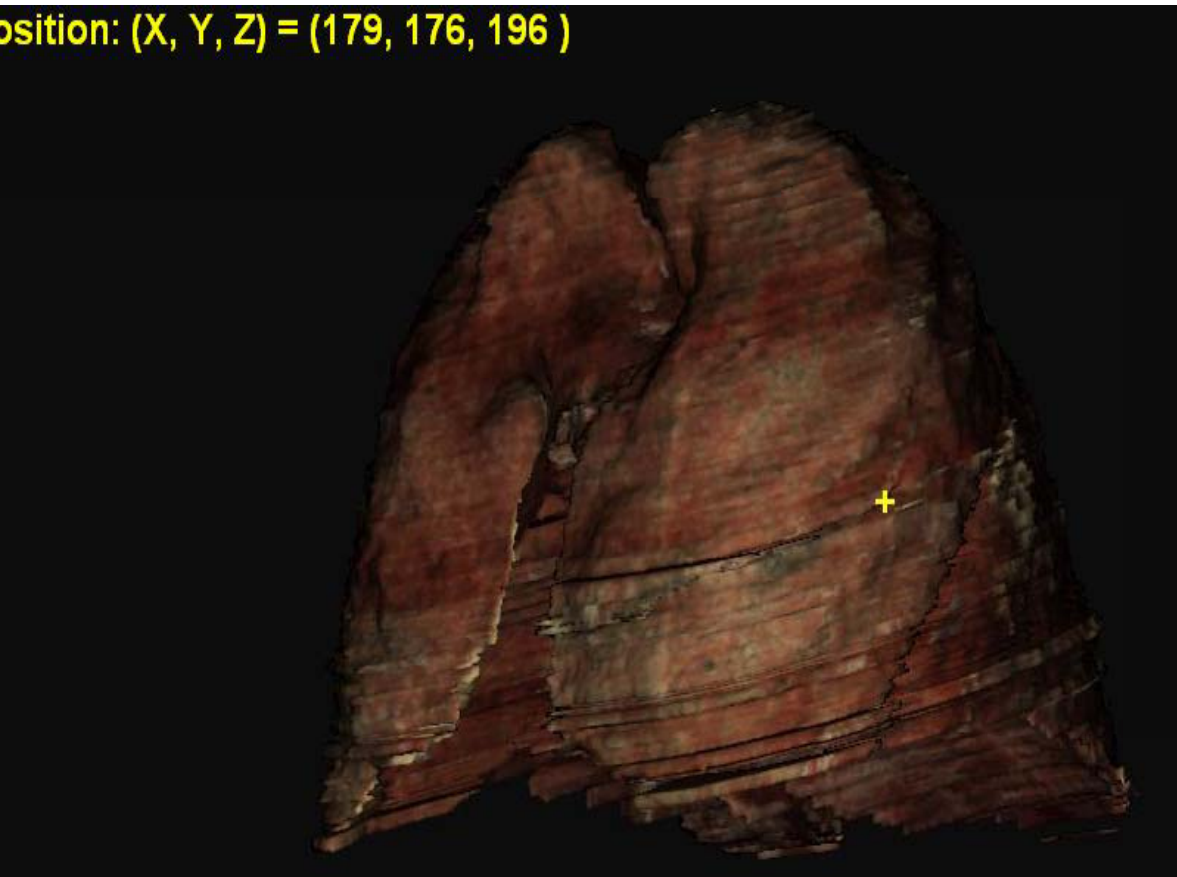


3D organ Reconstruction process

- Assignment of organ names
 - Each contour in an image should be assigned a correct organ name for the students to learn.
 - The same organ in the rest of the images can be easily assigned an organ name automatically.
 - An expert can double-check the correctness of the name assignment.
- 3D object reconstruction
 - The 3D organs are reconstructed from a series of 2D images.

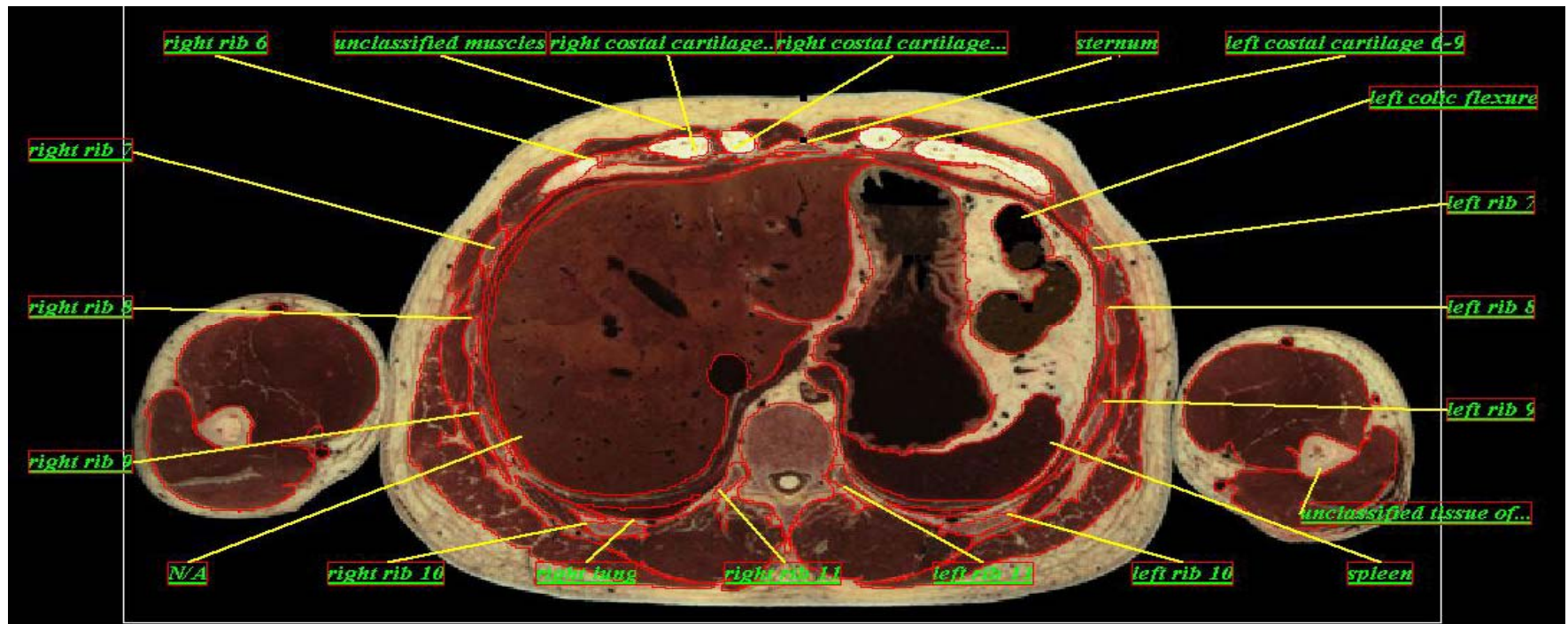
3D organ Reconstruction process

- Correction of the 2D organ segmentation and assignments of organ names



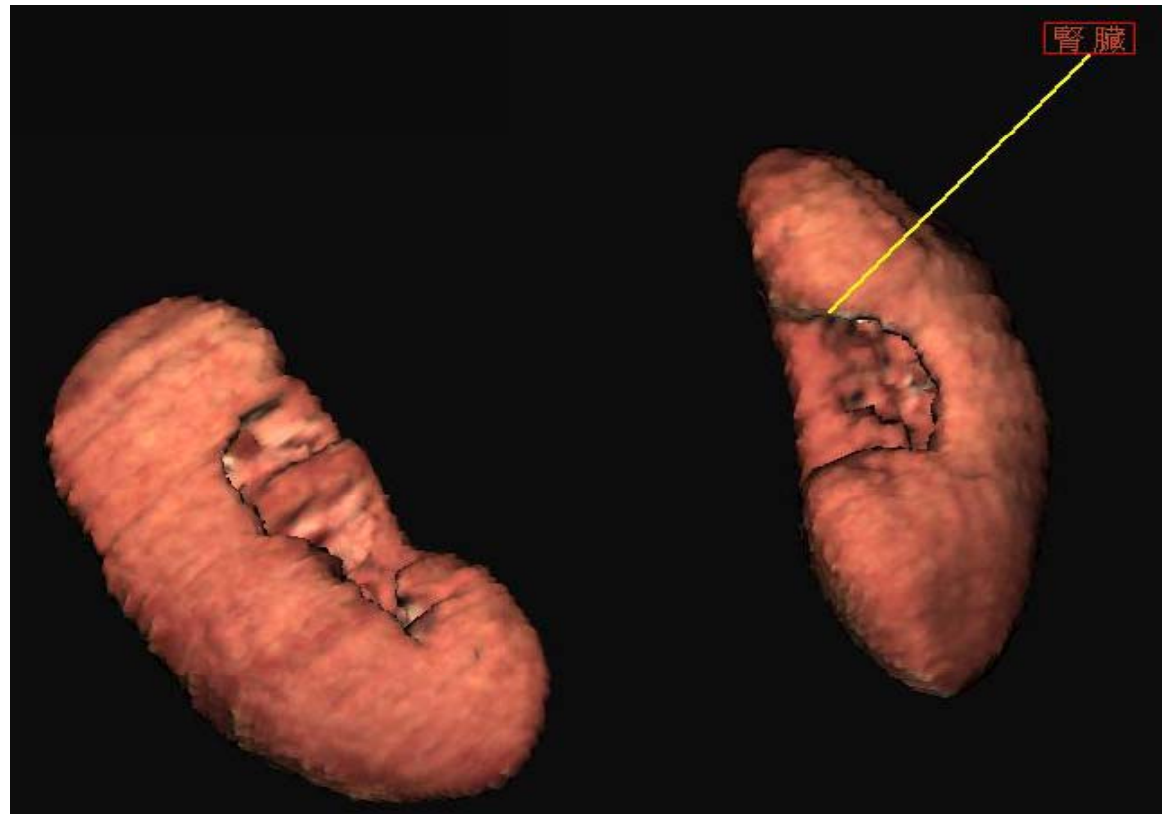
System functions for anatomy education

- 2D and 3D display
 - **2D cross-sectional images** of an organ are useful for the students to learn where they are in the human body and the detailed internal structures of the organ.



System functions for anatomy education

- the 3D images are useful for the students to visualize its shape in a 3D space and its spatial relationships with other related organs.



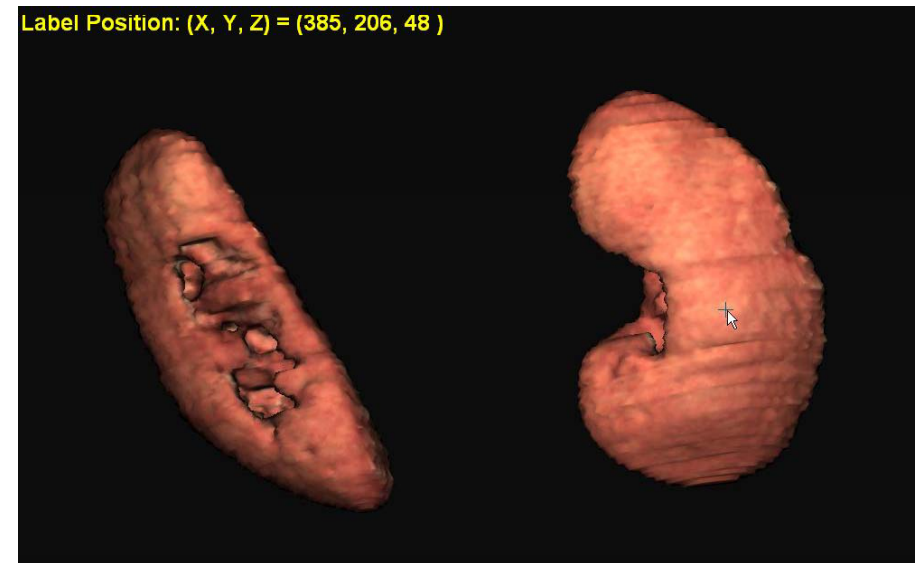
System functions for anatomy education

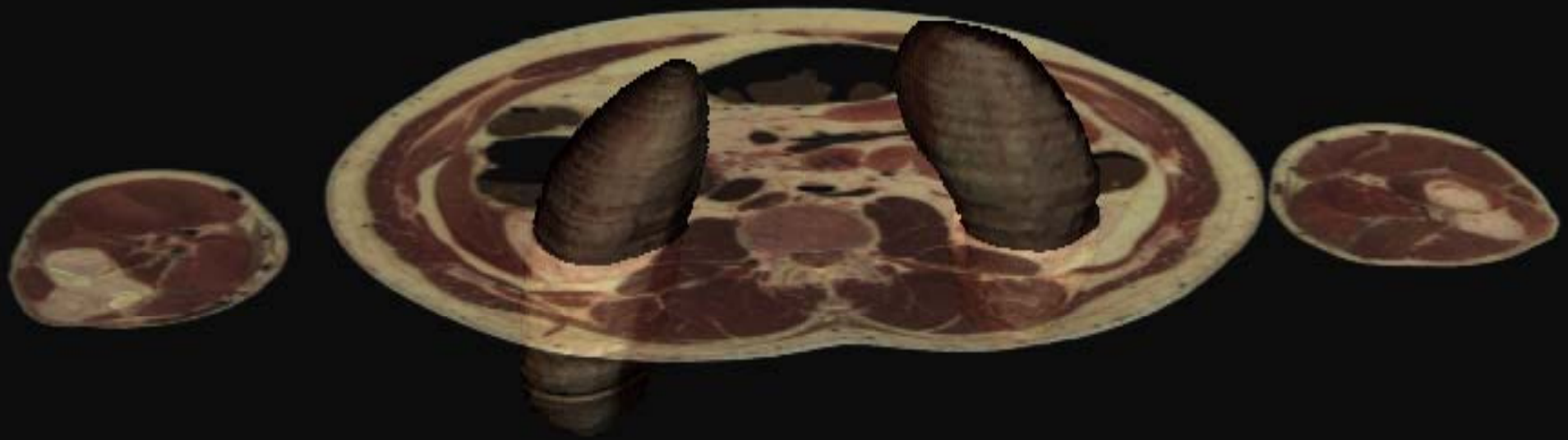
- The students want to be able to **see the spatial relationships between the 2D images and 3D images.**



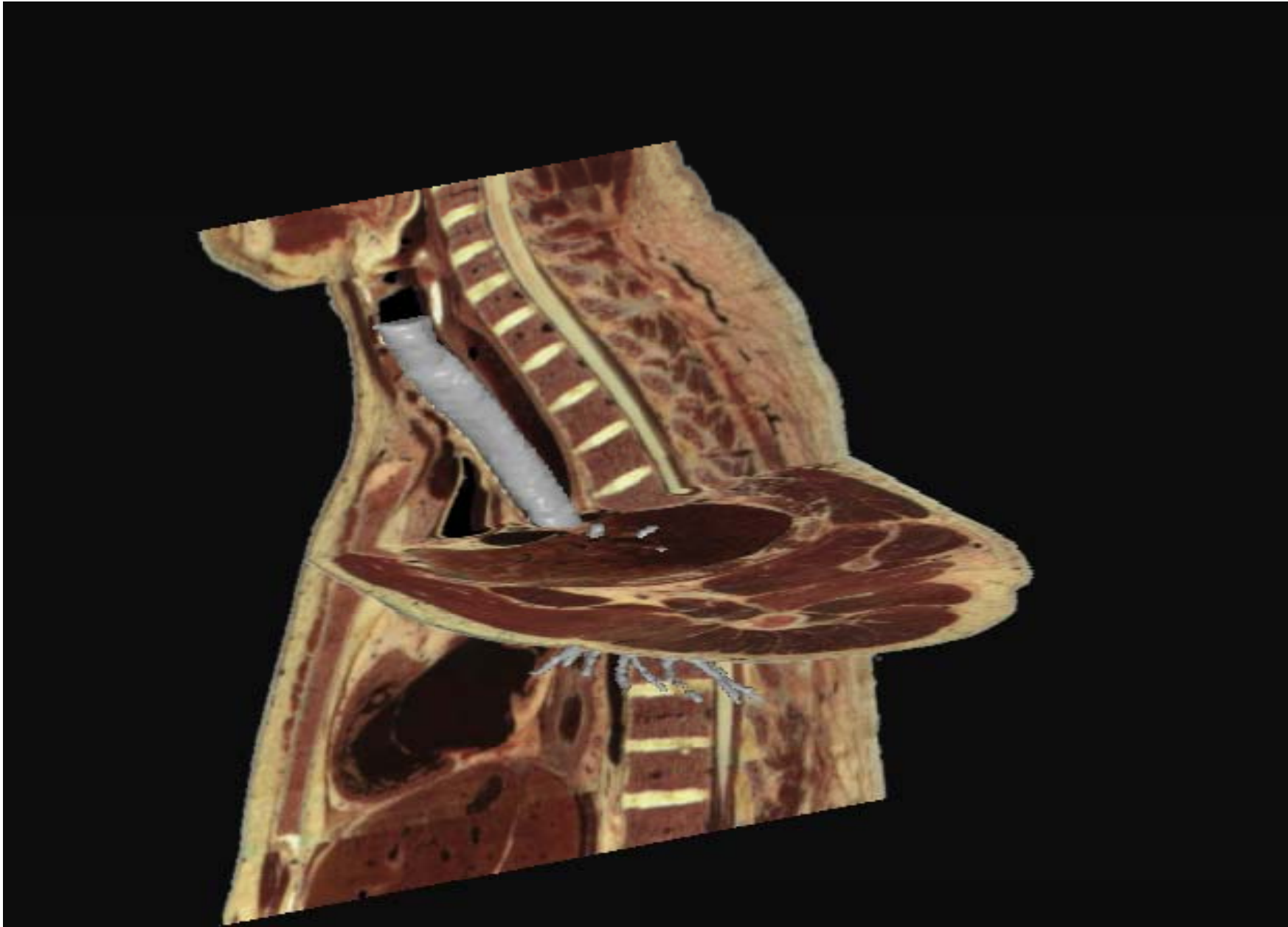
System functions for anatomy education

- The students can also **click at a point in a 2D image** and the system will show the **corresponding point in the 3D image.**





The 3D kidney and some 2D cross-sectional images

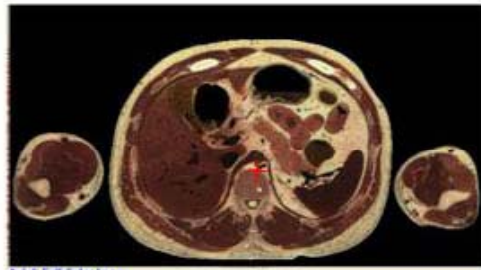


The 3D trachea and some 2D cross-sectional images

System functions for anatomy education

- Learning CT and MRI images
 - In general, different organs have different image features in the same type of images.
 - The same organ may have different image features in different types of images, such as T1, T2, and proton density MRI images.
 - Find the corresponding points in different images.

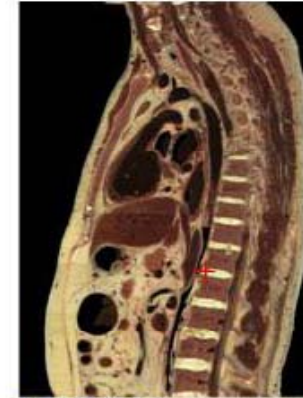
tem functions for anatomy education (corresponding nts)



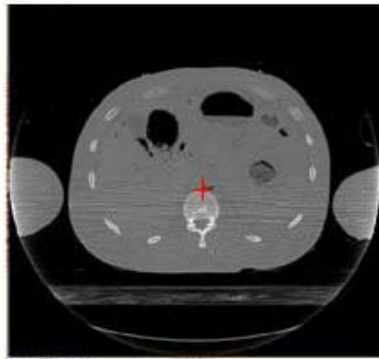
Axial: Full Color Image



Coronal: Full Color Image



Sagittal: Full Color Image



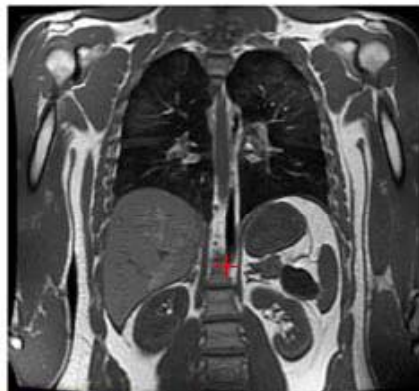
Axial: CT Image



Coronal: MRI T1 Image

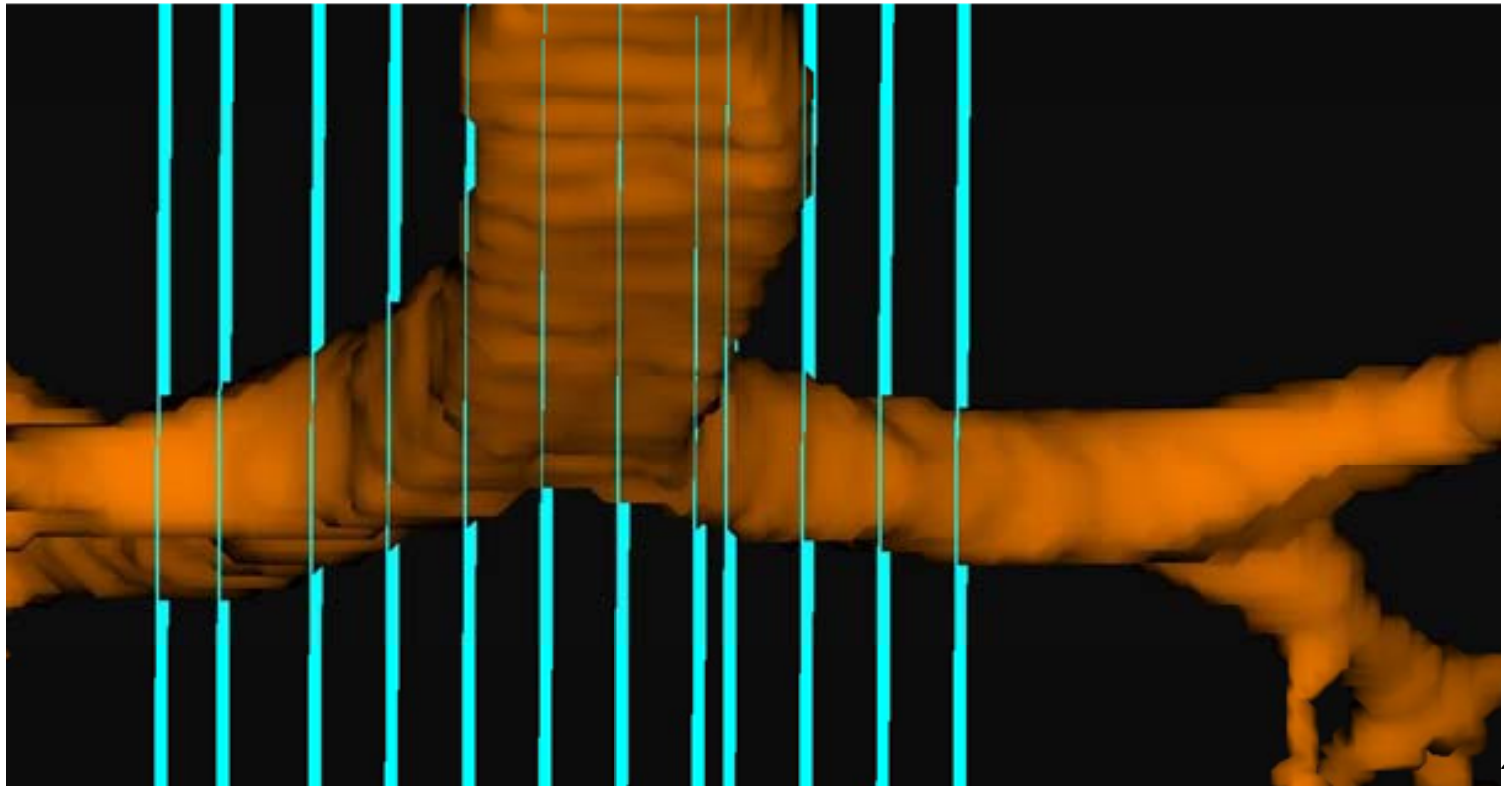


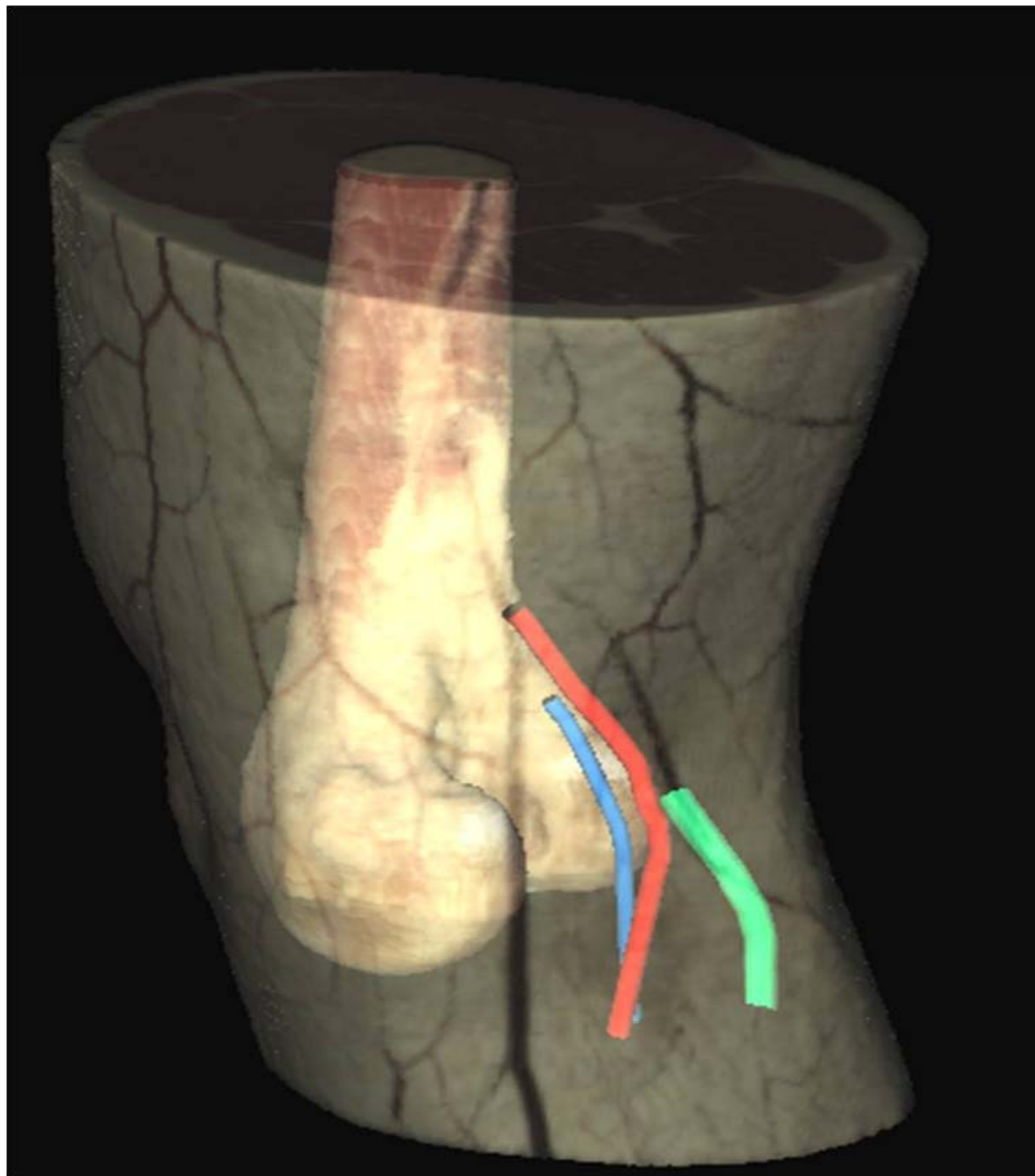
Sagittal: MRI T1 Image

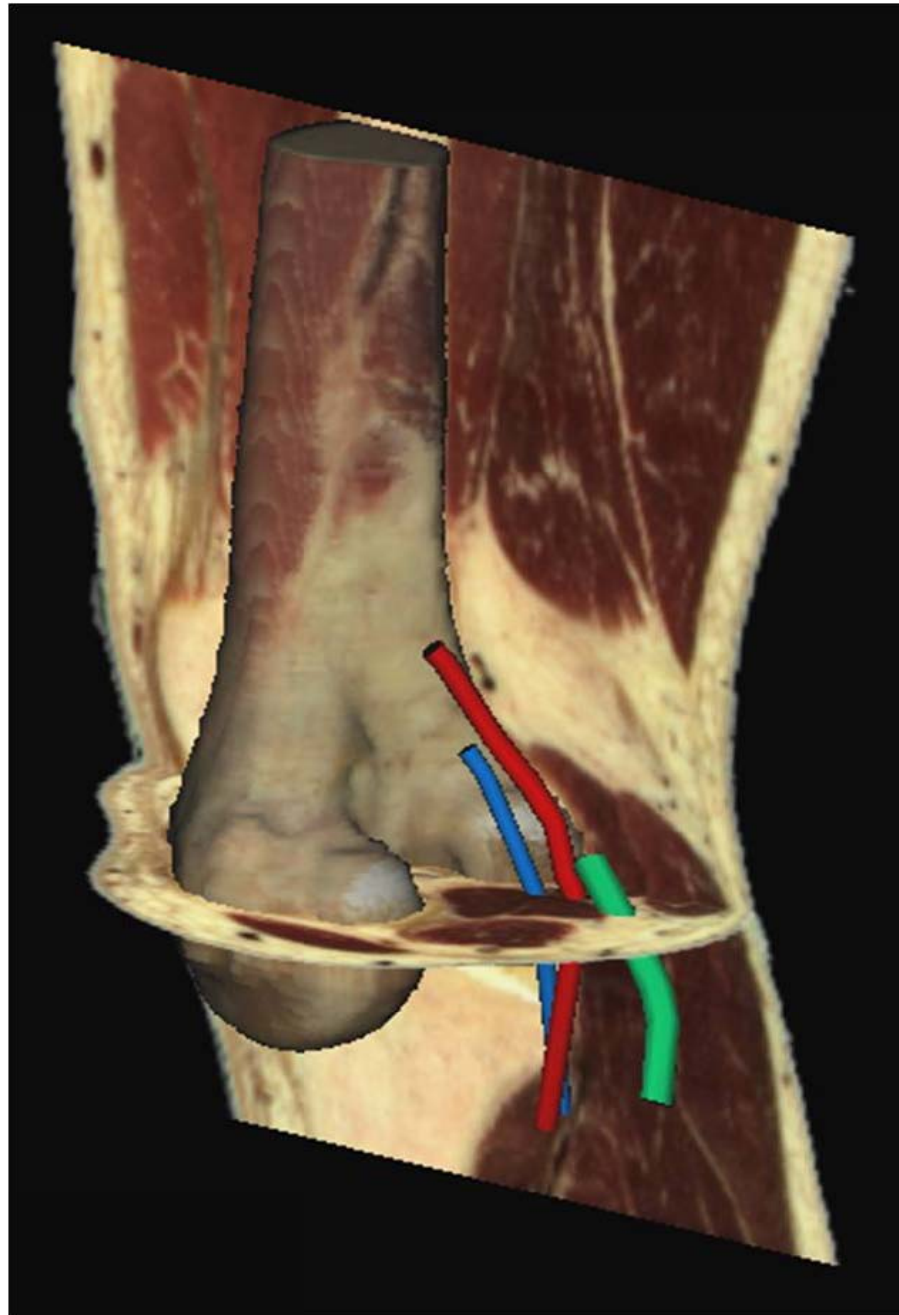


System functions for anatomy education

- The system **will show the 3D image of the organ and all the 2D image planes** that have CT and MRI images in the 3D scene.

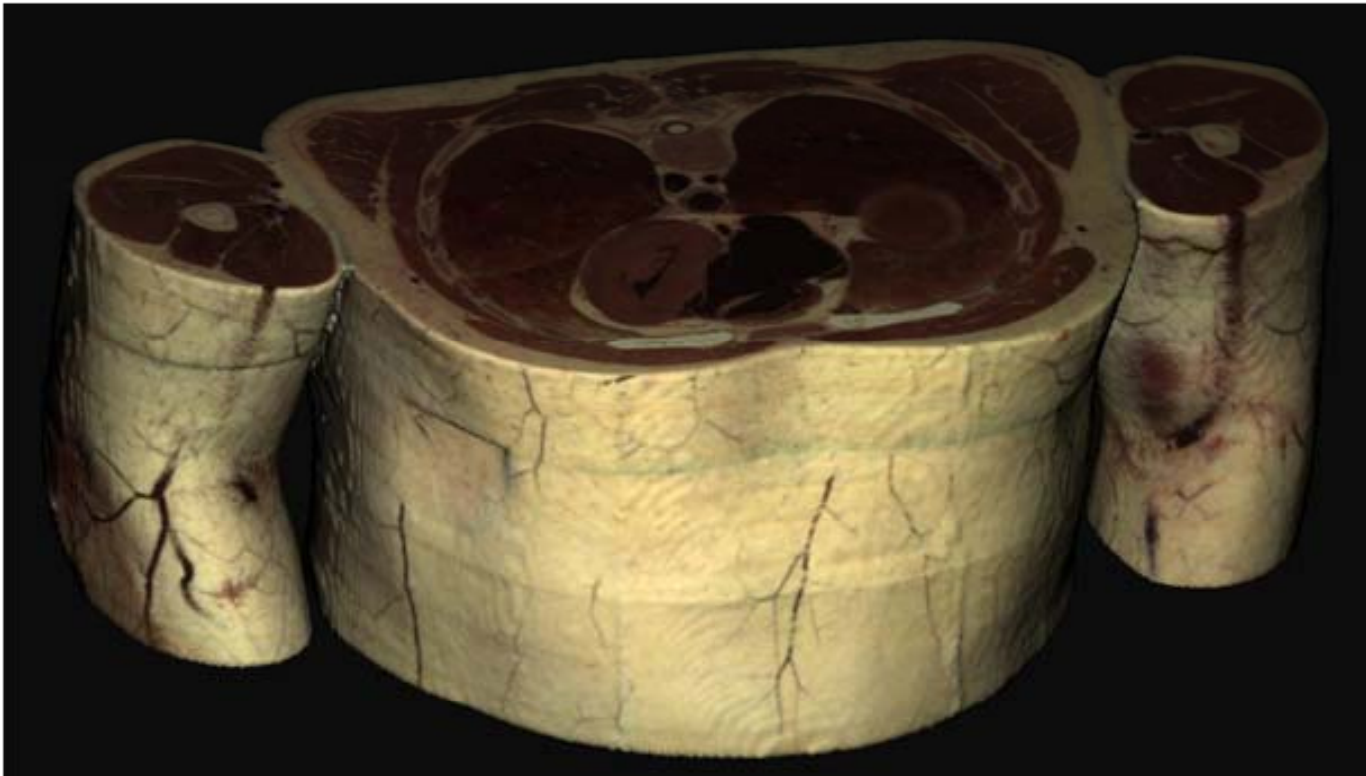






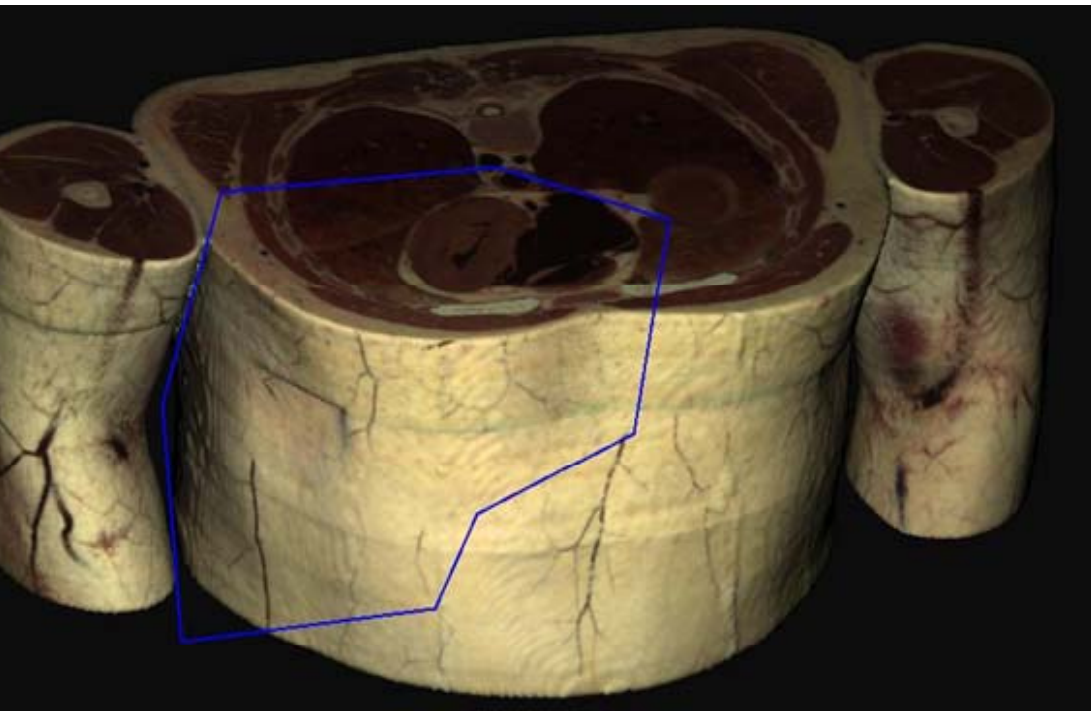
System functions for anatomy education

- Manipulation of the 3D object
 - Move, scale, and rotate the object



System functions for anatomy education

- The user can further use some tools to **manipulate** the 3D object interactively.



Cloud computing platform for education

- This kind of anatomic learning system **needs a relatively “big” hardware platform system**
 - Need at least 8G byte memory
 - Need at least 100G byte disk for storing the data
 - Need a PC level GPU to display 3D image
- It can not be used by **a mobile device.**

Cloud computing platform for education

- A cloud computing platform with a RemoteApp can be used to allow a mobile device, which is affordable for most students, to use the system.
- Currently, we are working in this direction.
 - Azure (GPU was not supported) + RemoteApp (will not be supported)
 - Azure + ZenApp essentials (in the future)
 - Simple demo.

Current status of the system

- Currently, the system has been developed **for some initial trials**.
- Both the instructors and students have found that the system indeed can **provide much more anatomical information for the students to learn** the anatomic structure and related information.
 - It is much easier for the students and instructors to share the images and discuss various problems simultaneously.
- Students can interactively manipulate the organs over and over again until they fully understand the anatomical structures.
- The system is still **under development**.