Modeling non-Expert Text Entry Speed on 12-Button Phone Keypads

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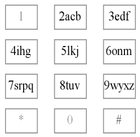
Keypad Layouts

Traditional layout (used by Multitap, T9 and others)



Layout used by Less-Tap

Phone Text Entry Techniques

Multitap (1.95 keystrokes per character)

press a key repeatedly until letter appears

Less-Tap (1.44 KSPC)

one keystroke for most frequent letters on each key…

T9 (1.0072 KSPC)

possible interpretations of key sequence compared to words in dictionary

Models and Text Entry

Models help developing new text entry methods. However, existing models predict only *expert* text entry rates. Since the notion of *expert text message user* is unrealistic, the existing models do not agree with experimental results for novices

Existing Models:

Keystroke Level Model (Card et al. 1980)

– General (typing, mouse pointing, drawing etc.)

– Predicts *execution time* by accounting for times of different actions

key **press**, **pointing**, **homing**, **drawing**, **mental** preparation time, **system response** time, etc.

– Not specific enough – only a framework

Fitts' Law Based Model (Silfverberg et al. 2000)

– Two parts: *movement model*, based on Fitts' law, and a *linguistic model*

– Only for "experts"!

Non-Motor Actions in Text Entry

– Re-reading phrase to be entered

– Figuring out next letter (spelling out word)

– Determining which button to press and how many times

– Deciding if *second* key press is required

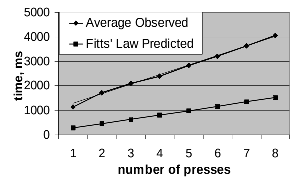
– If pressing key more than twice, keeping count of number of presses made

– [Verifying the result]

The following figure shows the Times for Various *Multiple* Presses in multipress methods and demonstrates the significance of considering cognitive components in a model.

Figure1: Time for Various ***Multiple*** **Presses in multipress methods**

Data obtained from novices [4]. Note the different slope, and that it is linear beyond 2.



New Movement Model (time to enter a character)

Multi-press Input Methods

3 possible cases:

1 press (N_1, $N_2 = 0$)

2 presses ($N_1 = 1$, $N_2 = 0$)

3 or more presses ($N_1 = 1$, $N_2 > 0$)

$$T_{char} = D_{init} + T_{Fitts} + N_1 \cdot (D_{repeat} + T_{repeat}) + N_2 \cdot (D_{count} + T_{repeat}) + [T_{timeout}]$$

Predictive Input Methods

Since the presses of NEXT are rare (<1% of total), assume D_{init} is the same as in multi-press methods

$$T_{char} = D_{init} + T_{Fitts}$$

Completing and Verifying the Model

Combine the Movement Model with a Linguistic Model (letter digraph frequencies p_{ij}):

$$T_{char\_in\_corpus} = \Sigma\Sigma\,(p_{ij} \cdot T_{char\ ij})$$

Conversion to words per minute:

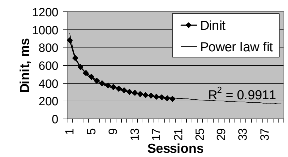
$$WPM = (1/T_{char\_in\_corpus}) \cdot (60/5)$$

Comparison with Experimental Data:

Technique	New Model	Model by Card et al. [1]	Model by Silfverberg et al. [5]	Experiment 1 [2]	Experiment 2 [4]
Multitap	6.97	18.35	22.3	7.98	7.15
Less-Tap	8.01	23.47	26.8		7.82
T9	10.07	24.97	40.6	9.09	

Learning Effect

Naturally, D_{init} should decrease with learning. Based on results for *Multitap* in [3] (0.5 hrs per session, 20 sessions), we have compiled the following graph. Note that D_{init} is still 200 ms after 15 hours.



Summary

New predictive model for text entry speed on 12-button telephone keypads

– also predicts mental overhead

– values computed by the model are reasonably consistent with experimentally observed results

– can quite accurately predict performance of novice users

– potential prediction of learning

REFERENCES

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3. MacKenzie, I. S., Kober, H., Smith, D., Jones, T., & Skepner, E. (2001). LetterWise: Prefix-based disambiguation for mobile text input. *Proceedings of the ACM Symposium on User Interface Software and Technology – UIST 2001*, pp. 111-120, New York: ACM.
4. Pavlovych, A., Stuerzlinger, W. Less-Tap: A Fast and Easy-to-learn Text Input Technique for Phones, *Graphics Interface 2003*, pp. 97-104.
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