

Miniature Keyboards Supporting Text Entry in Wearable Computing Environments

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가		가	
(KSPC)가	가	가	가
QWERTY	가	가	가
가	20 5	18.9WPM,	24.5WPM
가	10 20	14.7WPM,	17.0WPM

Many of the commercialized wearable text input devices are wrist-worn keyboards that have adopted the minimization method of reducing keys. If the keys of a keyboard are reduced unduly in order to get good wearability, its KSPC(Key Strokes Per Character) may increase; Consequently, the text input efficiency would therefore become worse and users would need to make additional efforts in learning a new typing method. We are faced with this kind of wearability-usability trade-off problems in designing wearable keyboards. We tried to develop new text input devices balancing between the trade-offs. As a first step, we proposed the One-key keyboard which has only one key and is smaller than a business card. The One-key keyboard detects the position of the user's fingertip when pushed and it figures out which character is entered. We built a prototype of the One-key keyboard and conducted a text entry performance test comprised of 5 20-minute sessions. The participants typed on average 18.9WPM in the final session and the best reached up to 24.5WPM. Minimizing the One-key keyboard even more with touch sensor array, we developed a Button keyboard that is so small that it can be attached onto clothing just like a button. The text entry performance test with 20 10-minute sessions revealed that the participants, on average, were able to enter texts at 14.7WPM in the final session and the best reached up to 17.0WPM. The One-key keyboard and Button keyboard show good text entry performances despite its small size in comparison with traditional alternative input methods.

Keywords: Wearable computing, Text entry, Keyboard



1. QWERTY (WristPC Keyboard™, Halfkeyboard™, FrogPad™)

I.

Keyboard

KSPC(Keystrokes Per Character)가 가

가

Eleksen Fabric keyboard™

가

가

Twiddler™

가

가

가

SCURRY[Kim , 2005], Senseboard™, Lightglove™

[Schneiderman, 2000].

가

가 [, 2006].

SCURRY

ThumbCode[Pratt, 1999]가

Halfkeyboard™
[Matias , 1993], WristPC Keyboard™
FrogPad™, Stick Keyboard [Green , 2004]
가

가

Keyboard™

Halfkeyboard™ WristPC

가 (

QWERTY

1).

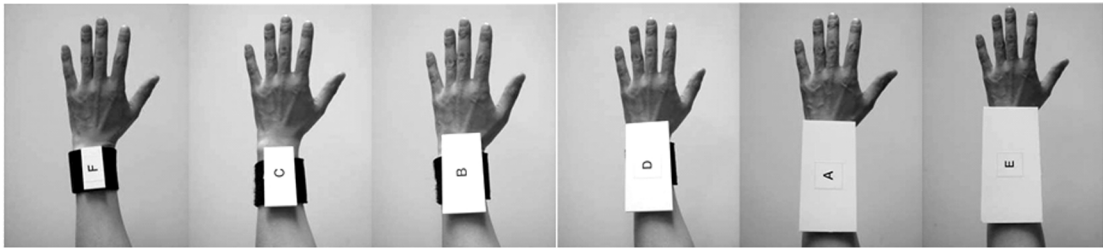
QWERTY

1/3~1/2

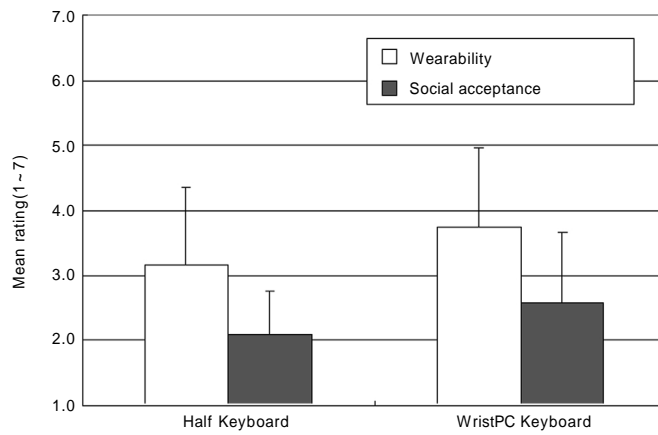
1

FrogPad™

Stick



2. 가 (50mm, 70mm, 90mm, 110mm, 130mm, 150mm, 1/2)



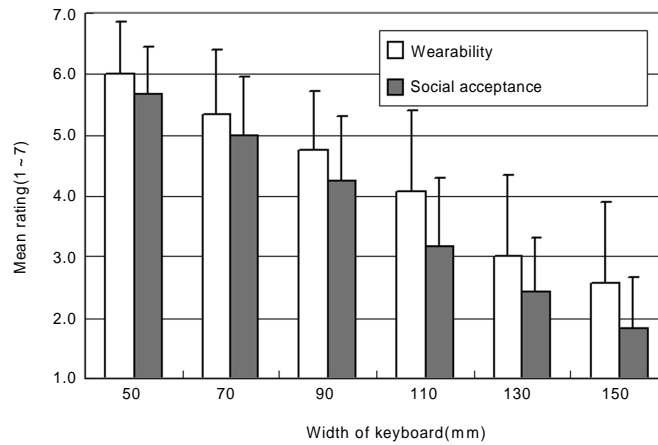
3. Halfkeyboard™ WristPC Keyboard™

II. 가 QWERTY 가

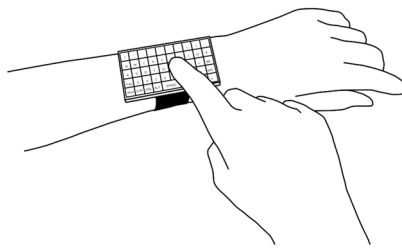
II.

가

WristPC Keyboard™ (148mm * 65mm * 13mm)
 Halfkeyboard™ (145mm * 80mm * 18mm)
 가 2 6 가 50mm, 70mm, 90mm, 110mm, 130mm, 150mm
 가 1/2 가 7 (1 : , 7)
 가 6 가 6 12 23.8
 가 24.2 가 23.8
 가 7 (1 : , 7)

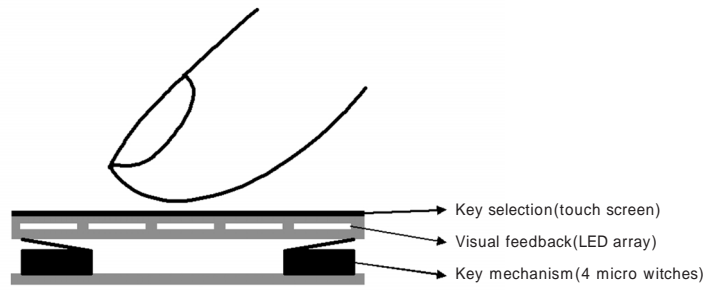


4.



5.

” 7 (1 : , 7 : (F_(5,55) = 26.307, p<0.01).
) 가
 WristPC Keyboard™ Halfkeyboard™ (F_(5,55) = 53.039,
 p<0.01). 가
 3 4 가
 3 WristPC Keyboard™ 4.0 90mm
 2.6/7.0 (SD = 1.1) 3.8/7.0 (SD = 1.2), 가 70mm 50mm
 Halfkeyboard™ 3.2/7.0 (SD = 1.2), 가
 2.1/7.0 (SD = 0.7) 가
 WristPC Keyboard™가 Halfkeyboard™ KSPC 가
 가 가 KSPC가 가
 가 가
 가
 QWERTY
 PDA (on-screen
 keyboard) Targus Dell (mini-



6.

QWERTY keyboard)가 . 4mm

7mm

가

[Kotringer , 2004]

7X7mm

가 .

PDA
13.64WPM

4.11%

60WPM(20 20)

[Clarkson , 2005].

5

(One-key keyboard)

가

[Kim , 2006].

가

QWERTY

Twiddler™
가

QWERTY
, Stick keyboard,

가

(passive haptic feedback)

가

2.

가

LED

(3.5)
70X35mm

LED

6
4

III. 1: (One-key keyboard)

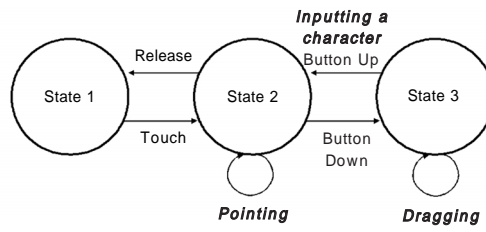
가
가

가

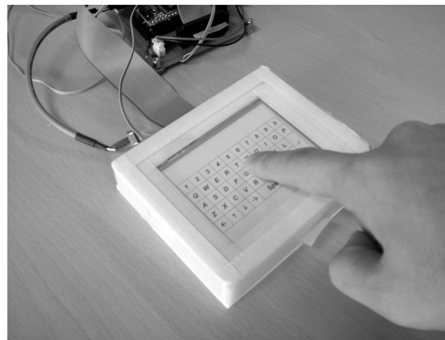
가

1.

QWERTY 가

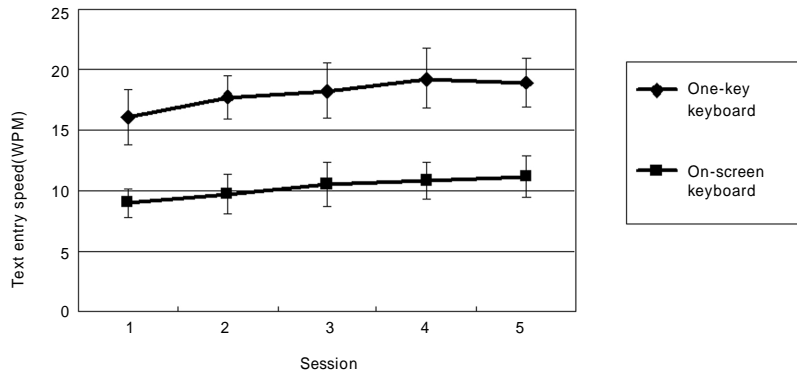


7.

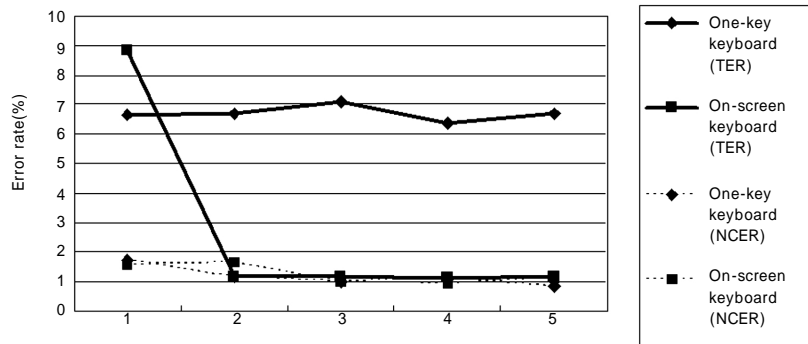


8.

3. 가
 가
 PDA
 가
 가
 (7).
 가
 GUI(Graphical User Interface)
 가
 가
 MacKenzie[2003]가
 가
 5 5)
 가
 7mm
 1/2
 16 (23.8) 가
 가 8 (23.9)
 8 (23.8)
 500
 가
 LED
 (feedforward)
 20



9.



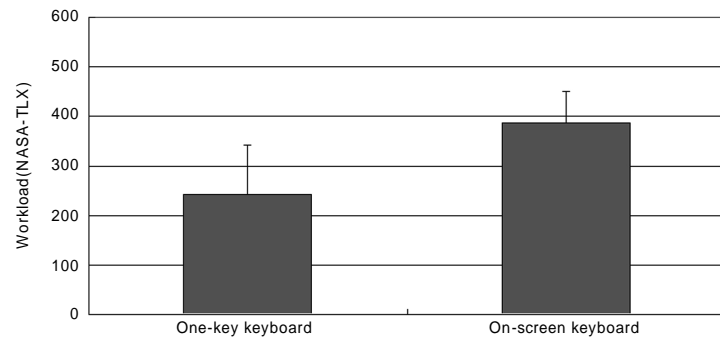
10.

가 6.0 (SD = 2.9),
 0.5% (SD = 0.5)

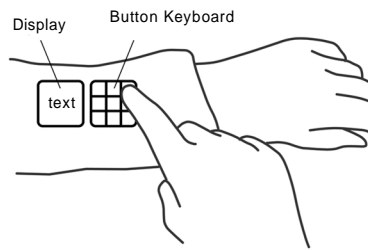
NASA-TLX [Hart, 1988]

1 (F_(1,15) = 326.240, p < 0.01) (F_(4, 60) = 32.329, p < 0.01)

18.9WPM (SD = 2.1) 6.7% (SD = 2.7) 26.8WPM 가
 (TER: Total Error Rate), 0.9% (SD = 1.0) , 가
 (NCER: Not Corrected Error Rate), 242.8 (SD = 99.8) (NASA-TLX) 16.9WPM 가
 [MacKenzie, 2003, 2004]. 10.2WPM (SD = 1.4) (9).
 1.2% (SD = 0.1) , 1.1% (SD = 2.0) (10).
 , 386.6 (SD = 66.1) (NASA-TLX) 6.71% 가
 가 가 8.8%
 가 57.2WPM (SD = 13.8) 0.06 ~ 0.08%



11.



12.

$(F_{(1,15)} = 59.453, p < 0.01)$
 $(F_{(4,60)} = 24.838, p < 0.01)$
 $(F_{(1,15)} = 47.583, p < 0.01)$
 $(F_{(4,60)} = 25.951, p < 0.01)$

242.8 (SD = 99.8)
 386.6 (SD = 66.1)

가 가 가 가 가 가 가 가 가 가 가

1.1% 가 0.9% 가 가 가 가 가 가 가 가

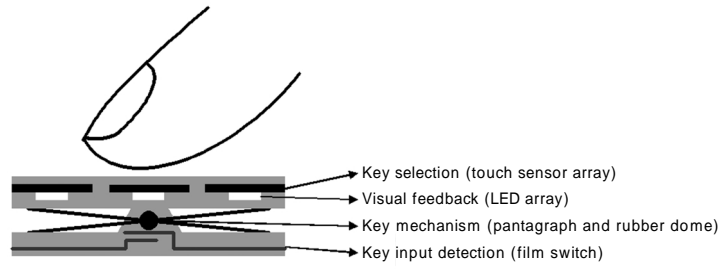
IV. 2: (Button keyboard)
 1. 가

가 가 가 가 가

(11).

NASA-TLX 가 가

(12).

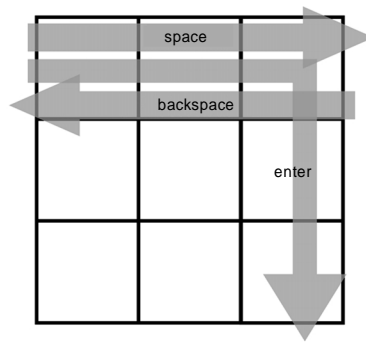


13.

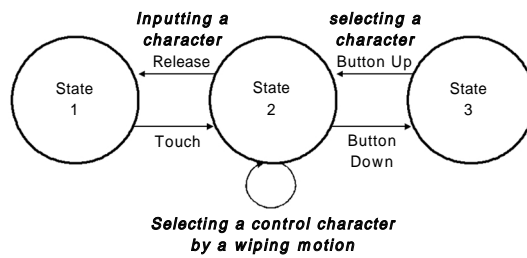
EWQ	TUY	OP
ADZ	RFV	ILJ
SCX	HGB	NMK

14.

[Kim, 2007].
 가 motion) 가 (wiping [Rekimoto, 2003].
 KSPC 1.0 가 15
 가 16
 KSPC가 2.0 가
 QWERTY 가 가 가
 가
 2. 가
 3 (segmentation problem)
 (QT1101) 3X3 LED [MacKenzie, 2002].
 13 가
 14 QWERTY
 [Hwang, 2005].



15.

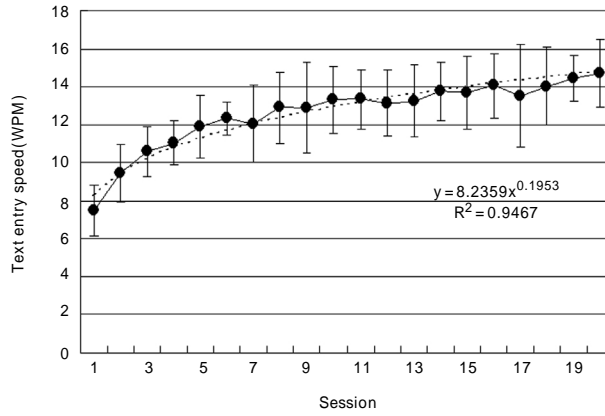


16.

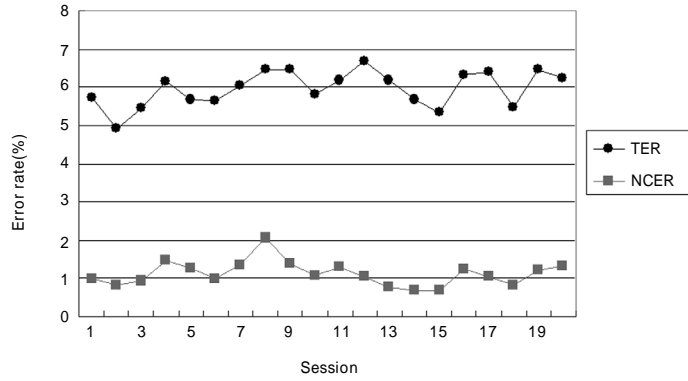


17.

3. 가 14.7WPM(SD=1.7) 가 가 17.0WPM 가
 가 10 가 18
 가 (4 , 6) 23.9 p<0.01). 100 (10 X100) (F_(19,380) = 44.228,
 MacKenzie [2003] 20WPM 6.0%(SD=0.7)
 20 10 1.1%(SD=1.0)
 20 (19).



18.



19.

MacKenzie[2001]

25 ~ 30 20

V.

5.0%)

15.5WPM(

MacKenzie

12WPM

QWERTY

MacKenzie
가

가

QWERTY

20

6.0가

5
24.5WPM

18.9WPM,

가

10 20
17.0WPM

14.7WPM,

80%

가

가
6.0%
가
가
가
가
GUI
HMD

[1] []
: QWERTY
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