



DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING NATIONAL INSTITUTE OF TECHNOLOGY PATNA

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CSX4159: Virtual Reality

L-T-P-Cr: 3-0-0-3

Pre-requisites: Fundamental knowledge of Computer Graphics, Visual Perception from a Computer Graphics Perspective

Course Objectives.

1. Historical and modern overviews and perspectives on virtual reality.
2. Fundamentals of sensation, perception, and perceptual training.
3. The scientific, technical, and engineering aspects of virtual reality systems.
4. Evaluation of virtual reality from the lens of design.

Learning Outcomes.

Sl. No.	Outcome	Mapping to POs
1	Identify, examine, and develop software that reflects fundamental techniques for the design and deployment of VR experiences.	PO1, PO3
2	Describe how VR systems work.	PO1, PO3
3	Choose, develop, explain, and defend the use of particular designs for VR experiences.	PO1, PO4- PO7, PO12
4	Evaluate the benefits and drawbacks of specific VR techniques on the human body.	PO4, PO5
5	Identify and examine state-of-the-art VR design problems and solutions from the industry and academia.	PO3, PO4-PO7, PO12

Module I: Introduction- Course mechanics, Goals and VR definitions; Historical perspective; Birds-eye view (general); Birds-eye view (general); Birds-eye view (hardware); Birds-eye view (software); Birds-eye view (sensation and perception)

Lectures: 5

Module II: Geometry of Virtual Worlds- Geometric modeling, Transforming models, Matrix algebra and 2D rotations, 3D rotations and yaw, pitch, and roll; 3D rotations and yaw, pitch, and roll; Axis-angle representations; Quaternions; Converting and multiplying rotations, Converting and multiplying rotations; Homogeneous transforms; The chain of viewing transforms; Eye transforms; Eye transforms; Canonical view transform; Viewport transform; Viewport transform

Lectures: 6

Module III: Light and Optics- Three interpretations of light; Refraction; Simple lenses; Diopters; Imaging properties of lenses; Lens aberrations; Optical system of eyes

Lectures: 5

Module IV: Visual Physiology- Photoreceptors; Sufficient resolution for VR; Light intensity; Eye movements; Eye movements; Eye movement issues for VR; Neuroscience of vision **Lectures: 5**

Module V: Visual Perception Depth perception; Depth perception; Motion perception; Frame rates and displays; Frame rates and displays **Lectures: 4**

Module VI: Tracking Systems Overview; Orientation tracking; Tilt drift correction; Yaw drift correction; Tracking with a camera; Perspective n-point problem; Filtering; Lighthouse approach

Lectures: 5

Module VII: Visual Rendering Visual Rendering-Overview; Visual Rendering-overview; Shading models; Rasterization; Pixel shading; VR-specific problems; Distortion shading; Post-rendering image warp **Lectures: 5**

Module VIII: Audio Physics and physiology; Auditory perception; Auditory localization; Rendering; Spatialization and display; Combining other senses **Lectures: 5**

Module IX: Interfaces

Interfaces -overview; Locomotion; Manipulation; System control; Social interaction; Evaluation of VR Systems **Lectures: 5**

References

1. Grigore C. Burdea, and Philippe Coiffet, Virtual Reality Technology: Wiley Interscience publication; 2 edition, 2010.
2. George Mather, Foundations of Sensation and Perception: Psychology Press; 2 edition, 2009.
3. Peter Shirley, Michael Ashikhmin, and Steve Marschner, Fundamentals of Computer Graphics, A K Peters/CRC Press; 3 edition, 2009.