One Handed Keyboard

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Construction Process:

Construction began with the 3D printed top surface of the keyboard incasing. After the physically tangible framework( top surface )for the geometry of the keyboard existed it became possible to select and order key switches and a microcontroller that would fit correctly. Once all the important components were acquired, the MX Cherry Key switches were hot glued into the 3D printed framework. At this point it became apparent that the semicircular geometry would not allow for a linear matrix if all rows and columns were to have the same number of connections. This obstacle called for the creation of an improvised schematic that would allow for consistent row-column connections by establishing rows and columns that did not exclusively consist of keys that were within the immediate vicinity of their row or column. Subsequently, most of the soldering connections were made according to the adapted schematic. Due to the complexity of designing and prototyping a keyboard from scratch, the soldering and subsequent stages of construction were not completed within the time constraints but shall be listed below as if they were. Once soldering was complete the beginnings of each row and column were connected to arbitrary IO pins on the Teensy 2++ integrated microcontroller circuit. Once all connections were made the Teensy chip was connected to a computer via micro USB where each row-column intersection was mapped out by the matrix finder option available on Humblehacker.com in Arduino software language. Once all of the keys were assigned their names on the chip, the remaining source code provided by Humblehacker.com was uploaded to the chip to enable key press events.

Changes made to design:

Originally the concept of a one handed keyboard was intended to be a miniature version of its conventional counterparts. Upon further research and consideration it was discovered that even the 26 letter keys alone could not be configured as a rectangle within reach of a single human hand. The solution came in the form of an extended semi circular configuration, which more closely resembled the shape of an outstretched human hand. After creating a solid works model and printing out to-scale sketches a better design was chosen that relied on a standard semi circle rather than one with that extended out approximately 230°. In order to account for the reduced angular displacement the radius of the semi circle was extended towards the forward end of the keyboard, forming a slight elliptical. Due to the geometry of a semi circle the keyboard matrix needed to be designed and built from scratch because any matrix that might have been salvageable was constructed around the standard rectangular QWERTY keypad. In addition, it was decided that all keys would be of uniform size and shape rather than the tradition of enlarging control function keys such as “enter”, “ space bar”, “shift”.

Changes made during construction:

Construction has not been completed at this time. The only change made to date was the orientation of the schematic whose intersections were originally drawn with key cap side of the top in mind. The orientation had to be corrected to account for the fact that when flipped over to the underside, (where soldering connections were to be made) the leftmost key became the rightmost key.

Recommendations for improved design:

The ergonomics of the keyboard could be further investigated and possibly improved. The current configuration was decided by writing a program that counted the number of times each letter of the alphabet occurred within text and finding the average abundance of each letter using the total number of letters input. The letters that occurred most often were placed on the left side of the outer two circular columns (geometric semi circular columns, not the seemingly sporadic electrical connections). Letters that occurred less commonly were either placed towards the less accessible center bottom or the outer right columns of the semi circle. In actuality these decisions were based off conventional assumptions rather than ergonomic studies. It is entirely possible that a superior configuration could be created that considers commonly occurring letter groupings rather than just commonly occurring letters. The key caps for this prototype were constructed of cardboard paper because it is easily cut and cheaper than building key caps out of plastic or ordering manufactured keycaps. Cardboard keycaps leave much to be desired in the way of durability and aesthetics and so an alternate material would be an obvious improvement. Another improvement could be made on the schematic by placing columns E and F after columns A and B respectively. Many different arrangements were considered for a semicircular matrix each with their own respective pros and cons. This proposed alteration would require slightly more wire but would reduce the number of physical wire overlaps, a common point of failure caused by contact of conductive elements which results in a short circuit. Furthermore it would simplify the logistics of wiring key switches by placing keys such that most end up in closer proximity to their preceding and following keys in each row and column. It is also possible to increase the functionality of this keyboard by wiring the columns with diodes in parallel in tandem with downloading extended source code that allows for each key to have and additional meaning (ex, holding shift to capitalize letters or switch between numbers and symbols). By wiring diodes in parallel it is possible to control the direction of current not only to double the functionality of each key but also to switch the entire mode of the keyboard such that one could replace letters and numbers with common words and return to letters and numbers when desired. Finally, despite conclusions drawn by placing an outstretched hand on a printed solid works model, when the prototype was created the numbers on the right side of the keyboard were out of comfortable reach without shifting the rest position of the hand. The shortcomings of a semicircular keyboard could be remedied by reducing the angle from 180°. Furthermore, the balance between angle and elliptical radius (distance from center bottom to forward center) could be treated as an optimization problem to establish what combination of angle and elliptical radius fits the most keys of a given size under an angle 140 ° (the angle of a **comfortably** outstretched human hand).

Commercial production:

If this keyboard were to go into commercial production it would make sense to construct the casing from a mold rather than 3D printing them. Along the same train of though, it would reduce cost to mass-print the matrix onto a circuit board, rather than wiring each one individually.

References:

1. Dr. Jesson: Dr. Jesson is currently an adjunct professor at TCNJ who teaches the 142-EC sections. He is employed by both PC as the Director of Telematics, and by GE as a technology and asset intelligence consultant. He originally worked for Motorola designing and prototyping keyboards and microcontroll-circuits and has provided invaluable guidance throughout the design and construction phases.
2. www. how stuff works.com- “how computer keyboards work”
3. blog.fsck.com- “massively parallel procrastination”
4. www.deskthority.net-“Building a custom keyboard from the ground up”
5. www.dribin.org- “keyboard matrix help”
6. www.humblehacker.com/keyboard - (firmware and software sections/ source code)
7. www.pcbheaven.com-“how a key matrix works”