Integrating Isometric Joysticks into Mobile Phones for Text Entry

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We present a new gestural text entry method for mobile phones that uses an isometric joystick and a special version of *EdgeWrite*. We want to investigate the use of joysticks on the front and the back of mobile phones. Therefore, we embedded two isometric joysticks into a real mobile phone to create a high-fidelity prototype. We used the prototype in a 30-session longitudinal study to evaluate our method.

The Problems

Keypad-based text entry methods such as Multitap and T9 have a number of drawbacks:

- **Large physical footprint**
  Keypads consume precious device real-estate.
- **Low physical stability**
  On-the-go users might find it difficult to press small keys while walking or riding.
- **Cannot write by feel**
  Users generally need to look at the keypad to locate the appropriate keys to press, or look at the screen to check the proposed text for methods that disambiguate key sequences (for example, T9).

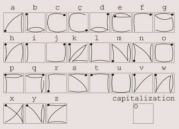
Our Solutions

We propose to use the isometric joystick together with *EdgeWrite* for text entry.

- **Extremely compact**
  The joystick is excellent for very small devices. It can be put on the back of a device to free up even more space on the front.
- **Higher physical stability**
  The operating finger can stay stationary on the joystick during text entry.
- **Can write by feel**
  There is no need to look at the operating finger in order to create characters.

What is EdgeWrite?

EdgeWrite is a gesture-based text entry method that provides high accuracy and physical stability for people with motor impairments or people "on the go."



The EdgeWrite unistroke alphabet uses gestures comprised of straight lines in a square. It was originally designed to leverage physical edges of a square hole for greater stability. In our case, we do not use physical edges but instead rely on crossing to stroke, somewhat analogous to "virtual edges."

For more info, go to **www.edgewrite.com**

The Prototype

Hardware

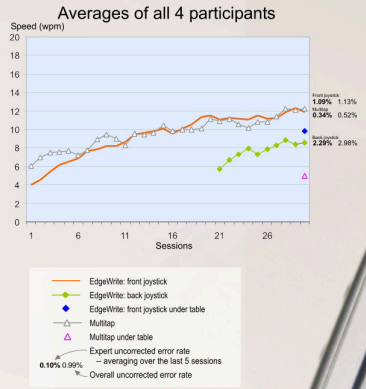
We are the first to integrate isometric joysticks into mobile phones for text entry. We embedded two **IBM TrackPoint isometric joysticks**, which are commonly used on ThinkPad laptops, into a real mobile phone. We ensured that the phone's LCD screen continue to work so that we can display text on it.

Writing a Character

1. The user draws an EdgeWrite character using the joystick.
2. Signals describing the joystick's movements are transmitted to a remote computer through a PS/2 cable at the bottom of the phone.
3. The EdgeWrite software on the computer translates the movements into character strokes and recognizes them as the appropriate character.
4. The recognized character is sent back to the phone through a USB connection.
5. We wrote a special program that runs on the phone to receive and display the character on the phone's screen.

Evaluation (Latest Results)

In a 30-session longitudinal study, we asked four participants to enter short phrases on cellphones using both joysticks and multitap. For every session, each participant entered two practice phrases followed by eight test phrases which were used to compute the text entry speeds.



Results: front joystick vs multitap
All participants started with slower joystick speeds. However, P1 and P3 became faster with the joystick and stayed consistently faster over the later sessions. P2's joystick and multitap speeds didn't differ significantly. P4 was substantially faster with multitap during his later sessions. Indeed, P4 was the fastest with both methods among all of the participants. Overall, the joystick method was competitive with multitap, as shown in the average graph.

All participants enjoyed using the front joystick and had strong preference using it over multitap. They would very much like to use one in production cellphones on a regular basis.

Results: back joystick
Entering text using a joystick on the back of a device is a novel method. It might be especially useful for very small devices that have limited space on the front.

We asked the participants to use the back joystick only in the last 10 sessions and their average speed reached ~8wpm. This shows that back-of-device text entry using the isometric joystick is highly feasible.

Likert Scales (1-5)	Front joystick	Multitap
Difficult → Easy to use	4.3 (1.0)	3.8 (1.0)
Difficult → Easy to learn	3.5 (1.3)	4.3 (0.5)
Slow → Fast	4.3 (1.0)	2.0 (0.8)
Error prone → Accurate	3.8 (1.3)	4.0 (0.8)
Frustrating → Enjoyable	4.3 (0.5)	1.8 (0.5)
Uncomfortable → Comfortable	4.0 (0.8)	2.3 (1.0)
Dislike → Like	4.0 (0.8)	2.3 (1.0)
Average	**4.0 (0.3)**	**2.9 (1.1)**

Means (and standard deviations) of post-test Likert scales. Higher values are better.

Entering text with situational visual impairment
We are also interested in the use of our method under situational visual impairment, where people cannot visually focus on the phone all the time such as during walking or riding. In the last session, we asked the participants to hold the phones under the table to simulate such a condition. Then we asked them to enter phrases using both methods. They could only look at a monitor for the output text, but not the phone nor their fingers.

The participants were able to write at an average speed of ~9.8wpm with the joystick, and ~5.8wpm with multitap. This shows that our method could sustain its performance relatively well even when constant focus on the phone is not possible — which commonly happens in typical "phone-using" situations.

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