THE DEVELOPMENT OF A KEYBOARD FORCE PLATFORM

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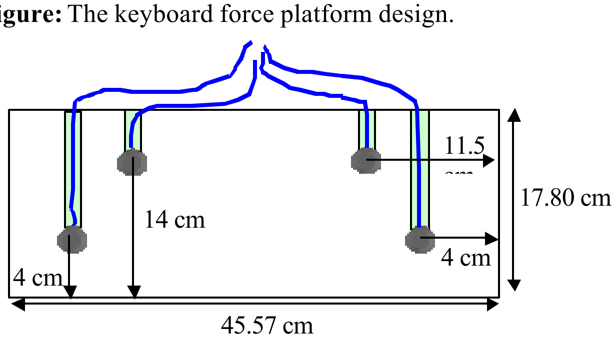
INTRODUCTION

As a person uses a computer there are many forces that act on their body. Many factors, such as the types of keyboard, mouse, computer workplace design being used, and the anthropometrics of the person will contribute to the type and magnitudes of the forces acting on the fingertips. Understanding the relationships between these factors and the applied forces can guide manufactures and researchers to design more ergonomically friendly computer keyboards, as well as the associations between computer keyboard use and musculoskeletal disorders. In order to better understand the forces experienced during typing we developed a force sensing system that allows us to test the magnitude and location of force on a keyboard, during use without significantly altering the height or position of the keyboard. The design will be used at people's own workstations and therefore must be minimally invasive. We are using this system as part of a larger study to determine the musculoskeletal exposure a person encounters during typical computer use activities.

MATERIALS & METHODS

The keyboard force sensing system (Figure 1) is comprised of a rectangular aluminum plate 3.18 mm thick and accepts most commercially available standard and alternative keyboards. Four, 5 lb. Entran load cells, model ELFS-B3-5L, are mounted to the underside of the aluminum plate in a trapezoidal arrangement to decrease the level of vibration. The load cells are mounted in shallow cuts into the surface of the plate. The wires from the load cells are mounted in grooves and lead to the rear of the plate and then to the keyboard amplifier and then onto the data collection computer through a National Instruments A/D board at 200 Hz. The force data was digitally low pass filtered with a cut-off frequency of 20 Hz.

Figure: The keyboard force platform design.



The keyboard platform was tested for load and position accuracy, both statically and dynamically. For the static tests three weights (1.0N, 3.0N and 6.0N) were placed on the platform in a grid with 41 points located 6 cm apart. For the dynamic tests five points on the platform were tapped five times each with a 0.25N weight dropped from a height of 3cm. This was done with no weight on the platform and then with a 1.0N weight over each load cell to mimic the weight of a keyboard resting on the platform. The centroid for the tapping experiments was calculated using the mean force during the tap.

RESULTS AND SUMMARY

As the weight on the point being tested is increased the platform becomes more accurate for both the static and dynamic experiments (Tables 1 and 2). The location algorithm contains the total force in the denominator. As a result, a small signal to noise ratio will increase the noise in the location prediction. For the dynamic tapping, the noise may be due the platform not resting on the table evenly and a rocking between supports may occur. With the weight of standard keyboard spread over the entire platform the platform becomes more stable. The precision of the key was increased with the 1.0N weight over each load cell. The area of a single keyswitch is approximately 2.25 cm^2. The standard deviations of the forces are more than acceptable for measuring forces on the keyboard. One limitation to this force platform is that it is only able to measure single keystrokes. For example if a person were to hold down two keys at the same time the resultant force would be measured somewhere between the two keys.

Table 1 Static Force

Wt.	Distance Err (cm)	
	Mean	Stdev.
1.0N	0.445	0.278
3.0N	0.178	0.112
6.0N	0.148	0.074

Table 2 Dynamic Tapping

Wt.	Distance Err (cm)	
	Mean	Stdev.
0.0N	3.936	0.703
4.0N*	0.651	0.376

*1N over each sensor.

In summary, the keyboard force platform is a useful tool for measuring the dynamic forces on a keyboard during typing. A single key strike on a keyboard requires approximately 1.5 N of force (Rempel, 1994), combined with the weight of the keyboard creates enough stabilizing force to make the force platform's accuracy and precision errors acceptable for use in research.

REFERENCES

(Rempel, J. Biomechanics, 27(8): 1101-1104, 1994)

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