Junior Research Proposal

Patrick Taylor - [taylor.patrick@charterschool.org](mailto:taylor.patrick@charterschool.org)

ISEF Category: EBED- Embedded Systems

The problem this project addresses is typing in foreign languages, especially Latin-based ones that utilize diacritics, such as German, Spanish, and French. The process for one typing in foreign languages using a standard American keyboard can be difficult due to the fact it has no built in support for characters featuring diacritics, such as Â, À, Á, etc. In my personal experience, the methods to insert these characters can significantly lower typing speed and consequently productivity. Now, for a unilingual keyboard user this is not the most pressing, however for anyone who speaks multiple languages this can easily start to become an issue. Translators need to have access to these characters, as well as language learning students like myself and the vast majority of our student body. It is unrealistic to have multiple keyboards (especially for three or more languages) and other methods, such as copy-paste, insert from a toolbar, or alt codes can be slow, unwieldy, and/or unintuitive. As such, this project aims to construct a device that is fast, easy to use, and intuitive and then test that device against other special-character typing methods.

Background Research

I had immense difficulty finding work relating to typing speed methods, which led me to believe this particular issue has never been scientifically explored, at least not in any published scientific journal. As such, I opted to instead to research on the materials and design required for the construction of the device.

The first decision I had to make in the design of this device is the microcontroller to use. Choosing a development board over a plain chip was an easy choice, as it would allow me to revisit and tweak my design easily. If I had opted for the cheaper chip without a board, I would have to deal with messy PCB design, interfacing, and surface-mount soldering, all of which are difficult to experiment with. If I were to consider making a full-production run of the product, I would further consider this option. However, due to my lack of time and resources, a development board is the way to go.

Making this decision, I began to look at the different options available to me. First, I decided or the criteria for a development board I would need. It would need to be USB-based, cheap, easy to program, reasonably small, and have at least 10 IO headers. I began my search with Atmel, the current leader in microcontrollers for DIY projects. I decided to use the Atmel ATMega32u4, as it is has the features I needed and also had many development boards that utilized it. I then began looking at the dev board options, including the Arduino Leonardo, Arduino Micro, Arduino Blend Micro, and Teensy 3.2. After weighing the options, I decided to use the Blend micro. While all the options did essentially the same thing, the Blend Micro was more compact than the Leonardo, more available than the Micro, and had the tried and true Arduino brand name the teensy lacked. In addition, it was the only board of these options with built-in bluetooth support, lending itself to a wider range of users, including tablet and phone users.

The next task was deciding how users would input the actual characters. I considered many options, such as touchscreen or trackball based, but in the end a standard keypad design won out, due to the fact it is what most typists are the most comfortable with and would be the easiest to design and construct. The next choice was deciding between mechanical or membrane switches. I chose mechanical switches, again due to ease of design. In the future membrane should be again examined if this device were to ever reach a large-scale production phase. Now I needed to decide on what mechanical switch to use. I chose to browse the Cherry brand, as they are the biggest and most reliable company in the market. Of the MX line, I decided on the Cherry MX Brown (MX1A-C1NW) due to their additional tactile feedback.

With these internals of the device decided, I then began to look at the external design of the device. I opted for 3D printing because it would allow me to easily design and produce a case without requiring expensive tooling or machinery. As for plastic, either ABS or PLA are viable options, and I will likely decide based upon what is most readily available to me. I will conduct some further research here, however this is one of the final steps of production and will be handled closer to production. Keycaps are likely to also be 3D printed.

Other various research included DIY keyboard design in general, including actual construction methods and smaller parts. I learned that having the keys laid out in a matrix pattern would save on IO ports, and by adding diodes to the matrix I could prevent ‘ghosting’(an error that occurs because the controller cannot determine what key is being pressed, due to multiple keys being pressed down simultaneously).

I also began to look at a couple libraries of Arduino code to see what could be applicable to my project. There is an existing keypad library for arduino, however after a couple hours reading through it, I decided that it wouldn’t meet my needs and I would need to construct my own library. I will be drawing from this library for inspiration for a few more general things.

Citations

Tymrak, B. M., Kreiger, M., & Pearce, J. M. (2014). Mechanical properties of components

fabricated with open-source 3-D printers under realistic environmental conditions.

*Materials & Design*, *58*, 242-246.

WHAT IS ARDUINO? (n.d.). Retrieved March 20, 2016, from https://www.arduino.cc/

An introduction to Cherry MX mechanical switches. (n.d.). Retrieved March 20, 2016, from

<http://www.keyboardco.com/blog/index.php/2012/12/an-introduction-to-cherry-mx-mecha>

nical-switches/

*ATmega16U4/ATmega32U4 8-bit Microcontroller with 16 /32K bytes of ISP Flash and USB*

*Controller DATASHEET* [PDF]. (2015). San Jose: Atmel Corporation.

*Keymodule MX* [PDF]. (n.d.). Cherry.

Teensy USB Development Board. (n.d.). Retrieved March 20, 2016, from

https://www.pjrc.com/teensy/

Spinelli, M. (2014, March 29). Build your very own PC keyboard. Retrieved March 20, 2016, from

http://cubiq.org/build-your-very-own-pc-keyboard

Hypothesis

One will be able to type more proficiently with a custom designed device for typing in foreign, Latin-based languages featuring specialized characters than with the traditional typing methods for said characters.

Variables & Procedure pt. 1

The testing for this device will be heavily involved, due to the nature of testing on humans. In order for this section to make any sense, I have decided to include portions of what one might consider procedure. For this test, a selection of subjects will undergo a series of trials to ensure any data obtained is bulletproof against interfering factors.

First, each test subject will receive a short prompt lacking any sort of special characters in order to determine a starting typing speed. They will then receive a prompt of identical length to type, however this prompt will feature special characters, and the subject will be given a certain method of typing these characters, such as copy-paste or alt codes. They will undergo this special-character typing assignment multiple times, each time given a new prompt of the same length and same number of special characters, but differing in actual word-to-word content. This is to ensure any increase in typing speed is due to growth in proficiency with the given tool rather than simply getting used to typing the prompt.

They will then go through the testing once more, this time with a different special character entry method. The purpose of this phase of the experiment will be not only show the difficulty of typing special characters, but also show the learning curve of different character entry methods.

The test subjects will then go through a similar set of trials utilizing the device in question. Prior to the testing using any special-character entry method, subject will receive a short lesson to ensure they understand how to use that method.

The independent variables are character entry method, and the presence of the special characters themselves. One could also say the trial number is also an independent variable, as it is being used to look at the learning curves for each methods. The dependent is the time required to complete the prompt given.

Materials List

* For the construction of the device:
  + Arduino Blend Micro
  + 25 Cherry MX Brown electromechanical switches
  + USB A male to Micro USB male cable
  + 25 diodes
  + 5 LEDs
  + Soldering iron w/ solder
  + Digital Multimeter
  + Desktop power supply
  + ABS/PLA filament
  + Wire strippers
  + 3D printer
  + Various CAD software
  + PCB
  + Drill
  + Hot glue gun w/ glue
* For the experiment
  + The device
  + Computer
  + Testing area
  + Testing prompts
  + Stop watch

Procedure pt. 2

1. Explain experiment to test subject
2. Present subject with normal character prompt
3. Have subject complete prompt & time him/her(via stopwatch), record time taken
4. Complete steps 2 & 3 twice more with different word content yet same length prompts
5. Explain to subject how the next portion of experimenting will go
6. Teach subject copy-paste method
7. Prevent subject with prompt
8. Have subject complete prompt & time them. Record the time taken.
9. Repeat steps 7 & 8 four more times in a similar method to step four(see procedure pt. 1)
10. Repeat steps 6-9 with the alt codes method, the insert character method, and using the device in question.

Procedure, by the numbers

* 10 test subjects (due to time constraints)
* 4 special character entry methods: alt-codes, copy paste, insert character, and the device in question
* 3 trials to determine base typing speed
* 5 trials for each special character entry method (due to time constraints)

Other procedural notes (aka the things I didn’t add because I didn’t read any of the document besides the headers until after I had finished writing this all)

* This is a within subject study, due to comparing typing speed via one method to another, and all participants use all methods
* Measurements are taken in seconds, via stopwatch
* The number of trials per method was chosen because I figured it was the largest number I could ask for before participants started asking for monetary compensation.
* The experiment will take place inside, in a pleasant, room temperature room.(Are all rooms room temperature?)
* I didn’t have time to do anything fancy with diagramming, but it’ll be present in the actual project binder and stuff. There’s probably a rough sketch on the back of this page.
* Sorry if this isn’t formatted precisely as wanted, but I think the dual engineering-scientific experiment approach of this project necessitated it. One couldn’t understand several sections were it formatted precisely to the guidelines.