CS 498 VR

Lecture 22 - 4/23/18

go.illinois.edu/VRlect22

Who are *you*?

Technically, a hologram in the Matrix

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Thesis research on natural environments in virtual reality for therapeutic applications

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Remember last week… ?

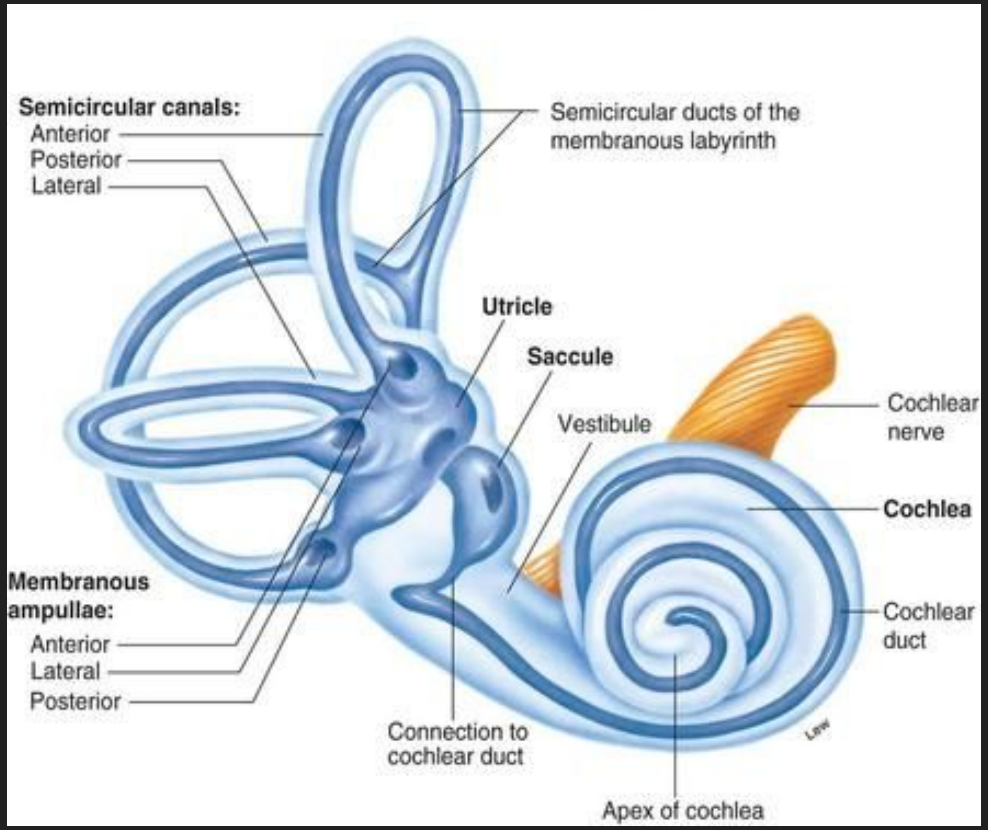
1. What type of motion does each sensor measure?
    - Odometer
    - Accelerometer
    - Gyroscope

2. What happens when sensory information from our visual and vestibular systems does not match?

Roadmap for Today

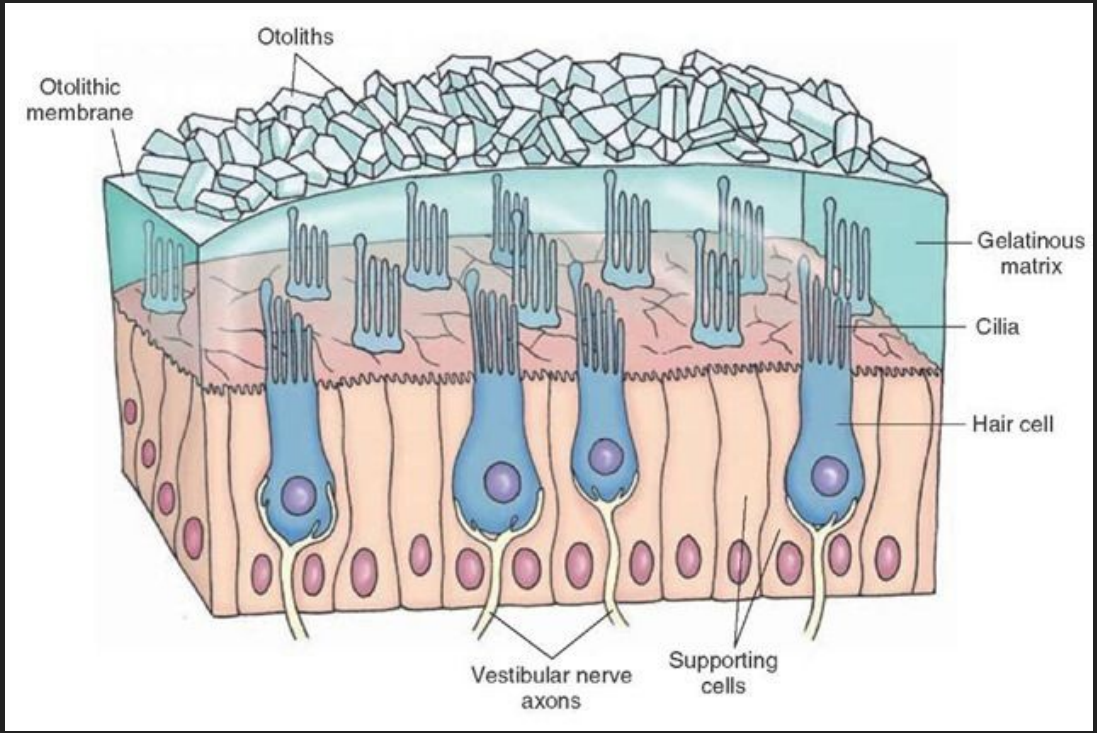
- Distinguish elements of the vestibular system & describe how they sense motion
- Define vection & identify factors that affect it
- Describe the effects of VR sickness & design virtual reality experiences for user comfort

The Vestibular System



LaValle, Ch 8.2

Otolith Organs - Linear Acceleration

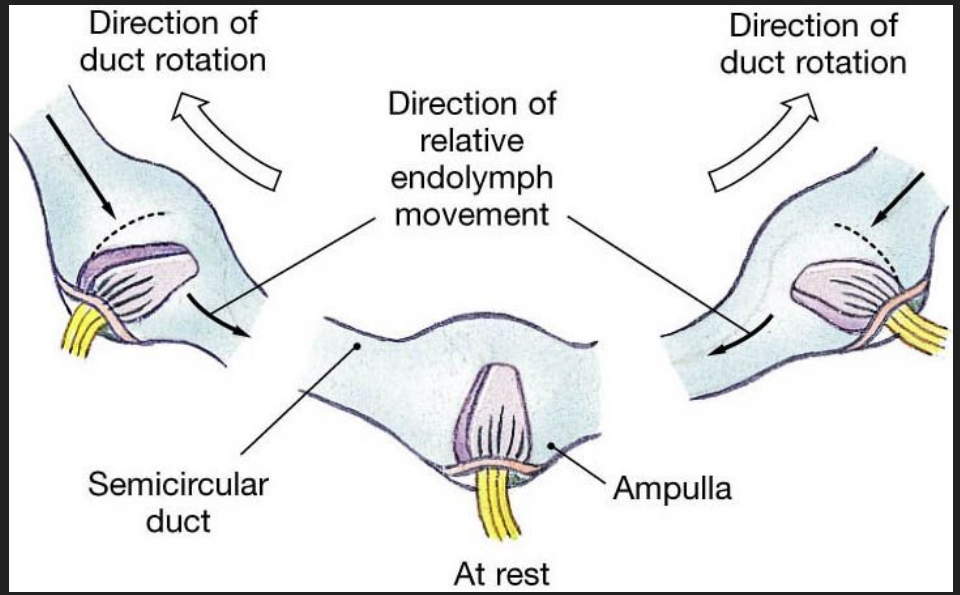


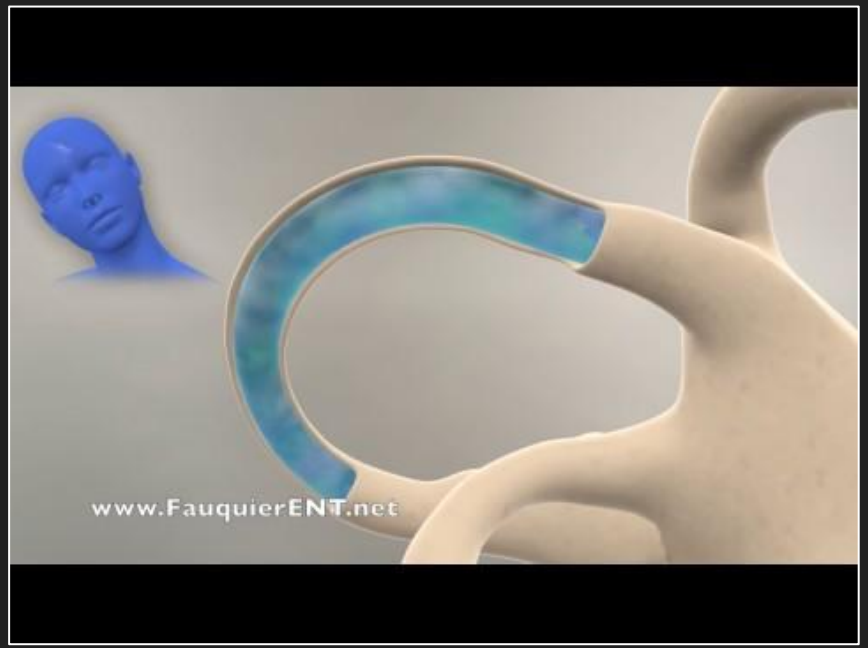
Gelatinous matrix made of cilia (hair cells) which convert acceleration into neural signals

Utricle → lateral acceleration

Saccule → vertical acceleration

Semicircular Canals - Angular Acceleration



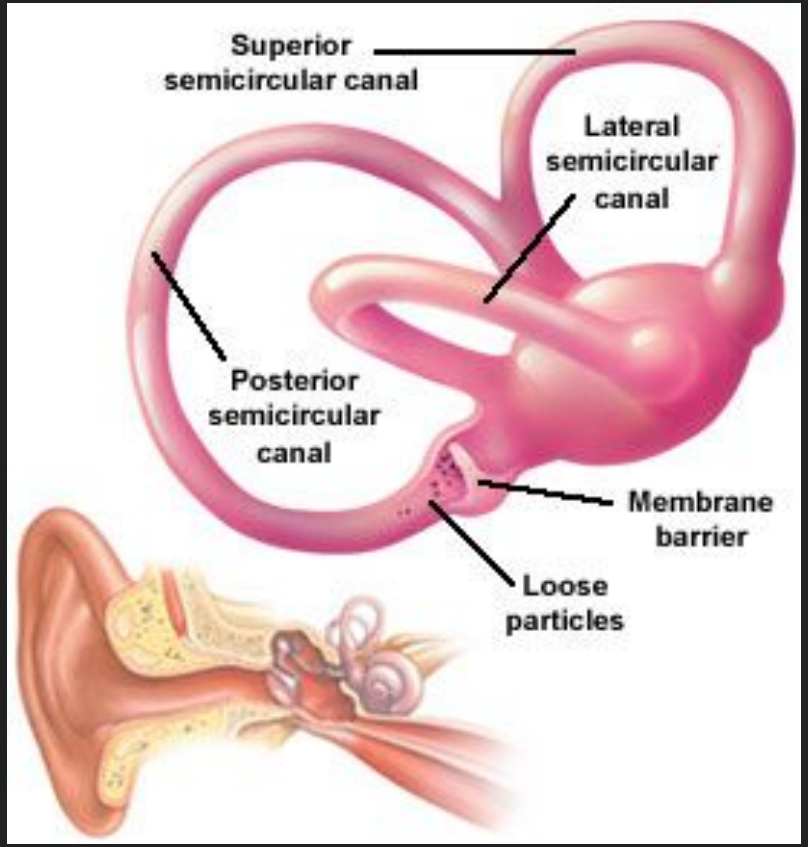


Semicircular Canals - Angular Acceleration

Anterior canal - pitch on yz plane

Lateral canal - yaw on xz plane

Posterior canal - roll on the xy plane



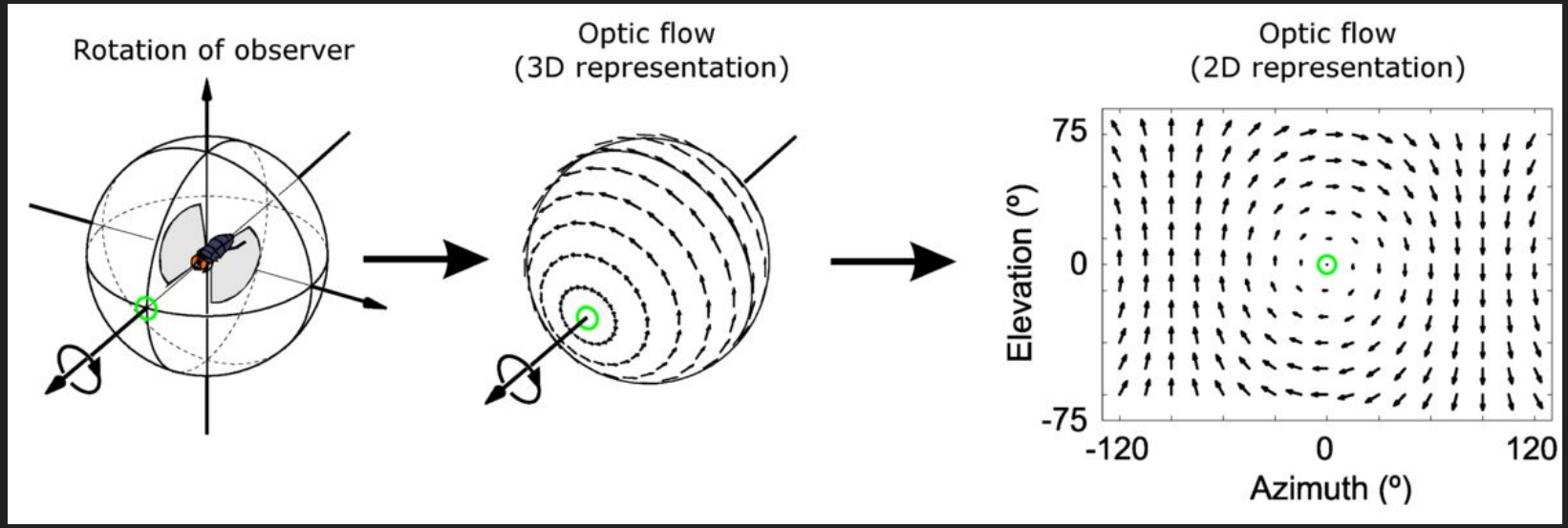
Are You Awake?

What does the vestibular system do?

What do the otolith organs measure?

What do the semicircular canals measure?

Optical Flow: Pattern of Apparent Motion of Objects

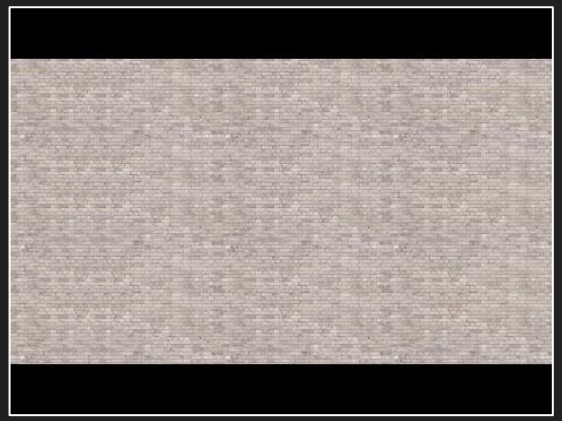


LaValle, Ch 8.4

Optical Flow: Pattern of Apparent Motion of Objects

Vection: Illusion of Self-motion

What causes vection?



LaValle Ch 2.3, 6.2 & 8.4

Object Motion vs Observer Motion

Your brain distinguishes between these two with:

- Saccadic suppression → movement of eyes can cause vection, so brain suppresses perception of motion during saccades
- Proprioception → did your eye muscles move?
- Scale → if motion in FOV is large enough, brain interprets that you are moving and the scene is stationary

Factors That Affect Vection

- Percentage of field of view - lower FOV, less likely
- Distance from center view - can be stronger in center and periphery
- Exposure time - longer the exposure, greater the effect
- Spatial frequency - more objects create stronger optical flow
- Contrast - better view of objects creates stronger optical flow
- Other sensory cues - wind blowing, sounds of objects moving past
- Prior knowledge - knowing about motion ahead of time (turn steering wheel)
- Attention - distraction can minimize perception of vection
- Adaptation - repeated, prolonged exposure

Anybody Out There?

What is vection?

What affects vection?

The Problem with Mismatched Cues from the Vestibular and Visual Senses

Don’t Get Down with This Sickness

VR Sickness (also called Simulator Sickness) causes:

- Fatigue
- Headache
- Nausea
- Dizziness
- Drowsiness
- Eyestrain
- Increased Salivation
- Cold Sweating
- Pallor
- Warmth/Flushing
- Accommodation Issues

But.. why?

- Sensory Conflict Theory - conflicting sensory stimuli create processing burden
- Forced fusion - perceptual systems must work harder to integrate mismatched information, resulting in fatigue, headache and eyestrain
- Poison hypothesis - symptoms from ingesting toxins involve conflicts of visual and vestibular systems. We become nauseated from this mismatch and vomit to remove poison from our bodies

Developer Recommendations

- Virtual Worlds - less locomotion
- Visual Rendering - avoid movement of objects in most of visual field
- Tracking - gradually reduce brightness and contrast at edge of tracked zone
- Interaction - reduce real-world motion to prevent gorilla arms
- User Interface - embed into the virtual world in natural ways
- Audio - simplify geometric models
- Self-appearance - enhanced presence from view of your body/avatar

LaValle, Ch 12.2

Another Brick in the Wall

What causes VR sickness?

What can we do about it?

Announcements

- New posts up on Piazza about second midterm, final project videos and presentations
- Read LaValle, Chapter 9