Detection of Torque Vibrations Transmitted Through a Passively-Held Rotary Switch

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Abstract. This study is part of an ongoing research program aimed at understanding how humans perceive the properties and qualities of everyday objects such as rotary switches. This article reports our measurement of detection thresholds for torque vibrations transmitted through a passively-held rotary switch. We show that the torque thresholds are very similar to published displacement thresholds in that both types of threshold vs. frequency curves are U-shaped and both reach a minimum around 100-300 Hz. As far as we are aware, this is likely the first report of detection thresholds for sinusoidal torque vibrations.

1 Introduction

One of the most basic studies in sensory performance is that of detection thresholds. The term "detection threshold" (or "absolute threshold") is defined as the "smallest amount of stimulus energy necessary to produce a sensation" ([1], p.1). In haptics research, the detection thresholds for the somatosensory system have been well characterized in terms of the smallest perceivable amplitude of sinusoidal movements over the frequency range 0.4–600 Hz [2, 3]. These studies typically involved placing a body site (e.g., the fingertip) in contact with a minishaker with calibrated sinusoidal movement amplitudes. Rigid surround was sometimes used to restrict the area of haptic stimulation. The experiments were typically conducted in a sound-proof and vibration-proof environment. Although the results such as those in [2] have been extremely useful in assessing the perceived intensity of vibrotactile stimuli, they do not generalize well to situations involving the use of tools and everyday objects. This is because that detection thresholds are known to vary substantially when conditions such as contact area and body site change [4]. A recent study examined the detection thresholds for vibrations transmitted through a tool held in the palm of the hand [3]. Thresholds were found to be lower than those reported earlier in the literature. The higher sensitivity was attributed to the larger contact area between the tool and the skin of the palm, the direction of vibration (parallel as supposed to perpendicular to the skin surface), and the stimulation site (palm was found to be more sensitive to lateral vibration than fingerpads). The study underscores the need for additional studies to assess detection thresholds associated with everyday tools.