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Usability Test of Communication System for the Disabled

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Introduction

In our days there are many systems and programs designed for the disabled. Most of them give possibilities to type text and control other applications in Windows OS. These systems and programs are used different ways of text input and application control.

The market offers programs for disabled: "Onscreen v1.75"[1] controls windows applications using virtual keyboard. "WinSCAN v2.0"[2] use one On-Off button. „*The 2000 Series Bundle"*[3] controls windows applications and virtual keyboard using head movements. „*Quick Glance Eye-Tracking System*"[4] use eye movements to control windows applications and virtual keyboard. These systems are only a small part of the offered systems. Most of them are designed for English, French, or other popular languages speaking people.

In this paper, we present software for the physical disabled people with language impairments. Our system is designed for Lithuanian speaking people. We are using a virtual keyboard [5] in our system and it can be controlled by one On-Off button (scanning method), two buttons, eleven On-Off buttons keyboard, or any pointing device.

Possibilities of the system

Designed communication system enables typing, editing text, sending, receiving, forwarding, replying e-mails using one, two or eleven On-Off buttons keyboard. There are possibilities to save and delete received mails and files created by a user. Also there are possibilities to edit e-mail address book. A disabled user can select virtual keyboard from four possible virtual keyboards (no predictive Lithuanian, predictive Lithuanian, no predictive Latin, predictive Latin). One more possibilities of designed systems is a possibility for a user to select scanning speed (2; 10/6; 10/7; 10/8; 10/9; 1 step/s.). A supervisor can select any possible scanning speed.

The functional structure of system is shown in figure 1. The functional structure consists of two main parts – communication and options. The options consist of two parts too – options for the disabled and options for supervisors.

Option for supervisors gives possibilities to adjust scanning speed, to configure e-mail and select the method of text typing.

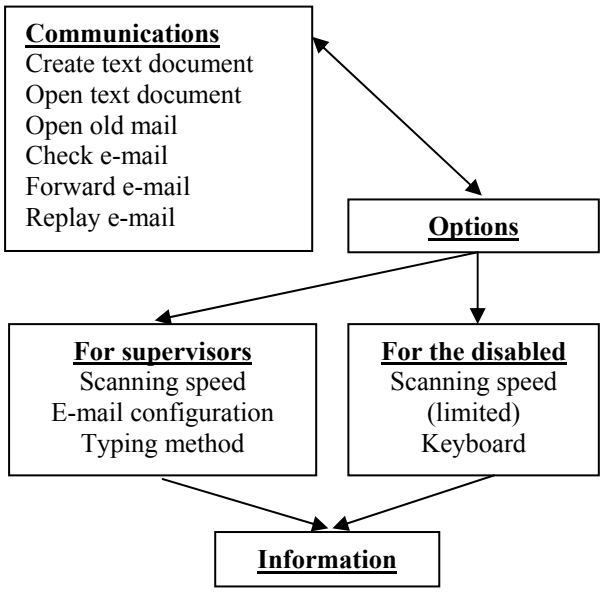

Fig. 1. Functional structure of system

There are three methods of text typing: one button method (computer scans symbols in virtual keyboard, the disabled confirm them); two buttons method (one button for selecting symbols in virtual keyboard, second for confirming selection); eleven buttons keyboard method (10 buttons are using for selecting column/raw in virtual keyboard, one for confirming selection).

Option for the disabled gives possibility to adjust a scanning speed from six suggested variants, if one button control method selected. The disabled user can select virtual keyboard from possible four keyboards. There are: no predictive Lithuanian (typing Lithuanian letters), no predictive Latin (typing Latin letters, have less letters), predictive Lithuanian (word typing using Lithuanian words prediction), and predictive Latin (word typing using Lithuanian words without Lithuanian letters prediction, have less letters).

Information - in this window is displayed common information about system's settings (control method, scanning speed, e-mail address, e-mail address book, keyboard type).

Virtual keyboard

The most common alternative text typing way for physically disabled with language impairment is to use virtual keyboard.

The first step we must choose is the size of the virtual keyboard. The keyboard size must be with minimum of letters number in alphabet. The maximum of keyboard size is limited by the time needed to seek the element of keyboard. The time gets larger when we are using more buttons. So we need to find golden mean between keyboard possibilities and growing time of reaching the element of keyboard.

The second step is to choose layout of keyboard. We must know the absolute frequency of the letters repeating in the language if we use non-predictive typing. Mostly used letter must be in position that we can reach in the shortest time and the seldom-used letter must be in position that we can reach in the longer time. We must know the absolute frequency in language of the letters that are the first letters in the word if we use predictive typing. Letters must be arranged in the same way.

We need to create a prediction algorithm if we using predictive typing. We are using a prediction algorithm where we predicting word after new letter typed.

The last step is to choose the scanning method. There are three main scanning methods: serial, rejecting half of keyboards elements [6], column-raw. Serial scanning is very slow; rejecting half of elements scanning is useful when the keyboard elements (letters, symbols) frequency of appearing in the word have not big difference. Column-raw scanning is more useful when the keyboard elements (letters, symbols) frequency of appearing in the word have big difference.

Using these guidelines were designed four keyboards mentioned above. One of them is shown in figure 2.

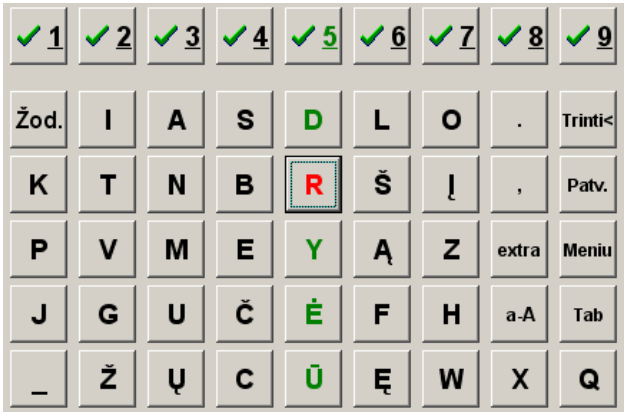

Fig. 2. Predictive Lithuanian keyboard

Figure 2 shows the predictive Lithuanian keyboard. Virtual keyboard have letters, numbers and additional buttons. These additional buttons are: **Žod**. – typing the predicted word or part of word if is impossible to predict, **Extra** – pointing to other keyboard for editing text, writing numbers and symbols; **a-A** – let type one capital letter; **Tab** – tabulation symbol for tabulation; **Meniu** – gives possibility to save, print or send by e-mail typed text; **Patv**. – Enter button – to next line; **Trinti<** - Back Space button)

Text prediction algorithm

We are using database with 2400 words for prediction. 1200 most popular Lithuanian words we have got from Lithuanian Language Institute and other 1200 we enter by self's. Predictive virtual keyboard uses a prediction algorithm shown in figure 3.

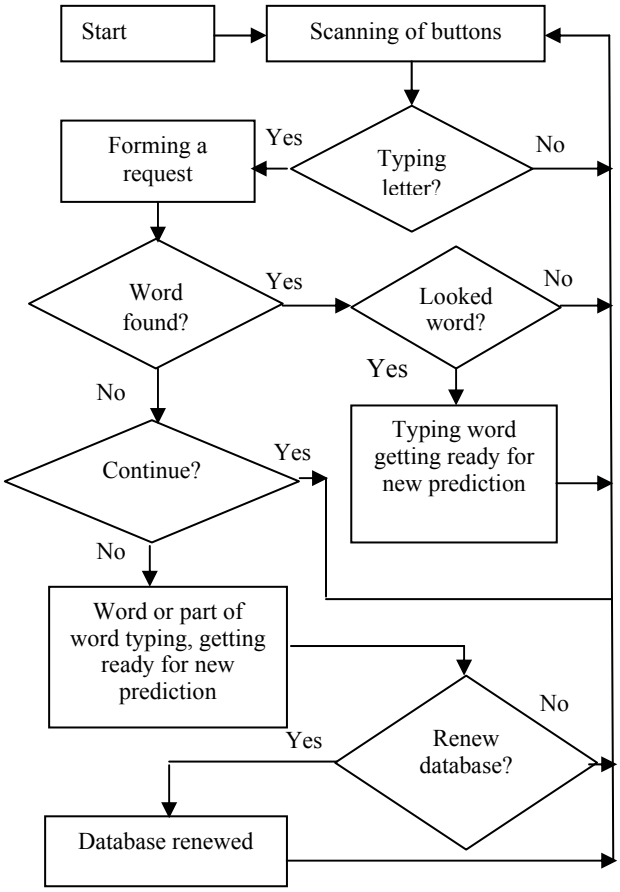

Fig. 3. Prediction algorithm

Research results

System's usability and efficiency were examined experimentally by few experiments. First of all every user typed some five sentences. Typing time for one sentence was one minute. All users typed these sentences using all three types of typing methods (one On-Off button, two and eleven On-Off buttons) and four types of keyboards (A – no predictive Lithuanian keyboard, B – no predictive Latin keyboard, C – predictive Lithuanian keyboard, D – predictive Latin keyboard). Scanning speed was selected 10/7 step/s for typing text with one On-Off button because it was acceptable for subject 3. Table 1 presents the results of this research.

The objective of second experiment is to find out how much time need a user to realize some task.

Description of the second experiment:

a – to reach text typing window and type one symbol,

b – to check e-mail,

c – to open document,

d – to open document, type the name of e-mail (one letter) and send this document by e-mail.

Table 1. The results of text typing efficiency (the number of typed symbols on minute)

Method /keyboard		1sub-ject	2 sub-ject	3 sub-ject	Mean	Std. devia-tion
One On-Off Button	A	10,2	8,8	6,0	8,3	1,75
	B	10,6	9,2	6,2	8,7	1,84
	C	12,8	10,8	9,2	10,9	1,5
	D	16,0	11,8	9,4	12,4	2,7
Two On-Off Buttons	A	27,6	24,8	15,4	22,6	5,2
	B	30,4	25,4	15,8	23,9	6,1
	C	24,2	23,8	15,0	21,0	4,2
	D	25,6	24,4	15,2	21,7	4,6
Eleven On-Off Buttons	A	17,0	13,8	9,2	13,3	3,2
	B	19,2	16,8	9,4	15,1	4,2
	C	20,2	18,8	11,8	16,9	3,7
	D	22,4	19,8	12,0	18,1	4,4

1subject – the system's developer;

2 subject – computer engineer;

3 subject – disabled person (difficult to move hands)

Every user perform task five times. For typing text with one On-Off button scanning speed was selected 10/7 step/s. The results of this research are presented in the table 2.

Table 2. The results of program control efficiency (Time in second need to complete task)

Method /keyboard		1sub-ject	2 sub-ject	3 sub-ject	Mean	Std. devia-tion
One On-Off Button	a	9,16	9,74	10,44	9,8	0,52
	b	9,58	9,64	10,88	10,0	0,60
	c	12,64	13,50	14,28	13,5	0,7
	d	56,41	59,15	62,35	59,3	2,4
Two On-Off Buttons	a	3,50	4,10	5,33	4,3	0,76
	b	3,44	4,19	5,26	4,3	0,75
	c	3,54	4,20	5,28	4,3	0,71
	d	18,11	19,79	23,05	20,3	2,05
Eleven On-Off Buttons	a	2,59	3,25	4,51	3,4	0,8
	b	2,14	2,60	3,47	2,7	0,55
	c	3,51	4,04	4,67	4,1	0,48
	d	14,77	16,20	18,29	16,4	1,45

Results and discussions

Data in the first table shows that:

- The fastest way of text typing is two On-Off keys method,
- Text prediction algorithm shown in figure 3 improves text typing speed about 25%, but gives distortion of words such as bad ending or case of word. When text was typed using two ON-Off buttons the prediction algorithm gave worse results. All users' point that is difficult at once type text and control process of prediction, particularly it was difficult to use prediction and eleven On-Off buttons keyboard at once because at the same time they need to watch the keyboard.
- Typing speed using one On-Off button improves if we choose the scanning speed greater than 10/7 step/s this can cause the significant number of errors.
- The research shows that usage of Latin alphabet instead of Lithuanian alphabet increase the typing speed approximately ~8%.

Also Two-Way Analysis of Variance [7] (ANOVA) were conducted. Results of analyses are presented in tables 3, 4 and 5.

Table 3. The results of ANOVA test, between different keyboard and users

	Users	Keyboards
	F / p	F / p.
One On-Off Button	6,02 / 0,0046	3,04 / 0,0378
Two On-Off Buttons	75,03 / 0	2,27 / 0,0921
Eleven On-Off Buttons	39,05 / 0	5,68 / 0,0021

Table 4. The results of ANOVA test, between different typing method and users

	Users	Method
	F / p.	F / p
A – keyboard	82,09 / 0	251,75 / 0
B – keyboard	124,7 / 0	299,82 / 0
C – keyboard	9,17 / 0,0006	16,56 / 0
D – keyboard	13,93 / 0	13,96 / 0

Table 5. The results of ANOVA test, between different typing method and keyboards

	Keyboards	Method
	F / p	F / p.
1 object	1,57 / 0,21	63.04 / 0
2 object	2,29 / 0,0906	108,85 / 0
3 object	1,19 / 0,3247	22,29 / 0

p – significance level;

F – Fisher coefficient.

According to data of tables 3, 4 and 5 some findings were conducted:

- The user skills are significant parameter affecting typing speed. This parameter has a little bit less affect when one On-Off button text typing method is used.
- The typing method is significant parameter. A user and keyboard's type affects typing method, especially when non predictive keyboard is used.
- The keyboard isn't significant parameter for users, especially for users with bad typing skills.

Data of the second table present such findings:

- The fastest system's control method is eleven On-Off buttons, because is easy to remember the combination of buttons to reach the needed symbol or function.
- The two button method for control isn't out of step for eleven buttons keyboard method. The program control

speed isn't a fundamental parameter of designed communication system for the disabled.

Conclusions

Such findings were conducted: to reject eleven On-Off button text typing and program control method, to reject both (predictive and non predictive) Latin keyboard. Other step is to improve prediction algorithm's productivity (more word, including word's cases, also prediction algorithm must suggest more than one word for users).

References

1. **Innovation** Management Group, Inc. http://www.imgpresents.com/
2. **Academic** Software, Inc. http://www.acsw.com/ws1.html
3. **Enablemart** http://www.enablemart.com/products_detail.asp?id=257
4. Charlier J., Vermandel S., Dubus F., Hugeux J.P., Visioboard: a gase controlled multimedia computer for severely handicapped subjects // Medical and Biological Engineering and Computing, 1997. – Vol. 35. – P.416-417.
5. **Balbonas D., Lauruška V.** Eurekos projekto rezultatai alternatyvių komunikacijos sistemų srityje // Biomedicininė inžinierija. – Kaunas: Technologija, 2003. – P. 167 – 170.
6. **Kubilinskas E., Lauruska V.** Smart home system for physically disabled persons with verbal communication difficulties // Assistive Technology – Added Value to the Quality of Life. AAATE'01. – ISSN 1383-813X. IOS Press, 2001.- P.300 - 304.
7. **Hogg, R.V., Ledolter J.** Engineering Statistics – MacMillan Publishing Company, 1987.

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D. Balbonas, V. Lauruška. Neįgaliųjų komunikacijos sistemos tyrimas // Elektronika ir elektrotechnika. –Kaunas: Technologija, 2004. – Nr. 3(52). – P. 31-34.

Buvo ištirta lietuvių kalbai sukurta alternatyvi žmonių su negalia komunikacijų sistema. Sistema leidžia neįgaliajam rinkti ir redaguoti tekstą, naudotis el. paštu, išsaugoti ir ištrinti gautus el. laiškus, savo paties sukurtus dokumentus, redaguoti el. pašto užrašų knygutę. Tai pasiekiama naudojant vieną On-Off klavišą ir tuo pat metu skenuojant arba dviem ar vienuolika On-Off klavišų neskenuojant. Neįgalusis gali pasirinkti vieną iš keturių klaviatūrų ir savarankiškai nusistatyti bet kokį skenavimo greitį. Nustatyta, kad neįgalusis priklausomai nuo teksto rinkimo būdo bei klaviatūros tipo gali pasiekti teksto rinkimo greitį nuo 8 iki 24 simbolių per minutę. Tyrimo metu prieita išvados, kad neverta atsisakyti lietuviškų raidžių siekiant padidinti teksto rinkimo greitį; atmestas teksto rinkimo, naudojant vienuolika klavišų, būdas, nutarta tobulinti prognozavimo algoritmą. Il. 3, bibl. 7 (anglų kalba; santraukos lietuvių, anglų ir rusų k.).

D. Balbonas, V. Lauruska. Usability Test of Communication System for the Disabled // Electronics and Electrical Engineering. – Kaunas: Technologija, 2004. – No. 3(52). – P. 31-34.

The communication system in Lithuanian language for disabled was researched. System allows typing, editing text, send, receive, forward, replay e-mail using one On-Off button and scanning at the same time, two or eleven On-Off buttons keyboard without scanning. There are possibilities to save and delete received mails and files created by user. Also there are possibilities to edit e-mail address book. Disabled user can select one of four keyboards; also user can select scanning speed. Healthy person can enter anyone possible scanning speed. Research discover that disabled depending on text typing method and the type of keyboard can achieve text typing speed from 8 to 24 symbols per minute. The decision was made to reject eleven On-Off button text typing and program control method and reject both Latin keyboards. Also the authors notice a need to improve the prediction algorithm's productivity. Ill. 3, bibl. 7 (in English; summaries in Lithuanian, English and Russian).

Д. Балбонас, В. Лаурушка. Исследование системы коммуникации для инвалидов // Электроника и электротехника. – Каунас: Технология, 2004. – № 3(52). – С. 31-34.

Была исследована система коммуникации для инвалидов. Система позволяет писать и редактировать текст, посылать и получать электронные письма. Всё это можно осуществить, используя один On-Off клавиш и метод сканирования или два, или одинадцать On-Off клавиш без сканирования. Также имеется возможность сохранить и удалить электронные письма, документы и редактировать записную книжку электронных адресов. Для работы с программой инвалид может выбрать одну из четырёх клавиатур и изменить скорость сканирования. Исследования показали, что инвалид в зависимости от выбранного метода писания текста и выбранной клавиатуры может писать текст со скоростью от 8 до 24 букв в минуту. После исследований решено отказаться от метода писания, используя одинадцать On-Off клавиш и двух латинских клавиатур (остались только литовские). Также решено поысить продуктивность алгоритма, прогнозирующего слова. Ил. 3, библ. 7 (на английском языке; рефераты на литовском, английском и русском яз.).