Generalized Fitts' Law Model Builder

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ABSTRACT
A tool for designing experiments, capturing data, and building Fitts' law models is described. The software runs on an IBM or compatible computer equipped with an appropriate graphical display and selection device (e.g., mouse, joystick). Features intended for HCI educational purposes or experimental research are included, making this a very powerful utility for research in input techniques or Fitts' law. The software is available via anonymous FTP through the internet.

KEYWORDS: Fitts' law, mouse, input techniques, human performance modeling, HCI education.

INTRODUCTION

Fitts' law is a highly successful relation that accurately models human movement time [3]. It has attracted increasing attention since its inception in 1954, and has been widely researched and applied in human-computer interaction (HCI) [2, 7].

It has been suggested that HCI remains "soft science" [8], that research is short on mathematical models and theories. Instead, there is an abundance of anecdotal "research" (*We built this new interface and users liked it!*). It is felt that HCI could benefit from "explicit computer program tools ... The tools may be of any kind – simulation, measurement, analysis or system building" [8]. This implies a role for tools to assist in the rapid development of experimental software to test a variety of input devices in diverse task settings. This poster presents a tool for this purpose: the Generalized Fitts' Law Model Builder. The program is highly extensible and supports the capture and subsequent analysis of relevant data for experiments using input devices (e.g., a mouse) in point/select tasks. The software assists in building Fitts' law models, or in capturing data for other analyses. Applications include experimental research and HCI education.

A Brief Introduction to Fitts' Law

Fitts' law can be stated as

$$MT = \frac{ID}{IP} \tag{1}$$

where MT is the movement time to complete a task, ID is the index of task difficulty (in bits), and IP is the index of performance (in bits/s).

The index of difficulty was originally defined by Fitts as

$$ID = \log_2\left(\frac{2A}{W}\right) \tag{2}$$

where A is the movement distance or amplitude, and W is the width of the target.

Other formulations have been proposed for the index of task difficulty, including

$$ID = \log_2\left(\frac{A}{W} + 0.5\right) \tag{3}$$

proposed by Welford [9] and

$$ID = \log_2\left(\frac{A}{W} + 1\right) \tag{4}$$

introduced by MacKenzie [4]. See also [5, 6].

Fitts' Law Studies

The first study to apply Fitts' law to the mouse was by Card, English and Burr in 1978 [1]. Since then, Fitts' law has been applied to many other selection tasks, all of which differ in small but significant ways. In all cases, the researchers developed their own software to present tasks to the subjects. Typically, for each trial, subjects manipulate a cursor using a pointing device and select a target using a button on the device. Data on the speed and accuracy of the trial are captured and stored in a file. The utility of the Generalized Fitts' Law Model Builder is its built-in flexibility and configurability. This software can be used for many such studies, without requiring the experimenters to develop new software.

THE GENERALIZED FITTS' LAW MODEL BUILDER

The software allows many types of movement tasks to be tested in experimental settings. To facilitate this, many features are tunable through a setup screen and a configuration file read by the program.

The most common task parameters are amplitude (distance from starting position to the target), target width (horizontal

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size), target height (vertical size), and approach angle (from the starting position to the target. The experimenter can set specific values or enable random values to be chosen.

The type of selection task is fully configurable, including the trial repetition (serial versus discrete), whether the task should be a pointing or dragging task, and how the user indicates the beginning or ending of a trial.

The target may be configured as a circle, square, rectangle, or a word chosen from text. It follows that the set of tunable parameters is not orthogonal and some exclusions apply (such as the inability to control target height and width for square or circular targets).

The behavior of the equipment is configurable, including C–D gain of the device, device type (mouse, joystick, other), and type of feedback (e.g., beeps upon an erroneous movement). The aspect ratio of the display device is corrected for, and all distances are measured in millimeters.

Lastly, the software supports the recording of external factors which the experimenters may be interested in, such as the age, sex, or previous computer experience of the subjects.

The Setup Screen

All adjustable parameters are controlled by means of a configuration file. This file uses a simple syntax and can be edited, created, or modified with any DOS text editor. Additionally, there is a setup screen through which all parameters can be set. This allows the configuration file to be altered using a friendly graphical user interface.

The Results Screen

After a block of trials, summary statistics and Fitts' law models are displayed in graphic and text forms. The results are tentative at best, since a single block of trials for one subject is inadequate to draw conclusions. However, the immediate results are useful to educators or students investigating Fitts' law.

Output Data File

Output data files contain the data measured by the software for each session and subject. The data files are numbered, and well commented to reduce the chances of confusing the files during the follow-up analysis.

AVAILABILITY

The Generalized Fitts' Law Model Builder is available through anonymous FTP at our local site (`snowhite.cis.uoguelph.ca`) to anyone with internet access. The software is in the directory `pub/fitts-law/gflmb`. The filename is `gflmb_xx.exe`, where xx is the version number. This directory also contains a file called `GFLMB-README` which contains information relevant to the installation and operation. The file is a self-extracting archive file, which, when executed on DOS, creates files containing the software, a sample configuration file, a users' manual, and any further instructions pertaining to the software. Further inquiries regarding the software should be directed to the second author.

CONCLUSION

The Generalized Fitts' Law Model Builder is useful to HCI educators and students alike. The ease of use and instant data analysis are valuable features of this teaching aid.

At the same time, the Generalized Fitts' Law Model Builder is a robust tool with enough flexibility and rigor for use in serious experimental research in input devices and interactive techniques for human-computer interfaces.

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