Engineering Acoustics, Inc.

# Physiology of Haptic Perception

EAI developed Tactors to exploit the sensitivity of the body's largest organ, the skin, for communication of information. The sense of touch is often overlooked as a method of communication, particularly when considering man-machine interfaces such as conveying information from aircraft and automotive instrumentation. Significant research has been performed in the area of tactile sensory perception, and in recent years, Government funded programs have helped to advance the state-of-the-art in technology as well as enhancing the understanding of human tactile response.

The field of tactile response is formally known as Haptics, from the Greek word haptesthai, meaning to touch. How the body "feels" and interprets physical sensations is much more complex than might be imagined from casual experience. The skin (and muscles) contain a variety of sensory organs called receptors. These are grouped by type and include Mechanoreceptors (sensitive to pressure, vibration and slip), Thermoreceptors (sensitive to changes in temperature), and Nocioreceptors (responsible for pain). These functional groups are composed of specialized receptors which include free receptors (nerve endings), Meissner corpuscles, Merkel's disks, Pacinian corpuscles, and Ruffini corpuscles.

- Ruffini corpuscles are Thermoreceptors, aiding in the detection of temperature changes. These are categorized as SA (slowly adapting) receptors.

- Merkel receptors are disk shaped organs that respond best to pressure, but also to low frequency (0.3-3 Hz) vibratory input.. Although Merkel receptors are distributed with about 25% coverage, they are categorized as SA (slow adapting) receptors which adapt slowly to stimulus (continue to transmit when subjected to constant pressure). Tactile input systems, by necessity, are in constant contact with the skin and are not well suited for stimulation of SA type receptors.

- Meissner corpuscles are a stack of flattened cells with nerve fibers. They comprise over 40% of the tactile receptors in the hand, located just below the epidermis. Meissner corpuscles function primarily as velocity detectors in the frequency range of 3-40 Hz providing feedback for the grip and grasping function. These receptors require a minimum force for meaningful reception. Meissner corpusles are categorized as RA (rapid adapting) receptors. Some studies are underway using EAI low frequency Tactors to explore communication efficacy using Meissner corpuscles.

- The Pacinian corpuscles are the largest of the skin receptors. These are located deeper in the skin, with about a 13% coverage. The Pacinian corpuscles are most sensitive in the frequency range of 200Hz -350 Hz. These serve as acceleration detectors and vibration sensors. Pacinian corpuscles are categorized as RA (rapid adapting) receptors, which means the effect of stimuli decays rapidly after onset. Pacinian corpuscle discharge only once per stimulus application, hence are not sensitive to constant pressure. EAI's standard Tactor systems are designed to exploit the characteristics of Pacinian corpuscles.

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