A multi-level haptic rendering concept

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Abstract. This paper describes a multilevel bandwidth haptic display devoted to fundamental studies on tactile and kinesthetic interaction. The proposed concept is an alternative design based on a multistage display that combines several actuation technologies in order to reproduce stable and "factual" haptic sensation for a truthful sense of presence. Each layer concerns a specific bandwidth that is to be determined according to the dedicated technology and the psychophysical data.

1 Introduction

The emerging of human-centered systems in information and human science technology reveals the necessity to consider sensory resources other than the visual one. Namely, the haptic sense is of prime importance in any process involving manipulation and physical interaction. The word *haptic* is known to designate a combination of tactile and kinesthetic modalities. The tactile sense brings awareness of a given stimulus over the human skin by means of nerve endings found in different skin levels at different densities and distributions. The kinesthetic sense provides information in regard to limbs' position and displacement thanks to different mechanoreceptors found in the muscles, joints and the skin!

Following the example of vision and 3D sound, our aim is to conceive haptic interfaces capable to convey remote haptic information originated from telerobots, teleworking systems, or virtual/augmented reality environments. The difficulty of conceiving haptic interfaces comes from the very fact that cues stimuli are subsequent to a physical interaction through direct *taction*. The haptic perception is extremely associated with the human motor functions. This is different from vision or 3D sound for which the information sampling does not alter its physical support. Many existing devices are labeled as haptic interfaces. In fact, most of them are either pure kinesthetic devices or pure "tactile" displays.

Kinesthetic or force devices come mainly from the telerobotics technology [1]. These devices seem to have reached a *standard design* carried on by existing commercial devices such as the PHANToM (www.sensable.com), the OMEGA (www.forcedimension.com) and the application specific devices such as force feedback medical training devices, steering wheels... Tactile or touch feedback