How Body Posture and Movements May Impact the Accuracy on Touchscreen Devices

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Abstract
This proposal introduces the topic of my Master Thesis, which is to investigate the influence of the posture and movement of the body when trying to accurately select small targets on touchscreen. The related work is introduced, as well as the main hypothesis for the thesis.

Introduction
Touchscreen devices are becoming more and more ubiquitous. One can find them in mobile phones, GPS navigators, in public displays…

The size of these devices, and hence, the size of their screen is shrinking. This becomes a problem for the user to accurately target a button.

In nowadays touchscreen devices, the common way to extract the touch position is to use the touch area center point. However, due to the so-called fat finger problem [1], i.e., "the softness of the fingertip combined with the occlusion of the target by the finger" [1], the accuracy of touchscreen devices is limited. It has been noted by researchers that the minimum

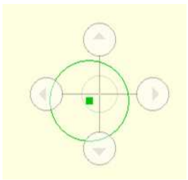

figure 1. Cross-Keys.

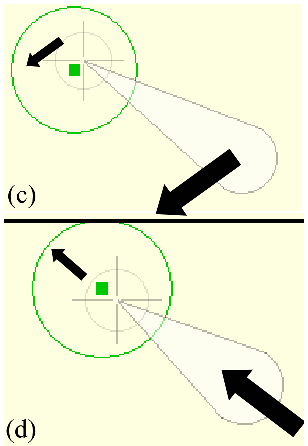

figure 2: Precision-Handle.

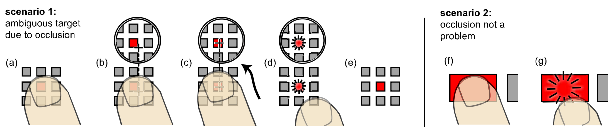

figure 3: Shift

target sizes width and height was between 10.5mm [2] and 26mm [3].

Holz [1] made the case that touch inaccuracy was not caused by the fat finger problem and created a new model based on the perceived input point model.

According to this theory, the finger posture can explain the offset between the target and the actual touch position. Holz investigated four variables; the angle of the finger with the surface (roll, pitch and yaw) and the user himself.

The results show that for a particular posture, each user's touch has a particular offset and can therefore be corrected, and thus increasing the accuracy of the system. The results also demonstrate that the target's size can be reduced to 4.3mm with 95% accuracy.

Objective

Holz used the finger posture to find a touch offset and make the user's touch more accurate. What would be of interest now is to find out what other factors may influence this offset and how they could be used to increase the accuracy of touchscreen devices.

At this point, we want to look into the possibility that the whole body posture and movement may have an impact on the actual touch point, and not only the finger. More precisely, we want to explore the hypothesis that the hand and arm posture, as well as the head orientation and the finger trajectory are involved in the offset calculation.

Related work

According to the literature, Holz is the only researcher who investigated the influence of finger posture to increase touch accuracy. However, many paths have been explored to solve this issue in different ways.

Some systems gather information about finger or body posture, not in order to increase accuracy, but with the intention of adding functionalities.

Targeting aids

CROSS-KEYS

Albinsson and Zhai [4] introduced two techniques to increase touch accuracy. The first one, Cross-keys, uses a crosshair with control keys. With the first tap, the crosshair is displayed. The user can then use the arrows to move the center of the target in discrete steps. When the target is reached, the user taps it to select it

PRECISION-HANDLE

Precision-handle is the second techniques presented by Albinsson and Zhai [4]. When the user taps the screen, a handle and a activation circle are displayed. Any movement on the end of the handle would cause the same movement, but at the smaller scale at the tip. Once the tip of the handle is on the target, the user can activate it by tapping in the circle.

SHIFT

Vogel and Baudisch presented Shift [2], a targeting aid based on Offset cursor [5]. The main idea is to address the problem of the finger occlusion. When the user wants to select a target among others in a small space, the area under the finger is shown in a circle away from the occlusion area with a cross representing the finger contact point. The user can then move his finger to pinpoint a location while seeing the effects. When the target is located, lifting the finger activate the touch.

When there is no doubt about the intended target, the system works like a regular touchscreen and there is no callout.

Finger and body posture use

Wang and Ren [6] identified and made use of the finger's contact area, contact shape and contact orientation to develop new interaction techniques.

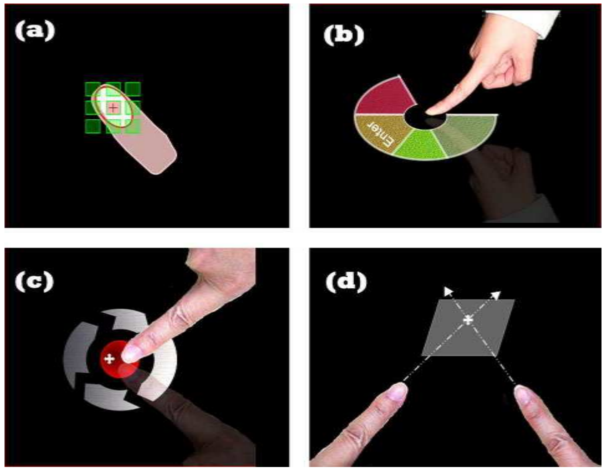

figure 4: (a) finger combination cursor, (b) finger sector menu, (c) finger pointing stick, (d) finger cross selection

FINGER COMBINATION CURSOR

The system uses both an area cursor and a point cursor determined by the contact shape. If only one target is in the contact area, the area cursor is used to select it. If there are several targets, the point cursor is used and the target closest to the contact center point is used.

FINGER SECTOR MENU

When the user selects a pie menu, the finger orientation is determined using the changes in the contact shape; the fingertip touches the surfaces first, then the user tilts his finger down. This movement is used to determine the hand position and display the pie menu around it. Once the pie menu is displayed, the user can select items by rotating or rolling his finger.

FINGER POINTING STICK

The finger can be used as a joystick. By rocking his finger, the center of the contact area changes and it can be used to control a cursor.

FINGER CROSS SELECTION

In order to select distant target, the user can use two fingers. Their orientation is determined like in the finger sector menu. A line extends from each finger. Rotating the fingers on the surface and thus changing the intersection of the lines is used to select the target.

BODY

Nickel and Stiefelhagen [7] investigated body posture in pointing task. They tested three approaches to establish the pointing target. The first one was the line of sight between the head and the hand, the second was the forearm orientation and the last one was the head orientation. The line of sight between head and hand, as well as the forearm orientation were determined using stereo camera, while a magnetic sensor gave the head orientation.

References

[1] Holz, C. and Baudisch, P. The Generalized Perceived Input Point Model and How to Double Touch Accuracy by Extracting Fingerprints. *Proc. CHI '10*, 581-590.

[2] Vogel, D. and Baudisch, P. Shift: A Technique for Operating Pen-Based Interfaces Using Touch. *Proc. CHI '07*, 657-666

[3] Hall, A.D., Cunningham, J.B., Roache, R.P., and Cox, J.W. 1988. Factors affecting performance using touch-entry systems: Tactual recognition fields and system accuracy. In *Journal of Applied Psychology*, 4, 711--720.

[4] Albinsson, P., Zhai, S. High precision touch screen interaction. In *Proc. CHI '03*, 105–112.

[5] Potter, R., Weldon, L., Shneiderman, B. Improving the accuracy of touch screens: an experimental evaluation of three strategies. *Proc. CHI'* 88, 27-32.

[6] Wang, F. and Ren, X. Empirical evaluation for finger input properties in multi-touch interaction. In *Proc. CHI '09*, 1063- 1072.

[7] Nickel, K. & Stiefelhagen, R. Pointing Gesture Recognition based on 3D-Tracking of Face, Hands and Head-Orientation. In *Proc. ICMI '03*, 140-146.