

## **Lecture Notes: Image Visualization in Medical Imaging**

### **1. Orthogonal Projection in Medical Imaging**

Orthogonal projection is one of the most important visualization methods used in medical imaging systems such as CT, MRI, and X-ray imaging. In this method, the projection lines are perpendicular to the image plane, which produces highly accurate and distortion-free images. Orthogonal projection is widely used because it helps doctors and radiologists make precise measurements and comparisons between different anatomical slices. The three major orthogonal views are axial, sagittal, and coronal views. The axial view divides the body into upper and lower sections, the sagittal view divides the body into left and right sections, and the coronal view divides the body into front and back sections. These views help doctors analyze internal body structures clearly and diagnose abnormalities such as tumors, fractures, or tissue damage. Although orthogonal projection provides accurate measurements, it does not provide depth perception, which is considered one of its main limitations.

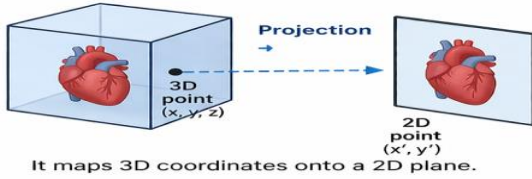
### **2. Perspective Projection in Medical Visualization**

Perspective projection is a technique used to represent three-dimensional objects on a two-dimensional display plane in a realistic manner. Unlike orthogonal projection, the projection lines converge at a single point known as the center of projection or viewpoint. This creates depth perception and allows distant objects to appear smaller while nearby objects appear larger, similar to normal human vision. Perspective projection is commonly used in advanced medical visualization systems, including virtual reality surgery simulation, 3D reconstruction of organs, medical training systems, and endoscopy applications. The technique improves understanding of spatial relationships between organs and tissues. There are three major types of perspective projection: one-point, two-point, and three-point perspective projections. These methods provide realistic visual representation, making it easier for surgeons to understand the depth and position of tumors or organs before surgery.

# PROJECTIONS IN THE MEDICAL FIELD

Projection is the process of converting 3D medical data into 2D images for viewing and analysis.

## WHAT IS PROJECTION?

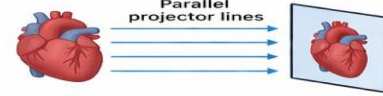


## COMPARISON

Feature	Orthogonal Projection	Perspective Projection
Projector lines	Parallel	Converging at a point
Depth perception	✗ No	✓ Yes
Size accuracy	✓ High (accurate)	✗ Less accurate (distortion)
Realism	✗ Low (flat view)	✓ High (realistic)
Main use	Diagnosis, measurements	Visualization, planning, training

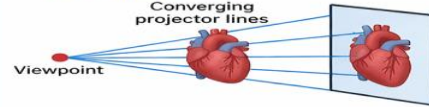
## TYPES OF PROJECTION

### 1. ORTHOGONAL PROJECTION (Parallel Projection)



- ✓ No depth perception
- ✓ True to actual size (no distortion)
- ✓ **Used in:** CT slices, X-ray imaging, measurements

### 2. PERSPECTIVE PROJECTION (Central Projection)



- ✓ Depth perception (3D effect)
- ✓ Distant objects appear smaller
- ✓ **Used in:** 3D visualization, surgical planning, VR & simulation

## APPLICATIONS IN MEDICINE

DIAGNOSIS	SURGICAL PLANNING	MEDICAL TRAINING	MONITORING & FOLLOW-UP
<p>Detecting diseases in X-ray, CT, MRI</p>	<p>Pre-operative 3D organ visualization</p>	<p>Learning anatomy through 2D/3D projections</p>	<p>Comparing images over time</p>

## 3. Medical Visualization and Projection Techniques

Medical visualization is the process of converting complex medical scan data into meaningful visual images that can be interpreted by healthcare professionals. Modern imaging modalities such as CT, MRI, ultrasound, and PET scans generate volumetric three-dimensional data. Since computer screens and medical films are two-dimensional, projection techniques are used to convert 3D anatomical information into 2D images. Projection methods help doctors visualize internal organs clearly, diagnose diseases, plan surgeries, and monitor treatment progress. Surface rendering and volume rendering are two major visualization approaches used in medical image analysis. Surface rendering displays the outer surfaces of organs, while volume rendering allows the visualization of internal structures without removing surrounding tissues. Medical visualization improves

communication between doctors and patients and supports accurate clinical decision-making.

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### **Conclusion**

Projection techniques and visualization methods are essential components of modern medical imaging systems. Orthogonal projection provides accurate and distortion-free visualization, while perspective projection offers realistic depth perception for advanced medical applications. Medical visualization supports diagnosis, treatment planning, and surgical simulation, thereby improving healthcare quality and patient outcomes.