The Effect of Surface Contouring on Capacitive Computer Keyboard Sensitivity

Ethan Chun[1] and Suresh Subramaniam[2]
[1]Palo Alto High School, [2]Apex Semiconductor

INTRODUCTION

It is established that capacitive computer keyboards are extremely tolerant of harsh working environments (Silicon Labs, 2013). However, due to a user's inability to feel their finger position on a traditional capacitive keyboard key, the benefits of capacitive keyboards have not be realized by the general public (Pavlus, 2013) (Findlater & Wobbrock, 2012).

The majority of capacitive keyboard research has focused on non-contoured flat keyboards and attempted to provide feedback through alternative means (Fujitsu Microelectronics, 2010) (Microchip Technology Inc., 2007). While valid, this approach does not take into account the root of the problem: the flat capacitive keyboard surface (Figure 1). This study addresses such an issue by testing the viability of physically contouring the top surface of a capacitive keyboard sensor to enhance a users ability to locate their finger atop the key.

Figure 1. A traditional capacitive keyboard with flat key surface. From (Systec & Solutions, n.d.)

METHODOLOGIES

This study utilizes the experimental methodologies framework.

For each of the sensor contours in Table 1:

1. Create a 3d computer model of sensor surface
2. CNC machine the model from cell cast acrylic
3. Affix TTP223 capacitive sense module to sensor surface
4. For each location indicated in Figure 3:
   a. Tap location 10 times and record the number of responses using an arduino (T.E.D., 2018)
   b. Calculate sensitivity by dividing number of responses by number of taps (10)

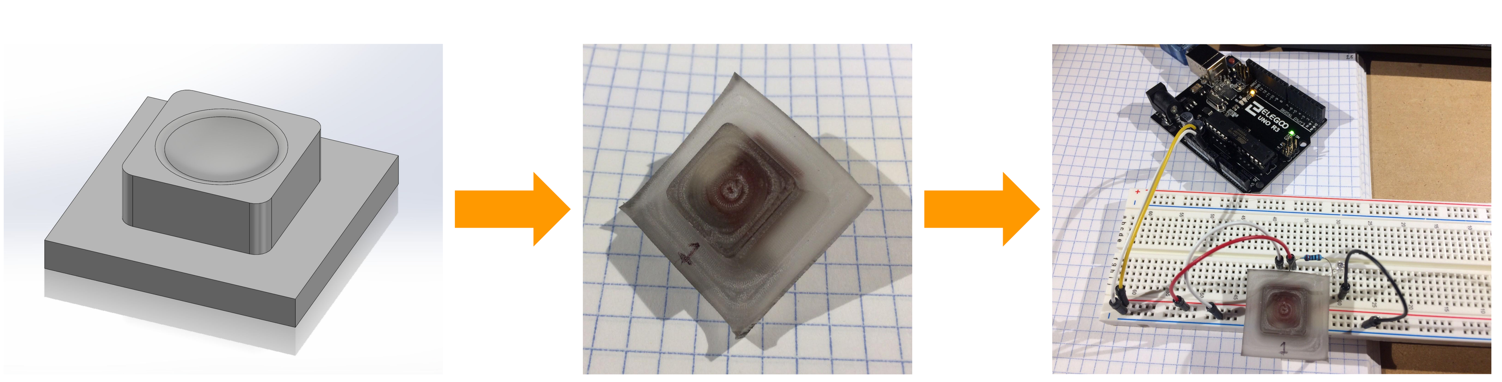

Figure 2. Progression of sensor from model to testing

RESULTS

Table 1. Sensor Sensitivity for each Tested Contour

Contour Description	Sensitivity per touch location (Percent of taps recorded per touch location) (%)				
	Center	20% to Left	20% to Right	20% Above	20% Below
Rounded - 0.050 wall	100%	100%	100%	90%	100%
Rounded - 0.100 wall	100%	70%	100%	90%	100%
Flat Bottomed - 0.050 wall	100%	100%	100%	100%	100%
Flat Bottomed - 0.100 wall	100%	80%	40%	70%	0%
Flat acrylic 0.300" thick	100%	100%	90%	80%	90%

Table 2. Summary Statistics for Touch Sensor Sensitivity

Grouping	Mean sensitivity
0.100" wall tests (excluding center)	77%
0.050" wall tests (excluding center)	99%
Rounded contour	95%
Flat contour	79%

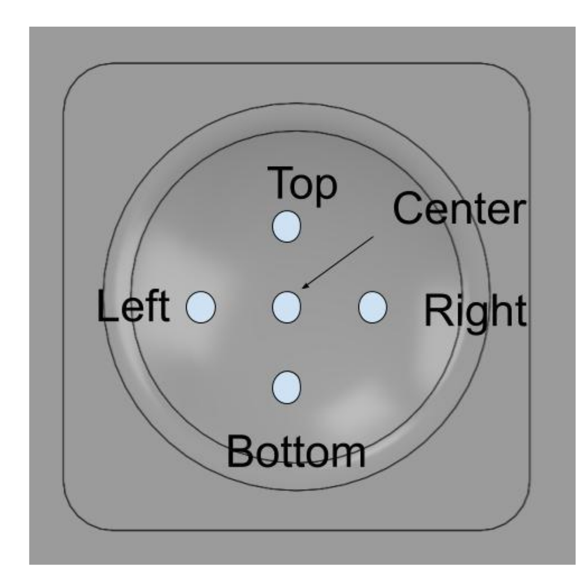

Figure 3. Top view of test locations on capacitive sensor

CONCLUSIONS

This study aimed to address two main questions: 1, is it possible to create a capacitive touch sensor with a contour top surface and 2, how can a contoured top surface provide passive sensory feedback to a user?

As indicated by the 100% sensitivity rating at all positions of Contour No. 1 (Table 1), a functional capacitive touch sensor with a contoured top surface is physically viable. Furthermore, by observing the variance of mean sensitivity based on different groupings (Table 2), one may refine the top surface design to produce the optimal sensitivity.

Experimental observations also indicate that the rounded surface contours demonstrated the ability to direct the finger into the center of the sensor, indicating the presence of centering sensory feedback. This preliminary result indicates that a contoured top surface of a capacitive touch sensor can serve to provide centering sensory feedback to a user.

IMPLICATIONS AND NEXT STEPS

The demonstration of a functional capacitive touch key with a curved top surface is of great importance to designers and manufacturers of capacitive keyboards and similar devices. With the feasibility and functionality of curved top surfaces proven at the experimental level, larger manufacturers have greater incentive to develop curved capacitive sensors that ultimately result in a product that offers a competitive typing experience to traditional keyboards, but also withstands even the harshest working environments and exhibits no mechanical wear.

It is recommended that further work explore more variants of contour depth and shape, as well as how building multiple sensors into the same top panel may affect the sensitivity of a given sensor in that array. These recommendations should produce a more intricate view on the effect of contouring a capacitive keyboard and provide insight into the potential development of a functional consumer grade model.

ACKNOWLEDGMENTS AND REFERENCES

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