EN717

Efficiency of Keyboard Glove Layouts

Versus Conventional

Full Keyboard Layouts

Salvador Razo

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Introduction

As computers shrink, keyboards remain one of the largest components. Every piece of technology needs an input method. Our handheld devices such as cell phones and PDA's are becoming smaller and people in the field sometimes cannot carry too much. A smaller input method is becoming necessary. The standard keyboard is resistant to shrinking. Keyboard gloves have been used before and are ergonomic to use. Some key layouts on a glove would be easier to use than others. The purpose of this project is to find an efficient alternative keyboard on a glove. Ideally the researcher would like to find a layout that matches the input speed of a regular full sized keyboard. This would be difficult, if not impossible because people have had most practice with a full keyboard, a glove limits the person to one hand, a glove has a limited space whereas a full keyboard has a full open area to type, and of course the learning curve that will be present in early testing of a new input method. Glove keyboards can be based on many existing keyboard layouts, Dvorak and QWERTY are common keyboards that can be used. ABCDE style keyboards will be more intuitive for beginners, but inefficient in the long run. A keyboard based on Dvorak one handed keyboards will be more efficient, and better than that would be a keyboard made specifically for the style of the glove. It will be based on the frequency of which letters are used. More common letters will be placed in easier to reach positions. The layout will seem random at first, but over time it will be more efficient. By making a simple script to go through digital copies of books and count characters, one can easily find the frequency of used characters. By going through 5 different EBooks, the researcher found that "space " (17%) and "E" (8%) and "A","O","T","N"(5%-6%) are most common. These should be placed in easy positions such as the front of the middle finger. After testing 5 to 6 keyboards the researcher decided on the "EON" keyboard (named after the three characters on the front of the middle finger). Since the keyboard seems random, people will be very slow when first introduced to the keyboard, the first few trials will be have low CPM, but as they grow accustomed to the keyboard they should increase. A few trials will only give a small idea of a person's true potential, when taking into account that they have been using a full keyboard most of their life.

Engineering goals

Every person is different. There are different thought processes, talents, levels of dexterity, size of hands, hand dominance, etc. All these variables will need to be taken into account to create a glove that suits everyone and can function as a suitable alternative to a full keyboard. Sizes of hands and hand dominance can be addressed by having interchangeable gloves. This will be addressed by having a 40 pin header and a removable glove on the prototype. In the future and when/if marketed, different sized gloves, left/right gloves, and even different color gloves can be provided to appeal to a larger base. The different level of dexterity has to be addressed by not making contacts in awkward places. Some people can touch the section on their pinky closest to the hand, many cannot. Some can touch the skin beneath where the fingers connect on the hand, and most cannot. The researcher will have to take this into account when laying out the contacts. Different talents and thought processes will have to be addressed by not creating a layout too difficult to follow or too complex. It has to be as straight forward as possible. There are also of course physical limitations. A Hundred or more keys will not fit on one hand and also follow the last prerequisite. The researcher will need to have a careful selection of which keys to use and which to omit, and what kind of shift keys to use while still following the previous prerequisite. Comfort in movement can be achieved and complexity lowered by having only one key to activate others instead of having multiple select keys that do different things when pressing the same contact. A keyboard layout has to balance intuitiveness and efficiency, but if it cannot, efficiency will take precedence. Materials will also need to be comfortable, but usable. Optimally, the glove would function and appear to be a normal glove, and when activated, will function accurately as an electrical device. In a prototype this will be difficult. Conductive fabrics should be considered, but metal contacts will most likely be more efficient.

When testing people on the glove the researcher has to take into account the fact that the subject has never used this input method and is accustomed to a full two handed keyboard. Asking for equivalent performance or performance that surpasses the standard keyboard is not reasonable, but one goal should be to see an increase in performance with the glove in each trial.

Being a prototype, multiple gloves will not be made. Instead a single glove that fits most people will be used. But it will be detachable for expansion of the project in the future. Metal snap pi contacts will be used because of their greater conductivity over conductive fabric. There will be only one key used to activate the rest. There will be 35 contacts and the keyboard will be based on frequency of characters used, putting efficiency over intuitiveness. There will be indicator lights on the glove and force feedback to indicate key presses.

Null Hypothesis

A new, random, one handed input method will not be able to replace the standard full keyboard, which is two-handed and familiar.

Hypothesis

Over time as one becomes familiar with a new input method one will become more proficient with it. It is improbable for a one handed input method such as a glove to replace the standard keyboard, but with enough practice and a good keyboard layout, a glove can become an acceptable alternative for input applications where a standard keyboard is too bulky or inconvenient.

Materials

1. Predrilled PCB board (7x9cm)
2. BS2
3. (5) pfc8574A
4. (5) 8 pin sockets
5. 20 pin wide style socket(for bs2)
6. µA7805 voltage regulator
7. 2N3904 NPN Transistor
8. Blue LED
9. Red LED
10. (9) 4.7KΩ resistors
11. (4) 1µF capacitors
12. 9v port
13. DB9 female port
14. 9v battery clip
15. (2) plastic cover pieces
16. Jumper cables and spare IDE computer cable wires
17. (2) 1/8’’ bolts ½ long
18. (2) 1/8’’ locknuts
19. Velcro strap
20. 40 pin header male
21. Usb mini B cable
22. Parallax USBTO232 adapter
23. 9v power adapter
24. 9v battery
25. IDE cable
26. Glove
27. 40 snap pins
28. Scrapped cell phone vibrator motor
29. Nylon thread transparent .005
30. Solder

Procedures

1. Create glove with 40 inputs following schematics 1.

2. Using data collected from research, create a keyboard based on frequency of use of characters.

3. People will first be tested on a full keyboard. This will be that person's baseline to find their difference on the glove. Their CPM on a full keyboard will be found in one trial since this is not what is being tested.

4. People should get practice with the glove. Most have had years of practice with a full keyboard so they will be most efficient and comfortable with those. To balance this out subjects should get practice trials to get comfortable with the glove and be explained the full functions of the glove.

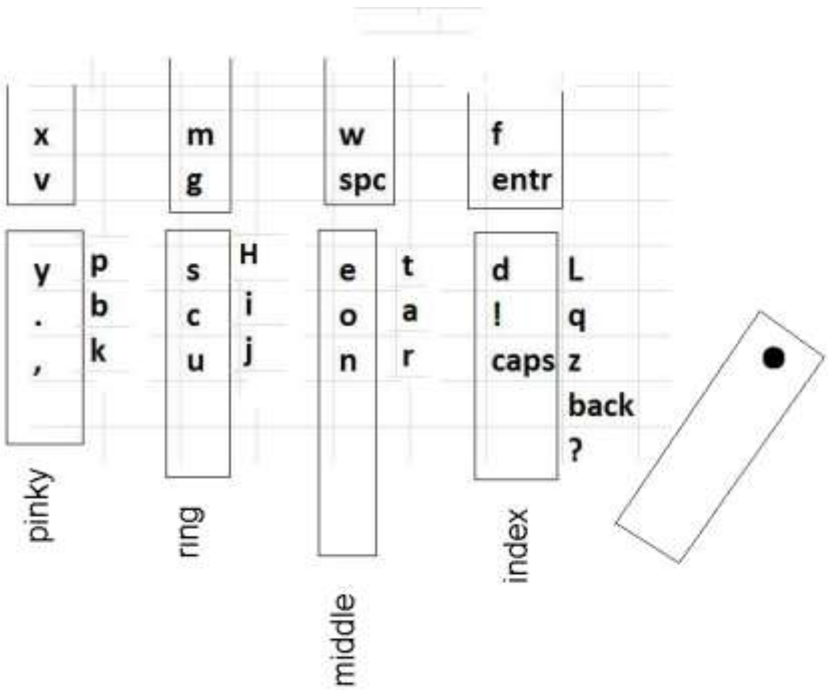
5. Five one minute trials will be taken and the speed on each will be recorded. At least 10 people should be tested, preferable more should be found to volunteer.

6. The average of the best 3 of 5 of each set of trials will be compared to the baseline on the full keyboard.

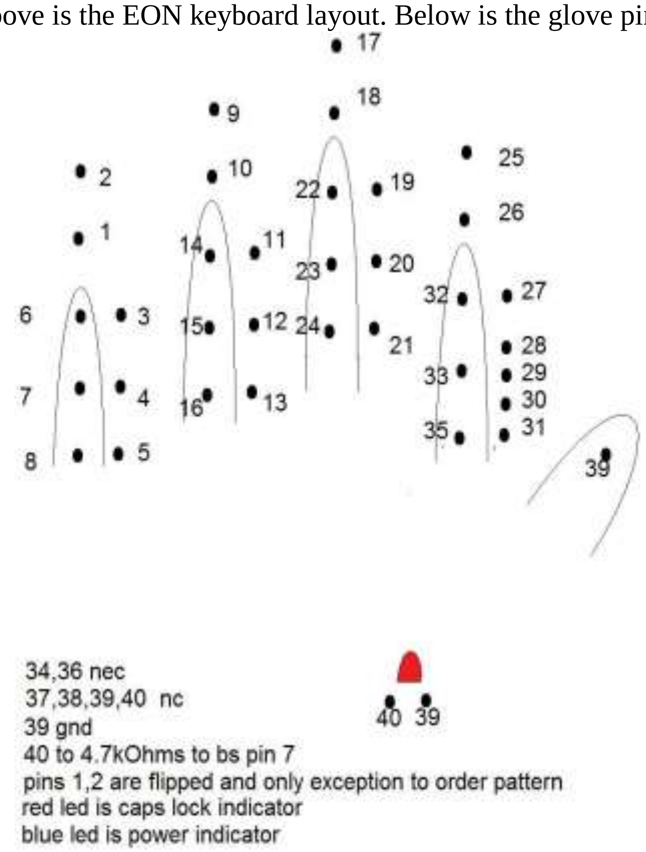
7. The researcher will calculate the percent difference between the two input methods and the layout with the smallest difference will be the most efficient.

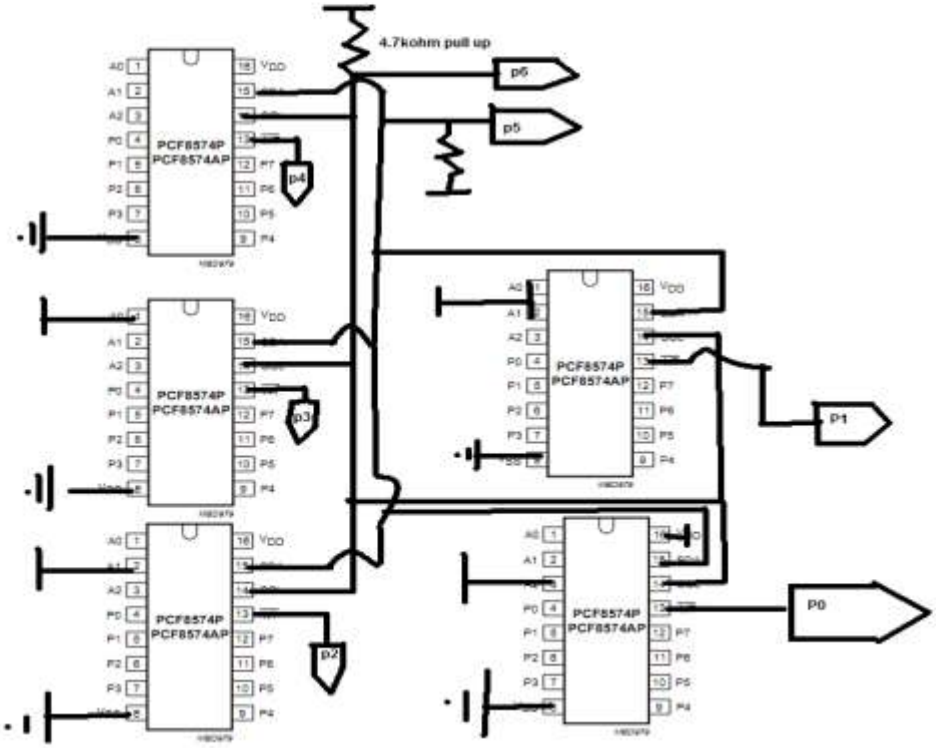
8. Percent increase in each trial will also be calculated to show how performance increases once accustomed to the input method.

Drawings

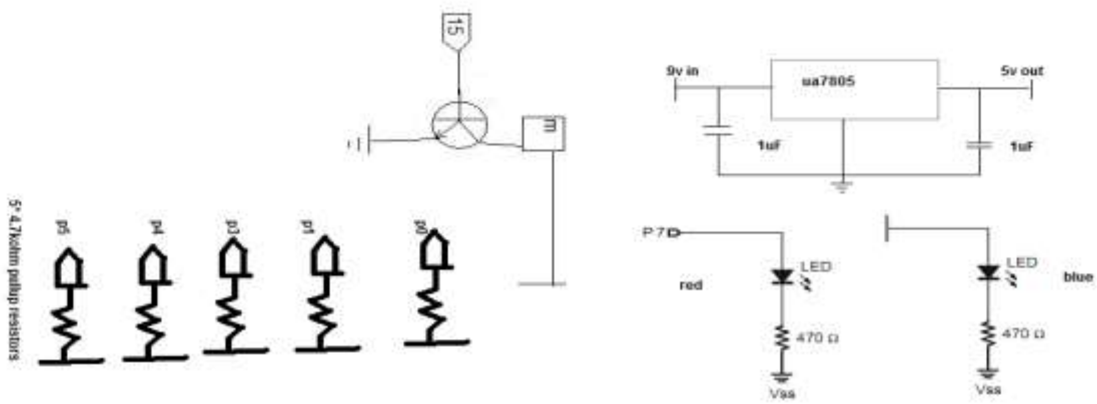


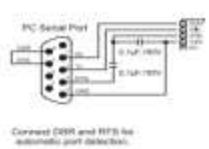
Above is the EON keyboard layout. Below is the glove pinout.





pins 0-7 on all 5 pcf chips are connected to the 40 pin header. connections are mited for clarity.





Schematics

Pictures

This is the side view of the glove. The circuit is visible on top of the hand

This is the top view of the glove. The contacts are visible on the front

Data

	Full keyboard	Glove keyboard				
Tester number	CPM	Trial 1	Trial 2	Trial 3	trial 4	Trial 5
1	216	15	14	15	17	14
2	254	11	17	18	20	22
3	323	19	22	23	28	27
4	197	10	14	10	11	12
5	215	11	12	15	15	16
6	140	10	17	23	25	29
7	263	18	8	24	20	26
8	214	10	16	18	18	14
9	274	11	16	23	14	19
10	196	9	12	7	14	14
11	288	7	12	14	18	18
12	189	10	14	11	10	12
13	125	10	16	16	21	20
14	149	10	11	19	20	20
15	185	13	14	18	11	17
16	188	20	21	23	25	23
17	147	19	25	24	29	23
18	274	9	14	16	19	19
19	424	9	10	19	19	17
20	165	10	6	8	11	13
21	206	13	13	12	11	12
22	238	9	11	8	16	16
23	190	8	11	11	12	11
24	319	16	15	21	24	24
25	270	7	7	12	14	12
26	267	11	17	18	22	22

27	244	15	19	15	19	14
28	78	9	14	13	13	14
29	98	9	12	20	14	21
30	119	9	8	10	14	12
31	162	18	19	14	22	28
32	251	6	20	21	22	18
33	324	15	21	18	23	25
34	210	12	14	16	21	22
35	141	15	12	16	16	16
36	53	4	5	5	5	6

Tester number	increase all	increase minus one	avg middle three	highest	increase
1	n	n	14.67	17	-1
2	y	y	18.33	22	11
3	n	y	24.00	28	8
4	n	n	11.00	14	2
5	y	y	14.00	16	5
6	y	y	21.67	29	19
7	n	n	20.67	26	8
8	n	y	16.00	18	4
9	n	n	16.33	23	8
10	n	y	11.67	14	5
11	y	y	14.67	18	11
12	n	n	11.00	14	2
13	n	y	17.33	21	10
14	y	y	16.67	20	10
15	n	y	14.67	18	4
16	n	y	22.33	25	3

17	n	n	24.00	29	4
18	y	y	16.33	19	10
19	n	y	15.33	19	8
20	n	y	9.67	13	3
21	n	n	12.33	13	-1
22	n	n	12.00	16	7
23	n	y	11.00	12	3
24	n	y	20.33	24	8
25	n	y	10.33	14	5
26	y	y	19.00	22	11
27	n	n	16.33	19	-1
28	n	y	13.33	14	5
29	n	n	15.33	21	12
30	n	n	10.33	14	3
31	n	y	19.67	28	10
32	n	y	19.67	22	12
33	n	y	20.67	25	10
34	y	y	17.00	22	10
35	n	y	15.67	16	1
36	y	y	5.00	6	2
	25.00	69.44			91.7
		average	16	19	
		median	15.83	19.00	
Avg keyboard CPM	211	standard deviation	4.381166604	5.455375	
		Ztest	0.5	0.5	

Performance over time on the keyboard glove

The general trend is upwards, showing that over time people are increasing in their performance of the glove.

Comparison of Keyboard CPM and Glove CPM

The full keyboard is far superior in CPM as can be seen here. It must be noted that subjects only had 5 minutes of experience with the glove and have had years of experience with the full keyboard. Also this chart shows that there is no correlation between keyboard speed and glove speed.

These are the first two testers extrapolated over 1000 trials using excel. 1000 trials is equal to 1000 minutes or 16-17 hours.

Conclusion

The researcher's hypothesis was that over time with enough familiarity a glove keyboard can replace a full keyboard for alternative applications. This hypothesis should be considered correct. The researcher showed that with practice performance on a new input method increases. The data predicts that after 1000 minutes of using this glove input speed can approximate 75% of standard input speed on a full keyboard for some people. This is an acceptable number for alternative applications where a full keyboard is too bulky or inconvenient.

One common problem that the researcher noted was that some keys were awkward for people. If testing were to continue effort should focus around more natural and easy to touch contact locations. In addition, more keyboards should also be tested. The current keyboard used in this test was the "EON" keyboard. EON is based on written works and the frequency with which characters appear in them. Socializing and more natural and informal styles of typing most likely use a different set of frequency of characters. Since this glove's most useful purpose was determined to be alternative input methods those styles should be reviewed and an appropriate keyboard should be made for those.

Another possibility for expansion of this project is a dual glove keyboard. Drawbacks would include more keys to memorize and a greater unfamiliarity with the keyboard for novices, but the benefits far outweigh that. Inputs will be doubled and efficiency will be increased. A problem with this test was that subjects had to use a look up table for the keys because the prototype had no labels on the keys. A more efficient, more final, version will have characters printed under the contacts like a standard keyboard.

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Mrs. Almeida was always willing to take time out of her planning or lunch to make sure I had my forms correct during the first few weeks of science fair. I remember getting passes to go to her class during school, and she would always put aside what she had to make sure my paperwork was correct and help me. I was one of the first few to get paperwork done so I did not see her during the more stressful times when she had to deal with about 100 kids who were entering, but it is still an admirable feat.

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Bibliography

"A brief history of wearable computing." 2010. MIT. 30 10 2010 <http://www.media.mit.edu/wearables/lizzy/timeline.html>.

"ASCII character codes." 2010. Ascii table. 21 10 2010 <http://www.asciitable.com/>.

Baker, Nick. "BBC. news technology." 11 Aug 2010. Why do we all use qwerty? 17 Aug 2010 <http://bbc.co.uk/news/technology-10925456>.

Casey, Barbara. "How to Make Keyboard Bullets, Stars, Hearts, French Accents, Copyright Symbols & More with the Alt Key." 25 Jan 2010. AGO design. 17 Sep 2010 <http://www.allgraphicdesign.com/graphicsblog/2008/02/13/how-to-make-keyboard-bullets-stars-hearts-french-accents-copyright-symbols-more-with-the-alt-key/>.

"EMF Shielding & Conductive Fabrics." 2010. lessemf. 21 10 2010 <http://www.lessemf.com/fabric.html>.

EPA. "recycle." EPA. 19 Aug 2010 <epa.gov/osw/conserve/materials/ecycling/donate.htm>.

"How to Build an Uber-Gamer Keyboard." Videopedia. 19 sep 2010 <http://www.5min.com/Video/How-to-Build-an-Uber-Gamer-Keyboard-27738677>.

"Humanscale." Ergodynamics. 29 Sep 2010 <http://www.ergodynamics.org/products.html>.

Jonathan Thorne, Nik Valke. "How to Switch to a Dvorak Keyboard Layout." wikihow. 30 Sep 2010 <http://www.wikihow.com/Switch-to-a-Dvorak-Keyboard-Layout>.

"Keyboard glove?" 1 May 2001. Greggman. 17 Aug 2010 <http://blog.greggman.com/blog/a_keyboard_glove___/>.

Kobakant. "conductive fabrics." Kobakant. 22 Aug 2010 <kobakant.at/diy/?p=376>.

lessemf. "stretch conductive fabrics." less emf. 22 Aug 2010 <http://www.lessemf.com/fabric.html-lessemf>.

Microsoft. "Alternative Keyboard Layouts." Miicrosoft accesability. 12 Sep 2010 <http://www.microsoft.com/enable/products/altkeyboard.aspx>.

MIT. "conductive fabrics." Wearables lab. 27 Aug 2010 <http://hlt.media.mit.edu/?p=04>.

—. "Wearable computers." MIT. 27 Aug 2010 <http://media.mit.edu/wearables>.

Osha. "computer workprocesses." OSHA. 17 Aug 2010 <www.osha.gov/stlc/etools/computerworkstations/workprocesses.html>.

—. "computer workstations." Osha. 18 Aug 2010 <http://osha.gov/sltc/etools/computerworkstations/checklist.html>.

Parekh, Alan. "Top 5 DIY Glove Keyboards." 19 May 2006. Hacked Gadgets Forum. 24 8 2010 <http://hackedgadgets.com/2006/05/19/top-5-diy-glove-keyboards/>.

Parkinson, Robert. "the devorak simplified keyboard." 13 June 2003. Shipman's home. 17 Aug 2010 <infohost.nmt.edu/shipman/ergo/parkinson.html>.

"POSITIVE-VOLTAGE REGULATORS." 2010. Texas instruments. 23 10 2010 <http://focus.ti.com/lit/ds/symlink/ua7805.pdf>.

Pratt, Vaughan R. "Thumbcode:a device-independant digital sign language." July 1998. Stanford university. 16 Aug 2010 <http:??boole.stanford.edu/thumbcode>.

Serong, Tim. "Keyglove." 16 Aug 200. Wirejunkie. <http:// wirejunkie.com/resources/wearable/glove>.

Sung, Micheal. "non invasive clothing." human dynamics. 27 Aug 2010 <http://web.media.mit.edu/~msung>.

"The qwerty keyboard layout vs the dvorak layout." Codesharp. 17 Aug 2010 <http://codesharp.co.uk/thumbcode>.

"typing injuries frequently asked questions-answered." TIFAQ. 17 Aug 2010 <www.tifaq.com>.