Motion sickness issues in VR content

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HMD Based 3D Content Motion Sickness Reducing Technology
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Contents

1. Tech Trends of VR content
2. Motion sickness
3. Human factor issues for VR content

1. Tech trends of VR content

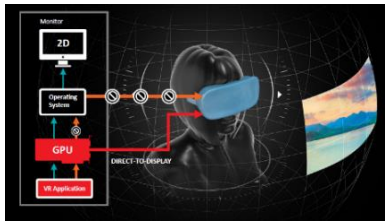
▪ VR content latency optimization

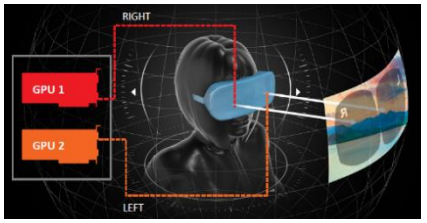
- ‘VR Works’ (NVIDIA)

Comprehensive suits of APIs, libraries, and engines for VR applications: visuals, sound, touch and simulations
Accelerates 360 video processing & supports for Immersive Displays & Clustering

- GPU Rendering Optimization: ‘LiquidVR’ (AMD)

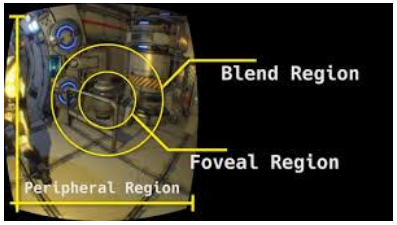
Asynchronous time warping (> 60 Hz)
Parallel processing for left & right eye image rendering

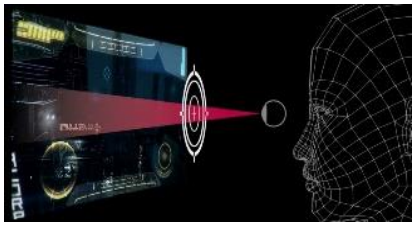




- Foveated Rendering (SMI, NVIDIA)

Eye tracking based rendering optimization for VR headset
Gaze information with HTC Vive at 250 Hz, Samsung Gear VR at 60 Hz, Oculus Rift DK2 at 60 Hz





1. Tech trends of VR content

▪ VR content latency optimization

- Virtual Nose (Purdue Univ.)

Place a virtual nose(visual reference) in the lower center of a simulation ⇒ gives a stabilization effect

- Dynamic FoV Modification (Columbia Univ.)

Artificially adjust the cFoV(camera field of view) while moving

- Best Practice (Oculus 2016)

Qualitative guidelines for VR applications development

– CG rendering, latency, movement velocity/acceleration, depth/FoV control, scaling, GUI, etc

1. Tech trends of VR content

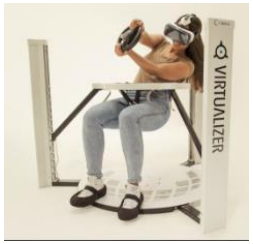
▪ Visual-Motion synchronization

- **ZERO Latency (Australia)**

Allows users to move freely in an open space ⇒ physical movements to be replicated by their in-game avatars 128 optical cameras tracks physical locations of up to 7 players in the game space of 400 m², Personal backpacking of PC

- **Virtualizer (Cyberith)**

Full Virtualizer H/W, S/W and Dev kit, testing and demo app.
Virtualizer control panel for MS Windows
Plug-ins for Unity 3D and Unreal Engine



- **GVS System(Mayo Clinic 2016)**

Apply electric current to the human vestibular organs for mimicking the stimulation needed for synchronizing the VR and user's motion
⇒ two receptors are stimulated : semi-circular canals, otolith organs
Adequate amount of current at the right timing is very tricky

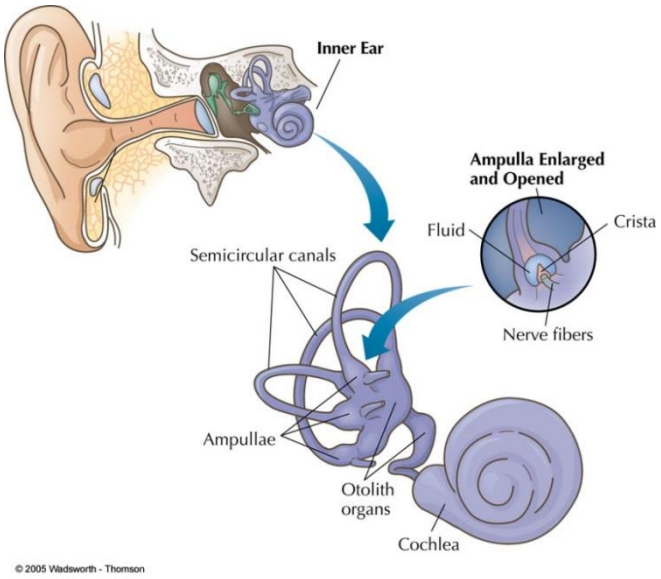
GVS (Galvanic Vestibular Stimulation)

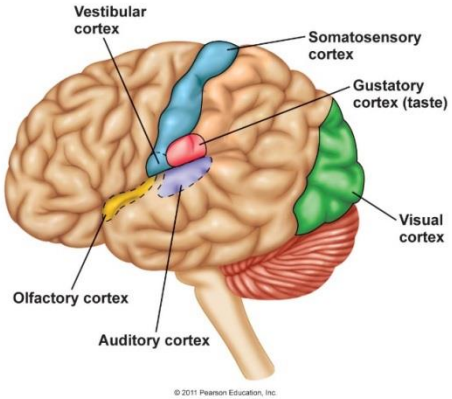
2. Motion sickness

- **Sensory Conflict Theory** (J. T. Reason & J. J. Brand, 1975)

  - VR sickness is directly related to vestibular system

  - VR sickness originates from conflicting sensory input(vestibular, visual and proprioceptive) ⇒ Motion sickness occurs because vestibular system sensations does not match sensations from the eyes and body





<The vestibular system>

2. Motion sickness

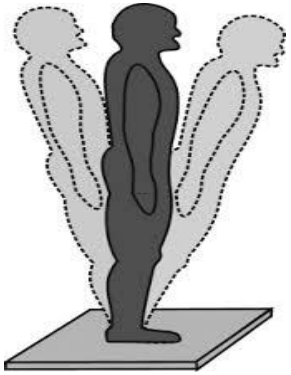
- **The Postural Instability Theory** (Riccio & Stoffregen, 1991)

  - One of the primary behavioral goals in humans is to maintain postural stability in the environment

  - Motion sickness is a prolonged postural instability

  - Motion sickness occurs in situations where the individuals does not possess or has not yet learned the control strategies for maintaining postural stability

    ⇒ People tends to get accustomed to VR sickness as they become frequently exposed to VR experiences



<**postural stability**>
the state in which uncontrolled movements of the perception & action systems are minimized

3. Human factors for VR content

- **Human factor design issues**

  - **Each symptom may have many possible causes**

    - some of them may be known, while others are not

    - dependency on hardware and/or particular content

  - **Variation among users to VR sickness susceptibility**

    - gender, age, ethnic background, prior experience

  - **Controlling the level of VR sickness experienced by the user**

    - Perform both SSQ(Simulation Sickness Questionnaire) and clinical (physiological) test

    - Do some mathematical analysis (via statistics or machine learning) to determine the quantified relationship between the causes and VR sickness symptoms

3. Human factors for VR content

- **Human factor R&D issues**
  - **Verifying the causes of VR sickness**
  - **Modeling the VR human factors**
    - Content-related
    - VR device-related
    - User-related
  - **Extracting the parameters of VR human factors**
    - Monitoring and Controlling of VR paras
  - **Deploying safe VR content**
    - VR human factor API
    - Reference content
    - Best practice of VR content

Conclusions

- **VR tech trends on VR HMD content with motion sickness**
- **The causes of motion sickness in VR HMD environments**
- **Developing issues of VR Human factors for reducing motion sickness**

Thanks for your attention!

Q & A