CMSC 498W Lecture 6
"Human Perception and VR Pipeline"
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Humans have a variety of different senses for receiving information about the outside world. (There are also several senses related to the internal function of the body, but we will not go into those.) The traditional five are:

- Sight
- Hearing
- Taste
- Smell
- Touch

However, there are several others:

- Temperature
- Pain
- Kinesthetic
- Acceleration

Several of these others (Kinesthetic and Acceleration) are particularly important for VR.

The simulation of the senses that are present in the skin (Touch, Temperature, and Pain) is sometimes referred to as Haptics, which comes from the Greek word for "touch".

VR worlds generally do not simulate all human senses. This produces mismatches between the information being received from from some senses and the information being received from others. Depending on the senses involved, this mismatch can produce effects ranging from a loss of immersion to physical sickness.

In rough order from least to most important, here is what has been done to incorporate these senses into VR.

Taste

This is a sense of chemical identity. Human tongues have receptors for five basic tastes, sweet, sour, salty, bitter, and umami (meaty). There has been some early work in incorporating taste into VR. One project, presented at the 2003 SIGGRAPH conference [1], uses a device that squirts substances into the user's mouth corresponding to the basic tastes. The device also uses haptic feedback to mimic the texture of food when bitten, contains a speaker to provide the sound of biting, and can emit scented vapors.

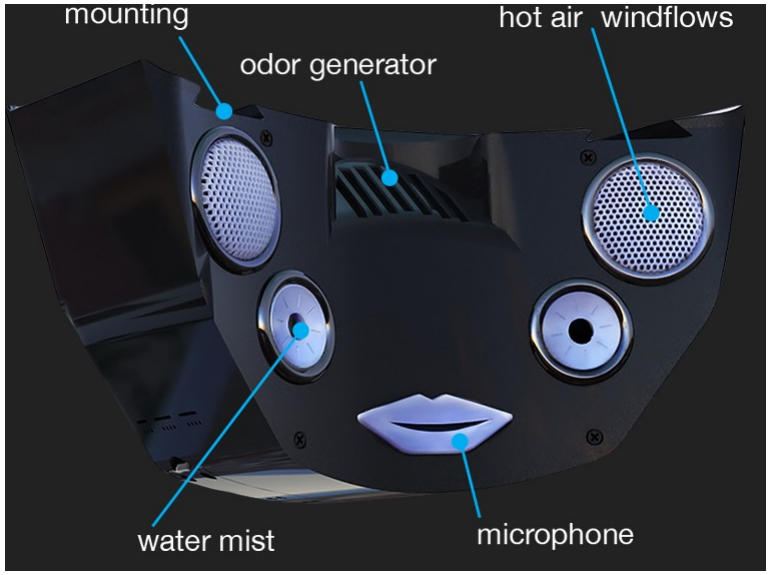
http://new.siggraph.org/s2003/conference/etech/food.html

Another project uses electric signals on the tongue to trigger sensations of taste [2].

http://www.nimesha.info/digitaltaste.html

Smell

Like taste, smell is also a sense of chemical identity. However, unlike taste, there are not a small number of basic scents. There have some attempts to incorporate the sense of smell into VR by using small sets of pre-made scents. The Feel Real device [3] can be loaded with seven scent cartridges, which can be chosen based on the content being viewed. The device also incorporates other senses through the use of hot and cold wind, water mist, and vibration.



http://vrworld.com/2015/03/11/feelreal-brings-sense-of-smell-to-virtual-reality/

Pain

There is not likely to be much desire for the sense of pain in entertainment VR since pain, in general, is not enjoyable. However, is may be desirable in non-entertainment applications; for example, if a user is being trained to perform some dangerous task, it might be desirable for the user to feel pain if they do something that would cause them to become injured if they were to do it in reality.

That being said, there have been some attempts to incorporate pain into entertainment VR. One example is the Legshocker [4], a device which is worn on the shin and can hammer the user with a “small, metallic button”, providing both Pain and Touch. This device is used during virtual soccer games to simulate being fouled.

Legshocker [4]

Temperature, Touch

These will be covered in the “Haptics Rendering” lecture.

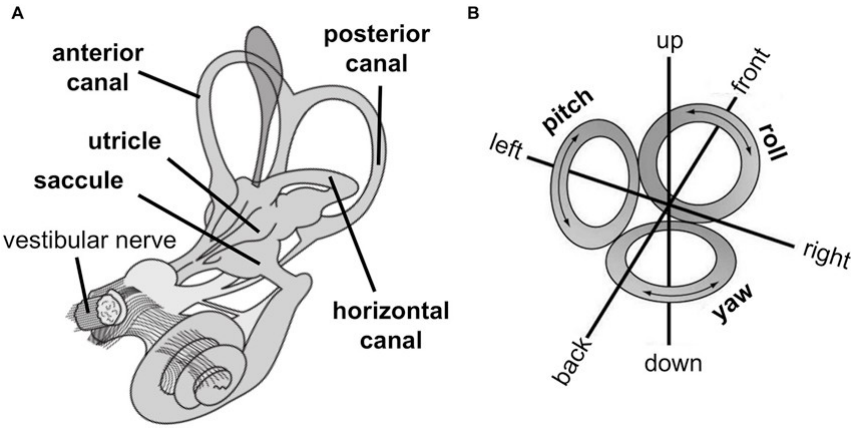
Kinesthetic

This sense tells us where our body is in space based on information such as joint angles. (Our brain can also perform the inverse process to determine what joint angles are necessary to position our body in a certain position in space.) This is the sense that is tested in field sobriety tests where the subject is asked to touch their finger to their nose with their eyes closed.

This will be covered in the “User Interaction” lecture.

Acceleration

This is sometimes referred to as the sense of Balance. In humans, the Vestibular system, located in the inner ear, detects rotational and linear accelerations. Since the force of gravity produces a linear acceleration, this sense can be used to tell which way down is.



Vestibular System [5]

The sense of rotational acceleration can be partially provided by having a user actually turn their head to rotate their view. Full sense of rotational and linear acceleration could be provided in limited circumstances by having the user actually move around in an environment. In more extreme circumstances, acceleration could be provided by placing the user in a cockpit that could be inverted, or in a centrifuge.

https://www.flickr.com/photos/superjetinternational/5997843034/

http://www.wyle.com/content/CapabilityB.aspx?Human+Centrifuge

Hearing

This will be covered in the “Aural Rendering” lecture.

Sight

This will be covered in the “Stereoscopic Displays” lecture.

The Oculus Best Practices Guide contains a section on Simulator Sickness [6], which is a general term referring to “symptoms of discomfort that arise from using simulated environments”. A large component of this is caused by a mismatch between the information being provided to the brain by different senses. Oculus identifies the Sight, Kinesthetic, and Acceleration senses as the primary culprits.

This sensory mismatch can occur in several different ways.

1. Certain senses may simply not be simulated.
2. Two senses may both be simulated, but not be in sync. For example, if graphical rendering lag causes a visual scene to be updated after a user turns their head, the user will first experience a change in Acceleration without a change in Sight, and then vice versa.
3. Sub-parts of a sense may not match. For example, in the sense of Sight, binocular convergence may not match with lens accommodation.

Simulator Sickness may be combated by reducing the amount of mismatches that occur. For example, if a part of the Acceleration sense is not being simulated, the developers could minimize the amount of those accelerations that occur in their program.

[1] http://new.siggraph.org/s2003/conference/etech/food.html
[2] http://www.nimesha.info/
[3] http://feelreal.com/
[4] “Games of Pain: Pain as Haptic Stimulation in Computer-Game–Based Media Art”. Pau Waelder Laso. Leonardo, Volume 40, Number 3, June 2007, pp. 238-242
[5] “The vestibular system: a spatial reference for bodily self-consciousness”. Pfeiffer et al. Front. Integr. Neurosci., 17 April 2014 | http://dx.doi.org/10.3389/fnint.2014.00031
[6] https://developer.oculus.com/documentation/intro-vr/latest/concepts/bp_app_simulator_sickness/