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EXPERIMENTAL ANALYSIS OF MODE SWITCHING TECHNIQUES IN PEN-BASED USER INTERFACES

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Abstract. *Mode switching is essential in pen-based systems, especially for multi-mode pen-based operations. In this study, we designed three pen suitable mode switching techniques (i.e.* Pressure*,* Tilt *and* Azimuth Mode Switch*), which utilize multiple pen parameters for pen input, and compared them with three traditional switching modes (i.e.* Timeout*,* Non-Preferred Hand *and* Barrel Button Mode Switch*). The results indicated that the techniques utilizing tilt angle and azimuth offered faster performance than the others.*

Keywords: Human-computer interaction, Pen interfaces, Mode switching, Pressure, Tilt, Azimuth

1. **Introduction.** In pen based interfaces, fluid and continuous interaction is a very important feature [7]. How to switch smoothly between different operation modes (e.g. ink and gesture) is an open question. For pen-based UI designers, especially for those who are seeking fluid multi-mode operations in pen-based interfaces, it is necessary to select a suitable mode switching technique for the UI design.

Mode switching techniques are used widely on some pen-based devices, e.g. PDAs and Tablet PCs. Up to now, some mode switching techniques have been proposed by researchers, such as *Non-Preferred Hand* [12] and *Barrel Button Mode Switch* [5]. However, current switching techniques usually impose intervals (called *switching intervals* hereafter) on operational sequences, e.g. *Timeout* imposes an extra time interval on operational sequences while *Non-Preferred Hand* and *Barrel Button Mode Switch* impose not only time but also space intervals on operational sequences. The intervals not only take extra operational time but also distract the user's attention from the targets. Therefore, our basic motivation is to explore some *pen-tip-originated* mode switching techniques, which allow fluid and continuous switch by eliminating or reducing *switching intervals*.

Fortunately, electronic pens commonly possess multiple input parameters (e.g. stroke, pressure, azimuth and tilt angles). However there is no study which comprehensively compares different mode switching techniques with multiple pen input parameters. Thus, this study comprehensively investigates mode switching techniques that utilize pen input parameters, so as to obtain some UI design guidelines for pen-based UI designers. Three *pen-tip-originated* mode switching techniques (i.e. *Pressure*, *Tilt* and *Azimuth Mode Switches*) have been designed for fluid pen-based operations. To perform these mode switching techniques, the pen tip does not need to be moved away from the targets, and no space interval is needed. The key feature of *pen-tip-originated* mode switching is that it has the potential to make pen-based operations much more fluid.