Assignment M3:

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***Abstract*—Keyboards are currently the most common electronic input device people use when typing text on a computer. Despite the large number of users worldwide, the keyboard designs only target the English proficient speakers. Although it is possible to change the language of typing on a computer, the keys on the keyboard only show the English letters. This poses a huge burden on people who desire to type letters of a different language. The current project aims to investigate this issue, find the needs of the user, propose new ideas to efficiently re-design the keyboard layout, and finally evaluate them systematically.**

1 BRAINSTORMING PLAN

1.1 Objective criteria

At the individual level, I will allow myself a couple of days to write down my ideas on a piece of paper, following the rules explained in the previous section. This way, I will have enough time to take breaks and refresh my mind to generate new ideas. At the group level, I am aiming for a one-hour session with three participants. I will use a stopwatch to allow people to express their ideas in one-minute timeslots. People will speak in their turn. I am aiming for at least 5 ideas for each of the following categories in order to be consistent with the amount of variation: interactions, interfaces, and audience. The goal for the number of ideas generated is 30, for individual and group level brainstorming levels combined.

1.2 General plan

Two steps are considered: individual brainstorming and group brainstorming. First, the ideas are generated at the individual level, following the objective criteria. Then, at the group level, the ideas will be discussed until the standards are met. After that, a flat list of ideas will be generated.

1.3 Specific Plan

At the individual level, the rules include writing down the problem at the top of the page used for brainstorming, constraining myself (i.e., define categories for different types of interactions, interfaces, and audience), aiming to generate 20 different ideas, divide the problem into sub-categories (i.e., for certain needs found in the need finding plan, try to come up with ideas for each of them). The schedule for generating ideas is a total of one hour per day, broken into two 30-minutes sessions.

At the group level, the rules include expressiveness (i.e., participants freely discuss their ideas), non-evaluation (i.e., no one in the group is allowed to evaluate the ideas at this stage), quantity (i.e., people are encouraged to bring more ideas to the table), building (i.e., people are encouraged to build on each other's ideas), stay focused (i.e., the problem will be written on a board where people can see it. They are encouraged to concentrate on the problem), no explaining ideas (i.e., people do not require to come up with reasons to back up their ideas), revisit the problem often (i.e., having the problem written on the board where everyone can see it help them to be reminded of the problem. Also, when getting stock on ideas, the problem can be revisited easily as a group), encourage others (i.e., participants receive an outline of the rules prior to the meeting and are encouraged to help each other to ease participation in the discussions). The schedule for group brainstorming is to come up with a one-hour time that works best for the participants.

1.4 Standards

At the individual level, the standard is considered to generate 20 different ideas. The time spent requires to be a couple of days. At the group level, minimum of 10 ideas are required in a timeline of one-hour session. The ideas are required to be addressing the problem space. They must fit into sub-categories of interactions, interfaces, and audience.

2 BRAINSTORMING EXECUTION

Details of the individual and group-level brainstorming are included in appendix 1. Below is an abstract flat list of generated ideas. An image of individual brainstorming sheet is provided in Appendix 1.

1. Mechanical keyboard (MK) with LED display on each key, showing language-specific letters on the LED display
2. MK with different stickers showing letters of different languages
3. MK with replaceable keys with language-specific letters
4. MK with more keys to avoid requirement to hold two keys at a time
5. MK with additional keys to enter accents
6. MK with no language-specific labels
7. Different MK for different language-specific requirements
8. MK with the keys separated in sections to assist with language requirements
9. MK with additional colored buttons used for different languages
10. MK with keys that can rotate around depending on language requirements
11. MK with a knob to rotate for changing language-specific letters appearing on the keys
12. MK with foot pedals instead of additional keys
13. On-screen keyboard (OSK) projected with laser on the desk.
14. OSK with keys rotating around depending on language requirements
15. Gesture-based keyboard- uses image processing
16. Spell out the words using voice
17. Add more keys to type accents using toe fingers
18. Wearable keyboard- uses haptic feedback to type letters
19. Use brain signals to obtain the letters users has in mind in different languages
20. Design smart glasses that project language-specific letters on the keys
21. Virtual keyboard projection in 3D space
22. Use eye blinking patterns instead of hot keys to eliminate the need to hold multiple keys at a time

3 SELECTION CRITERIA

Selection criteria are defined based on the requirements identified in the need finding plans. For each of the items below, rules are discussed in detail. Also, the link to the data inventory is provided in parentheses.

Requirement for visualize language-specific letters: The design requires to accommodate visualizations on the screen. The users must see the letters to be able to identify and press them (what is the user's need?).

Eliminate the need to press multiple keys to generate specific letters: The design requires to accommodate the need of the user to press multiple keys at a time (what are the user's tasks? Or sub-tasks? What do they need?).

Eliminate physical difficulties: In the need finding phase, the users expressed difficulties with using the on-screen keyboards due to their flat shape. The general structure of a mechanical keyboard was preferred (what is the context?).

Learnability requirement: The interface design requires to be learnable by its design. The preference is the design for which the user immediately knows how to operate the keyboard (what do the users need?).

Accessibility and compatibility requirements: The interface should also be accessible for multiple people having different language-specific requirements. The design also requires to be compatible for the user of Windows and Mac users (what is the context of the task? What are their goals?).

Affordability requirement: The design requires to be affordable in terms of cost. The estimated price requires to be not high relative to the current simple mechanical keyboard used generally (what do the users need?).

4 PROTOTYPE 1

As the first prototype, I would like to discuss about the design of the mechanical keyboard with additional and replaceable keys. I will use textural prototyping method in this section.

4.1 Prototype description

The design of the interface is similar to the current mechanical keyboard's general design. There are keys embedded for both letters and numbers. Keys that have other functionalities are similarly designed (e.g., enter, space, escape, etc.). Four additional keys are provided in order to accommodate for the language-specific requirements (e.g., accents) to eliminate the need for pressing down multiple keys together at a time. The locations of the keys are also similar to that of a general design of a keyboard.

The main idea behind this prototype is having a design similar to the current design of a mechanical keyboard but allowing for replacement of the keys. The keyboard originally comes with keys that have English letter written on top

assembled to the keyboard's palette. The keyboard also comes with a separate box that contains keys (with written letters in a language separate from English on top). The user can remove the currently assembled keys with English letters and replace them with the keys that show non-English letters. Once assembling is complete, users can start typing by pressing down the letter onto the keys replaced. It is important to mention that the users are free to choose where they want to put each key (letter) depending on their preference. Once the key is placed in a certain location on the keyboard palette, pressing that key results in typing the letter shown on that specific key.

The box containing keys with non-English letters can differ between the users depending on their language requirements. For example, one user might like to have a box that contains keys with Farsi letters written on top while another person prefers to have two separate boxes: one with keys with Spanish letters written on top and the other with keys with French letters written on top.

4.2 Prototype evaluation with respect to user's requirements

With this prototype, the requirement to visualize the letters is satisfied. By replacing the keys, users can easily see the written letters on top of the keys.

The need for pressing down multiple keys at once to generate language-specific letters such as accents is eliminated by providing additional keys on the mechanical keyboard.

The interface is similar to the mechanical keyboard. It does not cause additional physical difficulties that people brought up for when using on-screen keyboards.

Since the interface is very similar to the current general design of the mechanical keyboard, it would be trivial for the users to understand how to work with the interface (i.e., pressing down keys with desired letters on top).

The design is considered to be similar for the Windows and Mac users. The same layout and design for the simple current mechanical keyboard design is considered to be used in this prototype as well.

The cost of the prototype is not very different to that of the current mechanical keyboards. However, if the user requires to purchase multiple boxes containing keys used to type different languages, the price difference is considerable.

5 PROTOTYPE 2

As the second prototype, I would like to discuss about the design of the mechanical keyboard with a knob to rotate for changing language-specific letters appearing on the keys. I will use verbal prototyping method in this section. This section is presented in the form of questions and the answers anticipated. Below, first, the interface is described, then a list of the question-and-answer pairs used for prototyping are presented.

5.1 Prototype description

Imagine having a mechanical keyboard similar to the current mechanical keyboard you use on a daily basis but with five more keys. Now, add a knob on the side of the keyboard, maybe at the top right corner. Imagine that you turn the knob one step. The knob clicks showing that it has been rotated by a single step. As a result of this action, the letters currently being shown on the keys rotate back to the keyboard palette and the letters associated with another language pop up on the keys. Now, imagine that this can be done multiple times to change the letter labels into letters of multiple languages. After explaining the prototype, I will start interacting with the user in the form of questions and answers.

- What you think about this design?
  - This is straight forward since I am already familiar with how to turn the knob. However, I think it would be better to include the name(s) of the language(s) that can be selected around the knob. I like being able to visualize the letters from different languages only by turning the knob.
- Sure! That's a great idea. Can you think about any pitfalls of the prototype?
  - This design is limited to two languages because of the keys ' flat shape. Also, any problems with the knob restricts the user to be able to change the letters.

After this, if this prototype was selected, it is important to go through another need finding cycle and make changes to the design per user's requirements.

5.2 Prototype evaluation with respect to user's requirements

With this prototype, users can visualize the language-specific letters on the keys.

This prototype eliminates the need for pressing multiple keys at a time by providing five more keys to type special characters and additional letters.

This prototype is very similar to the design of the mechanical keyboard which were reported by the user to be more comfortable than on-screen keyboards.

Learning how to work with the new design is relatively easy. Users are already familiar with pressing keys on the keyboard. The only challenge would be figuring out how to use the knob to change the labels shown on the keys. However, turning the knob is trivial to the user (affordance). Also, marking language names around the knob (mapping) hint the user how to set the language.

The design can be similar for both Mac and Windows users. The only labels changing are the ones associated with typing language letters.

The additional cost of the knob and turning keys is estimated to be a few dollars when in batch production. Therefore, the price of the new design is not very different from the current mechanical keyboard.

6 PROTOTYPE 3

As the third prototype, I would like to discuss about the design of the mechanical keyboard with LED display on each key, showing language-specific letters on the LED display. I will use wireframe prototyping in this section.

6.1 Prototype description

The design of the interface resembles the current design for a mechanical keyboard. The shape and location of the keys remain exactly the same for the new design. The most common keys such as enter, space, and scape remain unchanged in terms of shape, presentation, and location. Five additional keys are provided in order to accommodate for the language-specific requirements (e.g., accents) to eliminate the need for pressing down multiple keys together at a time.

The major difference between the newly designed keyboard and the current design of the mechanical keyboards is the use of LEDs on top of the keys. This means that each key in the keyboard palette is embedded with a small LED screen. This screen shows a specific letter. When changing the language for typing on a computer, all screens on the keys change depending on the language selected. “Figure 1” shows an example wireframe prototype design for Farsi language. The blue color shows the LED screens on the keys. Additional keys are designed to be placed on the right side of the keyboard.

6.2 Prototype evaluation with respect to user's requirements

The current prototype satisfies the need for visualizing the language-specific letters on the keys to assist with typing. Each of the screens show a specific letter. The LED displays change upon changing the language on the computer. This way, the letters specific to any language can be displayed on the keys.

The additional keys provided eliminate the need to press multiple keys at a time to generate specific letters or accents. The optimal number of additional keys, however, require to be investigated in the next round of need finding.

In the need finding phase, users brought up the preference for using mechanical keyboards instead of the on-screen and virtual keyboards. This new design takes advantage of the on-screen keyboard by using LED displays but gives the user the comfort of the use for mechanical keyboards.

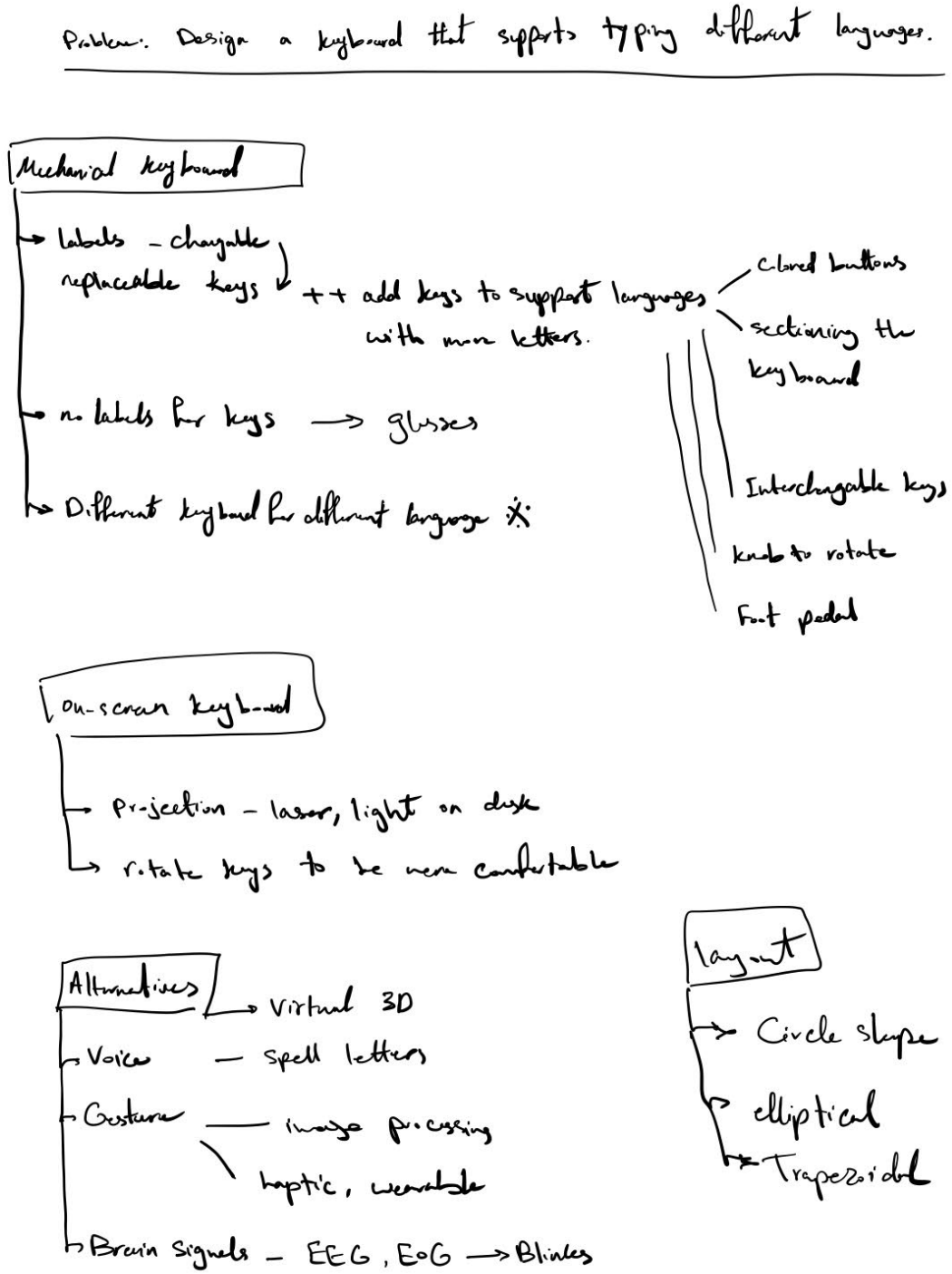
The newly designed interface is learnable. Since the location, sizes, shapes, and the functionality of the keys are similar to the original design of the keyboard, it is trivial for the user to understand how it works. In the first place, the user sees the English letters on the keyboard. After changing the language on the computer though, the user is able to visualize letters specific to the language selected. The functionality of the buttons remains the same. The user immediately knows to press down the keys.

A similar design can be used for both Windows and Mac users. The same layout and design are preferred. The only change would be using LED screens on the keys used for typing.

The cost of this prototype would be similar to that of the current mechanical keyboard. In batch production, small sized LED screens that fit to the size of the keys will cost cents each. Therefore, the difference between the price of the current design and the new design will sum up to a few dollars.

Figure 1- Wireframe prototype of the keyboard with current language set to Farsi

7 APPENDIX 1


Problem: Design a keyboard that supports typing different languages.
Mechanical keyboard
labels - changable replaceable keys
++ add keys to support languages with more letters.
Colored buttons
sectioning the keyboard
Interchangable keys
knob to rotate
Foot pedal
no labels for keys → glasses
Different keyboard for different language ⁂
On-screen keyboard
Projection - laser, light on desk
rotate keys to be more comfortable
Alternatives
Virtual 3D
Voice — spell letters
Gestures — image processing
haptic, wearable
Brain signals - EEG, EoG → Blinks
layout
Circle shape
elliptical
Trapezoidal