

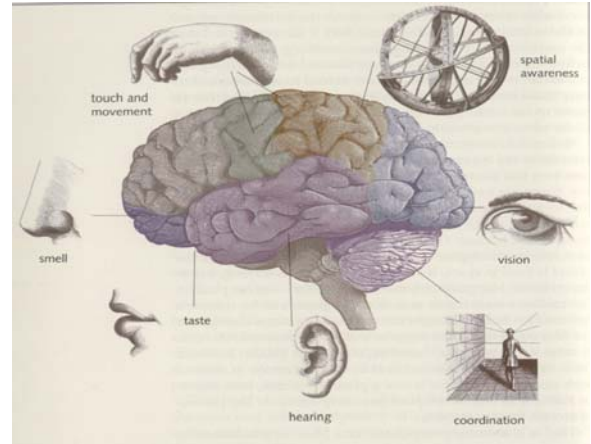
How can vibro-tactile sensations be presented to various body areas in order to enhance sensory information in everyday product ?

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Introduction

The concept of augmented cognition emerges from the observation that human cognitive mechanisms are often the bottlenecks of the information processing performed by person-machine systems during complex tasks. The goal is therefore to extend human capabilities by means of technologies which overcome human cognitive limitations and using either single or multi-modal sensory systems to help with the acquisition of stimuli information.



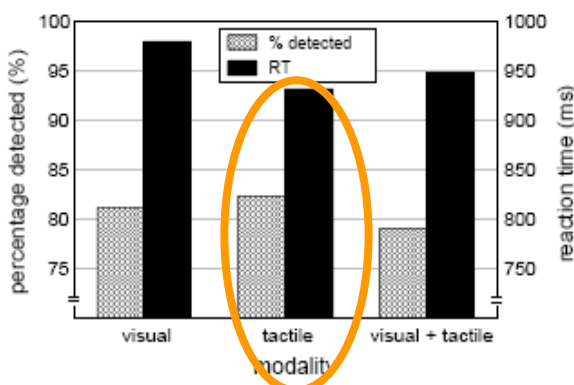
The use of the sense of touch can be useful when the visual and auditory modality are heavily loaded or degraded (1). Such systems convey information as a feedback to the user’s skin so as to enhance human sensory modalities.

Vibrotactile feedback system can communicate information through physical contact with the user’s skin. Such systems integrate sensors and actuators, signal processing algorithms and human perceptual characteristics so as to optimise the human detection and awareness by modifying the vibration stimuli.

An area of application for the vibro-tactile technology is in the field of vehicle feedback for active safety and support systems in the aviation and automotive industry.



Figure 1 - Examples of vibro-tactile feedback enhancement systems through physical contact with the user’s skin.



Enhancing tactile perception can greatly facilitate the user’s task of identifying the occurrence of a dangerous condition avoiding negative effects on performance. Tactile cues are found to be more effective than visual cues for indicating unexpected changes (1).

Figure 2 - Effects of modality on the performance in the detection task (Erp and Veen, 2004).

Inevitable failure of encoding vibro-tactile information is owned by level of incompatibility between the human skin and the physical interface properties. Encoding tactile information in human-machine interfaces not only involve the detection of the stimulus but also discriminability between them. Two primary parameters of the stimuli acting on the skin are studied in relation to vibro-tactile interfaces (2):

- frequency of the stimuli should match to that of the skin.
- amplitude of the stimuli should match to that of the skin.

Objectives

Research has been performed to quantify the effect of vibration frequency and amplitude on the human perception of the hand-arm vibration intensity. Several psychophysical test protocols are employed including paired-comparison and Borg CR10 Scale procedures in order to quantify the subjective perceived intensity of the hand-arm vibration stimuli. The objective was to establish a family of equal sensation curves for different perceived intensity of steering wheel rotational vibration with the aim of establishing a library of perceived vibration features which occur in road vehicles which can help in the process of understanding of what information they individually, or collectively, provide to the driver.

Discussion

The family of equal sensation curves obtained in this study suggest a non-linear dependency of the subjective perceived intensity on both the hand-arm vibration frequency and magnitude. The current results suggest the hypothesis that different vibration perception weightings are required for different amplitude ranges of steering wheel hand-arm rotational vibration. Frequency weightings for the human hand are proposed for converting measured vibration stimuli into perceived vibration stimuli so as to assist the engineering evaluation of vibro-tactile interfaces.

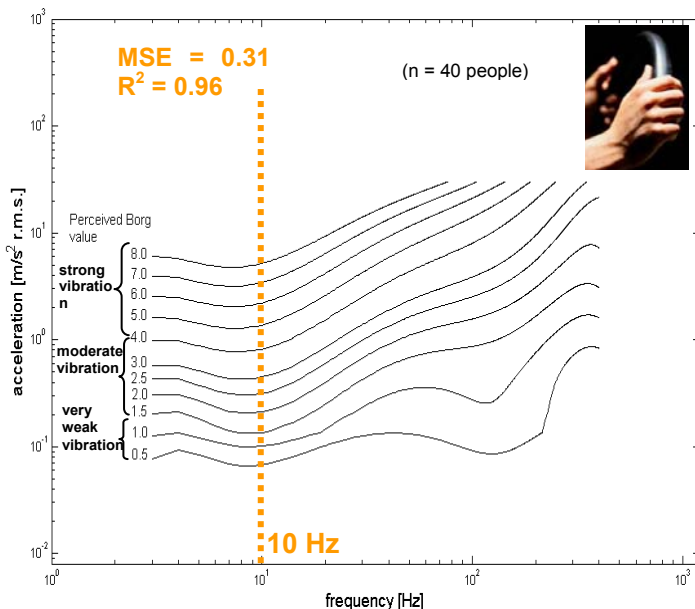


Figure 3 - Mean equal sensation curves for the hand-arm system vibration perception obtained for Borg subjective perceived intensity values from 0.5 to 8.0 using 40 people.

Results suggest that glabrous (non-hairy) skin is more sensitive to vibration between 10 and 250 Hz and that human subjective response to hand-arm vibration decreases with increasing frequency. Lowest thresholds are found with frequencies between 200 – 250 Hz.

For the manufacturers of automotive steering systems, of game controllers and of other tactile interfaces this study provides vibration perception curves from which one or more frequency weightings for different amplitude ranges of the hand-arm vibration are derived.

References

1. **Erp and Veen** (2004), Vibrotactile in-vehicle navigation system. Transportation Research Part F 7, pp 247–256
2. **Ajovalasit, M., Giacomini, J.**, 2009, Non-linear dependency of the subjective perceived intensity of steering wheel rotational vibration, International Journal of Industrial Ergonomics, Issue 1, pp 58-67.