A Monte Carlo Simulation Approach for Quantitatively Evaluating Keyboard Layouts for Gesture Input

Rylan T. Conway[a], Evan W. Sangaline[b]

[a]*Physics Department, University of California, Davis, CA*
[b]*National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI*

Abstract

Gesture typing is a method of text entry that is ergonomically well-suited to the form factor of touchscreen devices and allows for much faster input than tapping each letter individually. The QWERTY keyboard was, however, not designed with gesture input in mind and its particular layout results in a high frequency of gesture recognition errors. In this paper, we describe a new approach to quantifying the frequency of gesture input recognition errors through the use of modeling and simulating realistically imperfect user input. We introduce new methodologies for modeling randomized gesture inputs, efficiently reconstructing words from gestures on arbitrary keyboard layouts, and using these in conjunction with a frequency weighted lexicon to perform Monte Carlo evaluations of keyboard error rates or any other arbitrary metric. An open source framework, Dodona, is also provided that allows for these techniques to be easily employed and customized in the evaluation of a wide spectrum of possible keyboards and input methods. Finally, we perform an optimization procedure over permutations of the QWERTY keyboard to demonstrate the effectiveness of this approach and describe ways that future analyses can build upon these results.

Keywords: touchscreen keyboards, gesture input, model-based design, Monte Carlo simulation

1. Introduction

The advent of smartphones and tablets has made the use of touchscreen keyboards pervasive in modern society. However, the ubiquitous QWERTY keyboard was not designed with the needs of a touchscreen keyboard in mind, namely accuracy and speed. The introduction of gesture or stroke-based input methods significantly increased the speed that text could be entered on touchscreens [Montgomery (1982); Zhai and Kristensson (2003); Zhai et al. (2009); Kushler and Marsden (2006)]. However, this method introduces some new problems that can occur when the gesture input patterns for two words are too similar, or sometimes completely ambiguous, leading to input errors. An example gesture input error is illustrated in Figure 1. A recent study showed that gesture input has an error rate that is about 5-10% higher compared to touch typing [Bi et al. (2013)]. With the fast and inherently imprecise nature of gesture input the prevalence of errors is unavoidable and the need to correct these errors significantly slows down the rate of text entry. The QWERTY keyboard in particular is poorly suited as a medium for swipe input. Characteristics such as the “u”, “i”, and “o” keys being adjacent lead to numerous gesture ambiguities and potential input errors. It is clearly not the optimal layout for gesture input.