CMSC 498W Lecture 16
"Haptics Rendering"
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"Haptics" comes from the Greek word for "touch". The term is not strictly defined, but it generally refers to the senses that provide information about things which are adjacent to the body. Note that this generally includes more senses than just the sense of Touch, such as Temperature and Pain.

Just as your eyes contain multiple different types of receptors for sight (red, green, and blue cones and rods) and your tongue contains different receptors for taste (sweet, sour, salty, bitter, and umami), your skin contains different types of receptors for touch (in general, pressure, vibration, and stretching). In current-generation technology, vibration seems to be the most common form of haptic feedback.

Since most of our Haptic senses are present over wide areas of bodies, fully incorporating the Haptic senses into a VR experience could require some sort of full-body suit, which could be inconvenient for the user. Hand-held devices are more convenient, but offer only a limited region of sensation.

In addition to vibrating hand-help controllers, once type of hand-held haptics device is a force-feedback pen such as the Geomagic Touch [1,2]. A force-feedback device such as this can block the motion of the user's hand, providing the Touch sense of pressure as well as the Kinesthetic sense. (Vibration could also be provided.)

Another type of haptic device is a wearable suit, such as the one by Elitac [3,4]. This suit consists of an array of vibrators placed over various points on the body. Although it can produce haptic sensations over a large area, it only supports vibrations, and any area that can receive the sensations must be covered by the suit.

Wearable haptic devices, such as suits and gloves, can also use motors to provide force-feedback. This allows them to provide pressure and Kinesthetic sense.

A third type of device, such as developed by Ultrahaptics [5], uses convergent sound waves to apply forces to a user. This device has the potential to provide the sense of Touch over a wide area of the user's body without the inconvenience of a suite. However, it cannot stop the user's motion and so cannot provide the Kinesthetic sense.

"Rendering" refers to the process of converting a computer model of the world into a human-perceivable form. Just as graphics and audio are rendered, haptic feedback is also rendered. While graphics is generally thought to need a rendering rate of about 60 Hz to appear realistic, haptics is generally thought to need a much higher rate, around 1 kHz. The actual rate required for artifact-free rendering depends on the surface, with softer surfaces requiring lower rates and stiffer surfaces requiring higher. If the rate is too low, it can result in vibrating or "buzzing" effect.

[1] http://www.geomagic.com/en/products/phantom-omni/overview
[2] https://www.assetstore.unity3d.com/en/#!/content/34393
[3] http://www.elitac.nl/tactile-sdk/
[4] https://www.assetstore.unity3d.com/en/#!/content/36509
[5] http://ultrahaptics.com/