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# Identifying Finger Postures when Interacting with the Touch Screen of Mobile Devices

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## ABSTRACT

This study presents the results of preliminary test on the interaction between fingertip and touch screen. The objective of this study is to identify the fingertip posture when interacting with touch screen devices. Ten participants, 7 males and 3 females, participated in this study. The participants were asked to touch targets on the mobile devices screen by tapping them sequentially and connecting them. The participants performed the tasks in a sitting posture. A tablet with 10 inches screen and a mobile phone with 4 inches screen were used in the study. The results showed that all participants dominantly used their thumb to interact with the mobile phone in single and two hands postures. The common thumb posture adopted by the participants is the combination of the 60° pitch and 0° roll angles. While for interaction with tablet in various postures observed in the study, the participants commonly used their index fingers in the combination of 60° pitch and 0° roll angles. This study also observed the participant with long finger nails touched targets on the mobile devices screen by using her index or middle fingers very low pitch.

**Keywords:** finger posture, touch screen, single-handed interaction, mobile phone, tablet

## 1. INTRODUCTION

People can use their mobile devices everywhere in various postures. A field study by Karlson et al. (2006) observed travellers used their single-handed mobile devices at an airport in walking, standing and sitting posture. A larger survey done by Hooper (2013) showed that people use their mobile devices when they are standing, walking, sitting, and riding a public transportation, such as bus or train. Hooper (2013) observed how people hold their mobile devices at common places, such as university, park, office, public transport, and shopping centre. The largest device that Hooper (2013) recorded in his data set was the Samsung Galaxy Note 2. Meanwhile, Karlson et al. (2006) observed the users of mobile phone, Blackberry and PDA. There were two types of mobile phone recorded in the study, the candy bar and the flip type. From these surveys we can conclude that people grasp their mobile devices in many postures, such as single hand, two hands, and cradle. Additionally, people can also use their mobile devices in a flat and tilt posture on the table, especially if they were using tablets.

It should be noted that people hold their devices in various postures at a time. They change the way to use their mobile device very often. We can see people change their hand postures easily when interacting with their mobile devices. Hooper (2013) stated that he repeatedly found individuals using one hand at initial time, and then using their other hand for other additional activity, then changing to cradle posture, and then going back to the initial posture. In accordance with the statement of Hooper (2013), a study on the use of two thumbs, one thumb and one finger by Azenkot and Zhai (2012) showed that all participants used at least two methods. Hooper (2013) and Azenkot and Zhai (2012) also obtained that most people use their thumbs and index fingers to interact with the screen of their devices.

Regarding to the touching accuracy, it is commonly known that the target size has a significant relation to the user error. Parhi et al. (2006) found that user errors decline when the size of the target increases. Another study on touch key design was carried out by Park et al. (2008). These authors also found that user performance and subjective satisfaction of the larger touch key size were higher than the smaller size. It means the target size should fit the fingertip contact area on the target. Wang and Ren (2009) observed the fingertip contact area with the screen in two difference ways: vertical touch and oblique touch. They found that the size of the fingertip contact area has significant difference between two touching ways. Meanwhile, Holz and Baudisch (2011) found that users tried to touch the target point precisely by aligning the finger feature and outline. They studied the users' mental models of touch in their efforts to minimize error. The study explored techniques used by the participants in targeting crosshairs accurately (Holz and Baudisch, 2011).

This paper presents the results of pilot test on the interaction between fingertip and touch screen. The test is the preliminary observation of the proposed study on fingertip contact area with touch screen devices. The objective of this study is to identify the finger postures when interacting with touch screen devices. The rationale for this observation is to make a contribution for the determination of the fingers and their postures to be included in the proposed study on the fingertip contact area with touch screen devices.

## 2. MATERIALS AND METHOD

Two devices, a Samsung Galaxy Note 10.1 tablet (10 inches screen) and a Samsung Galaxy S Duos mobile phone (4 inches screen), were used to display touch targets in this study. There were 12 targets set on the screen of the tablet and 8 targets on the screen of the mobile phone.

Ten participants, 7 males and 3 females, were asked to perform two tasks. They performed the tasks in a sitting posture. In the first task, the participants were asked to touch targets appearing on the touch screen by tapping them sequentially. Second, participants were asked to touch each target by connecting them as he/ she usually drags an icon or an image on

the screen. The participants were able to choose which finger that he/ she wants to use when performing the required tasks.

In the planning phase, we set three postures that might be chosen by the users when interacting with the mobile phone and four postures when interacting with the tablet. Table 1 listed the users hand postures observed in this study. In cradle posture, we only observed the use of index finger or middle finger and ignored the use of the thumb. We assumed that the use of a single hand with one thumb interaction had adequately represented for the observations of the thumb postures.

Table 1 – Hand postures observed in the study

Devices	Posture
Mobile phone	Single hand: one thumb
	Two hands: two thumbs
	Two hands: cradle
Tablet	Two hands: two thumbs
	Two hands: cradle
	On table: flat
	On table: tilt (45°)

A Sony DCR DVD-403E PAL video camera and an Olympus VR-340 compact camera were used to record the hand postures while interacting with the devices. The video camera was placed in the left side of participants, while the compact camera was in the opposite of the participants.

### 3. RESULTS AND DISCUSSION

From the obtained results it was possible to see that only a few participants have a different behaviour when interacting with their mobile devices. From the seven postures we assumed that could be adopted by the participants, we ignored the two thumbs postures since the first five participants seem hard to perform this posture when interacting with the tablet and the reminding participants did not perform it. Consequently, we did not include the posture in the further calculation. We noted that three participants were not using the two thumbs to interact with their devices and two participants did not perform cradle posture. We also noticed one female participant used only her index and middle finger to interact with tablet because of her long nails.

In the interaction with the mobile phone, we observed the participants performed the tasks by using their thumbs for single and two hands interactions and their index fingers for cradle interaction. While for interaction with the tablet, since we ignored the use of the two thumbs posture, we only found the use of the index finger and the middle finger to interact with the tablet in cradle posture and on table in flat and tilt postures.

For the whole set of observations, we have recorded 272 touching activities in 16 thumb postures, 752 touching activities in 10 index finger postures and 72 touching activities in 2 middle finger postures adopted by the participants. Figure 1 shows the percentage of the thumb pitch and roll angles combination used by the participants for interacting with the mobile phone screen. We can see that the five most used combinations of thumb pitch and roll angles for the interaction are: 60° pitch and 0° roll (34.19%), 45° pitch and 0° roll (15.07%), 60° pitch and 30° roll (11.03%), 75° pitch and 0° roll (6.62%) and 30° pitch and 0° roll (6.25%).

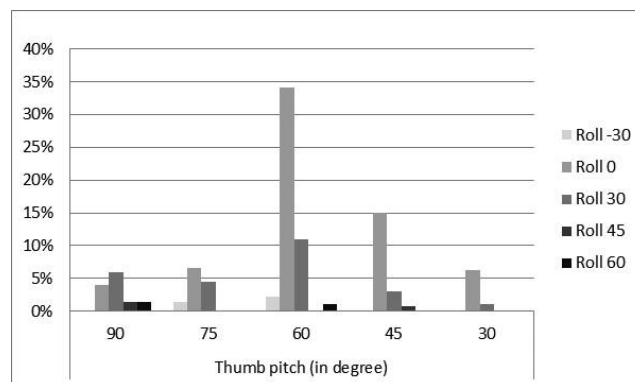


Figure 1 – Thumb pitch and roll combination occurred in the test of interaction with a mobile phone in one thumb and two thumbs postures.

Figure 2 shows the percentage of occurrence of various finger pitches and rolls in the interaction with the mobile phone and tablet by using index finger and middle finger. From the figure we find the six combinations of finger pitch and roll angles that most used by participants, namely: index finger with 60° pitch and 0° roll (27.79%), followed by 75° pitch and 0° roll (21.12%), 75° pitch and 30° roll (11.89%), 60° pitch and 30° roll (8.50%), 90° pitch and 0° roll (8.37%) and 90° pitch and 30° roll (6.07%). However, it should be noted that just a few people, especially those who have long

finger nails, may touch targets on their mobile devices screen by using another finger, such as index, middle, ring or little finger in 30° or lower pitches.

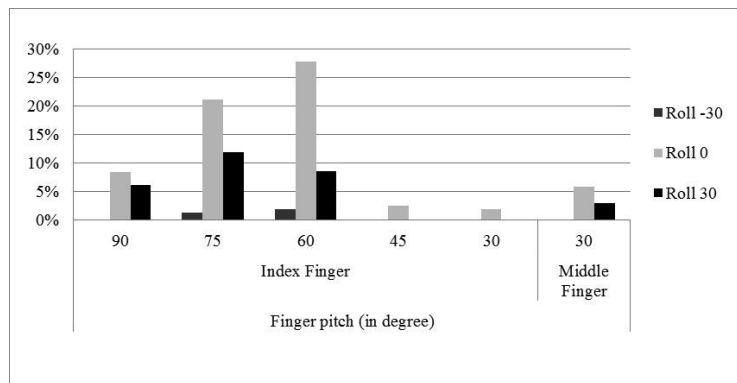


Figure 2 – Index and middle fingers postures occurred in the observed interaction with the mobile phone and the tablet.

The current study noticed that the index finger postures commonly used by the participants are quite different from the index finger postures observed by Holz and Baudisch (2011) in their study to understand the users' mental models of touch. Holz and Baudisch (2011) included four finger pitch angles (65°, 45°, 25° and 15°) and five finger roll angles (-15°, 0°, 15°, 45° and 90°), which were found from the exploration of the techniques used by their participants. This difference may occur because in the current study the participants were only asked to touch the targets freely regardless of the accuracy, while in the previous study by Holz and Baudisch (2011) the participants had to touch the targets accurately. Their findings suggested that users touch the targets precisely by aligning the finger feature and outline.

#### 4. CONCLUSIONS

This study is the preliminary observation stage for a deeper study on the fingertip contact area with touch screen devices. The main purpose of this study is to identify the finger postures when interacting with the touch screen devices. From the results of the observation, we can conclude that most participants used their thumb to interact with their mobile phone in single or two hands postures. The common thumb posture adopted by participants is the combination of the 60° pitch and 0° roll angles. While for interaction with the tablet, this study showed that the participants commonly used their index fingers in the combination of 60° pitch and 0° roll angles. This study also observed one participant with long finger nails that touched targets on the mobile devices screen by using her index or middle fingers with a very low pitch. In summary, it can be stated that the finding of this study can help the researcher in determining the finger postures on the study of fingertip contact area with the touch screen devices.

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