HOW FAST DOES A COMPUTER MONITORING PROGRAM NEED TO RUN TO ACCURATELY CAPTURE KEYSTROKE DURATIONS?

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Aims

Computer monitoring software can provide detailed information on computer use. In an earlier study, we measured keystroke durations during a typing test in the presence and absence of muscle fatigue. With muscle fatigue, there was a parallel decrease in muscle twitch contraction times and keystroke duration times measured during a typing test. To measure an individual keystroke with millisecond accuracy requires high sampling rates that utilize a majority of the CPU, this substantially interferes with the seamless operation of the other applications on the host computer. Therefore, in order to decrease CPU demands on the host computer, we aimed to determine the relationship between accuracy and scanning rate for multiple keystrokes

Methods

In a lab based study, using a computer-monitoring program that monitored the keyboard once every millisecond, the keystroke duration times from 16 subjects were collected across three different days/conditions during five, 5-minute long typing sessions spanning two hours. A total of 324000 keystrokes were collected (an average of 135 keystrokes per data cluster) with the software running at the fastest scan rate, once every 1 second. To understand the effect that different keyboard scan rates would have on measured keystroke durations, keystroke durations were recalculated by simulating the computer monitoring program scanning the keyboard once every 3, 5, 10, 15, 20, 30, 45 and 60 ms. The recalculated data took the original keystroke duration and calculated the new duration based on the closest integer multiple of the new scan rate. Duration error was calculated as the difference between the original keystroke duration and the recalculated keystroke duration. The mean duration error and mean absolute duration error were calculated for each data cluster. Based on keystroke durations from the actual keystroke data (using the 5^{th} percentile, average, and 95^{th} percentile keystroke durations), the same calculations were performed using a simulated digital signal. With the keystroke data collected from the subjects, ANOVA models were fit to the data (independent variable: fatigued/not fatigued, dependent variable duration) at the different scan rates to test if the statistical power for the comparisons changed with scan rate. With the simulated data, ANOVA methods were used to compare differences in keystroke measurement accuracy as the keyboard scan rates slowed from once every millisecond to once every 60 milliseconds.

Results

The average keystroke duration from the 16 subjects was 126ms (S.D 35), with 5%tile of 72ms and 95%tile of 202ms. For recalculated keystroke data, the average keystroke measurement error and the absolute measurement error increased as the scan rate decreased. Mean and absolute mean errors ranged between 0 - 1.3ms and 0.7 -14.8ms respectively for the range of scan rates between 3 - 60ms. For average and variability of keystroke durations, the simulated keystroke data results mirrored the actual keystroke results; however, the mean absolute errors ranged between 1.3 – 19.4 ms for the scan rates between 3 - 60ms. The ANOVA models on the recalculated data suggested that keyboard scan rates once every 20ms or faster will not alter the statistical power of detecting keystroke duration differences of 5 – 10 ms (measured keystroke durational changes during fatigue) among conditions and tests. Longer scan rates altered some of the statistical interpretations due to the combined change of mean and variability of keystroke durations. If the mean absolute error was to be limited to 5, 10 or 15 ms, the simulation indicated that the slowest respective acceptable scan rates would be 10, 26 and 43 ms.

Conclusion

When simulating a decrease in keyboard scan rate, both the keystroke durations based on the actual collected keystroke data and the simulated data showed similar trends. With the data derived from the actual keystrokes across different conditions, measurement errors were minimal until keyboard scan rates were slower than once every 20 ms. With the simulated data, if the scan rate was once every 20ms, the average keystroke duration measurement was 7.4 ms.