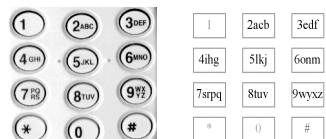


Modeling non-Expert Text Entry Speed on 12-Button Phone Keypads

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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"!

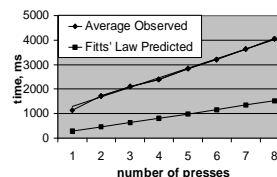
Non-Motor Actions in Text Entry

- 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 the linearity beyond 2.



New Movement Model (time to enter a character)

Multi-press Input Methods

- 3 possible cases:
- 1 press ($N_1 = 1, N_2 = 0$)
- 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}):

$$T_{char_in_corpus} = \sum \sum (p_{ij} \cdot T_{char\ ij})$$

Conversion to words per minute:

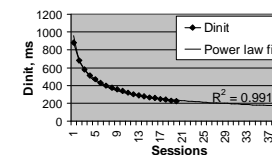
$$WPM = (1/T_{char_in_corpus}) \cdot (60/5)$$

Comparison with Experimental Data:

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

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

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