

Technical Product Specifications Paper

Senior Design Project I

Techblazers

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Product Definition Statement

The Keyboard Finger Position Detector and Display (KFPDD) is a product that enables the visually impaired to see which keyboard keys are being touched without them needing to look down at the keyboard. This device senses when a key is touched and displays this in an on-screen keyboard app on the user's computer. The user will be able to adjust the font type, size, and color for the character and background on each key to the setting that makes the characters easiest to see.

Constraints

- Our device is only compatible with Windows computers. The app will be developed for Windows 10, though Windows 11's backwards compatibility should allow use on Windows 11 personal computers. We could have developed the device for MACs as well but decided to focus on Windows due to the majority of people using Windows computers instead of MACs. According to Statista, Windows' desktop operating system share is over 70 percent, so a large majority of users should be covered anyways. In addition, we would need more resources (time and/or manpower) to develop an app for MACs.
- We would like to give the user the ability to change the transparency of the on-screen keyboard. We are limited on how transparent the on screen keyboard can be because this can decrease the transparency between the characters and background of each key.
- Each person's vision is different, and visual impairment can be best helped in a variety of ways dependent on the individual. As the product cannot initially cater to all of them, it must allow adjustment in any visual metrics the user may need to adjust. These include color, typeface, and character size.
- The physical keyboard-computer connection uses USB 2.0 cabling, so the program must function over a USB 2.0 interface.

Hardware Product Specifications

- Single-board microcontroller

Attribute	Value
Operating Voltage	5V
Flash Memory	32 KB
Clock Speed	16 Mhz
PCB Size	18 x 45 mm
Weight	7 g
Operating Temperature Range	-40°C to +85°C

- USB interface to Windows host

Attribute	Value
USB Type	Type A
Computer Operating System	Windows 7, 8, 8.1, 10, 11

- Capacitive touch sensor breakout board

Attribute	Value
Operating Voltage	1.71V - 3.6V
Capacitance Sensing Inputs	12
Operating Temperature Range	-40°C to +85°C

- Latency with Finger Touch Press

Attribute	Value
Latency: the duration between the moment a key is pressed until the app reads this information.	≤ 70 ms

- Wiring

Attribute	Value
Wire material	Copper
Wire type	Stranded
Wire size	> 22 AWG
Wire Insulation Material	Silicone

- Keyboard Layout (ISO/IEC 9995-2)

Requirement #1	Keyboard needs to have keys for all typical letters, digits, and spacebar on the bottom row.
Requirement #2	There needs to be 47+ Alphanumeric keys <ul style="list-style-type: none"> • Row 1: 12+ keys (for digits) • Row 2: 12+ keys • Row 3: 11+ keys • Row 4: 10+ keys

- USB 2.0 Standard (Applies to the Mini-B and Type-A plugs)

Attribute	Value
Data Rate	480 Mbits/s
Insulation Material	Polyvinyl Chloride
Wire Material	Stranded Tinned Copper
Wire Size	28 AWG
Conductor Resistance	0.232 Ohm / Meter (ASTM-D-4566)
Operating Temperature Range	0°C to 50°C
Storage Temperature Range	-20°C to 60°C
Operating Voltage	5V
Operating Current	500 mA
Durability	The USB plug should last 5000 cycles of insertion and extraction (EIA 364-09).
Mating Force	Max mechanical force required to insert USB connector: 35 Newtons (EIA 364-13).

- Software
 - Keyboard app
 - Variable font size
 - The character sizes should be adjustable, allowing the user to best fit their vision needs.
 - Multiple typefaces
 - There will be a selection of typefaces for use by the users.
 - The focus shall be placed on typefaces that work better for the visually impaired, such as Arial and Helvetica.
 - Both serif and sans serif fonts should be available for use.
 - Customizable Font Colors
 - Color-Vision deficiency could make use of the device harder. The defaults should be in plain black and white, but the ability to select whatever background and character color choice they would need.
 - Keyboard display
 - The onscreen keyboard should match the physical keyboard's layout and dimensional ratios to make the display as intuitive as possible.
 - The onscreen keyboard should have several factors the user can adjust to their own preference.
 - Contrast between keys and characters should be adjustable, with multiple color options to ensure visibility.
 - The onscreen keyboard's transparency should be adjustable to prevent it from completely blocking the background, while allowing it to remain visible.
 - Usage speed
 - Onscreen keyboard must update it's display within 0.1 ms of the keystroke being read, and cannot add more than 0.1 ms delay to keyboard usage.
 - Arduino Code Development(Finger Detection)
 - Arduino IDE
 - Arduino Software environment needed for code development
 - Arduino rest API to exchange data between the arduino and other external systems(arduino board)
 - Arduino IDE characteristics needed
 - Board Selection and Management
 - To try out different boards and find the one which best fits our project
 - Project Documentation
 - Keep project documented for other group members to understand each line of code
 - Libraries
 - Making use of libraries in Arduino to benefit our code development for capacitive touch sensing

- Development environment
 - Python
 - Microsoft Visual Studio
 - Arduino IDE

Alternatives Consideration:

- Arduino Uno
 - Less I/O pins than the Nano
 - Arduino Uno
 - 14 digital I/O pins (of which 6 provide PWM output)
 - 6 analog input pins
 - Arduino Nano
 - 22 digital I/O pins (6 of which are PWM)
 - 8 analog input pins
 - It can be powered with an AC-to-DC adapter or battery
 - We chose to use an Arduino Nano instead of an Arduino Uno due to its smaller size. This will allow us to have more room in our keyboard for other components.
 - Arduino Uno Dimensions: 68.6 x 53.4 mm
 - Arduino Nano Dimensions: 18 x 45 mm
- Power Supply for the microcontroller (Arduino Uno)
 - We could have used a 6-20V unregulated external power supply or a 5V regulated external power supply for the microcontroller. However, we are already using the Mini-B USB to transmit the capacitive sensor readings to the app. Since this USB will provide power to the microcontroller, we do not need any other power supply.
- Solid vs Stranded Wires
 - Since stranded wires have more flexibility and durability than stranded wires, we are using stranded wires for the grid that will help give the keyboard its capacitive-sensing capabilities. We did not want to use solid wire because it is not as flexible or durable as stranded wire
- Operating System
 - As mentioned previously under the constraints section, we chose not to develop our device for MACs because the majority of computer users are on Windows computers. In addition, we would need to develop another app for the MAC operating system, which will take more time than we currently have available this semester.
- Development Programming Language
 - C# typically offers better performance than Python as far as speed
 - C# has fewer libraries to use than Python
 - C# is developed by microsoft, and has somewhat better inherent Windows compatibility than Python
 - The team is more familiar and experienced with Python
 - Multiple members have no experience with C#
 - We decided the learning curve would likely be too long or steep to feasibly use for this project, so we decided to use Python instead.

Reference Page

- <https://www.statista.com/statistics/218089/global-market-share-of-windows-7/>
- <https://acb.org/best-practices-and-guidelines-large-print-documents-used-low-vision-community-authored-council>
- <https://www.w3.org/TR/low-vision-needs/c>
- <https://comparecamp.com/arduino-ide-review-pricing-pros-cons-features/>
- <https://cdn-shop.adafruit.com/datasheets/MPR121.pdf>
- [https://epub.uni-regensburg.de/40182/1/On the Latency of USB-Connected Input Devices author version.pdf](https://epub.uni-regensburg.de/40182/1/On_the_Latency_of_USB-Connected_Input_Devices_author_version.pdf)
- <https://store-usa.arduino.cc/products/arduino-nano?selectedStore=us>
- <https://www.altanatubes.com.br/Blog/AWG/ASTM-B258.pdf>
- [https://global.ihs.com/doc_detail.cfm?document_name=EIA%2D364%2D09&item s key=00127075](https://global.ihs.com/doc_detail.cfm?document_name=EIA%2D364%2D09&item_s_key=00127075)
- [https://global.ihs.com/doc_detail.cfm?document_name=EIA%2D364%2D13&item s key=00481554](https://global.ihs.com/doc_detail.cfm?document_name=EIA%2D364%2D13&item_s_key=00481554)
- <https://www.astm.org/Standards/D4566.htm>
- <https://www.altanatubes.com.br/Blog/AWG/ASTM-B258.pdf>
- <https://www.iso.org/standard/51644.html>

“I have read the entire report and it meets my personal quality standards”

Chase Williams

Emmitt Brandt

Slate Jordan

Victor Siooh

Chief Boateng