Automatically Adjusting Pointing Device Settings Enhances User Double-Click Performance

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Abstract. We are developing an Input Device Assistant (IDA) that automatically adjusts various input device settings to better meet a user's specific needs. As part of this system, we built and tested methods for recommending values for the Windows settings that define double-clicks. Twelve individuals with physical impairments used the IDA system to get recommendations for double-click settings that matched their abilities. Subsequent use of the IDA settings significantly enhanced subjects' speed and accuracy when double-clicking on targets with their pointing device.

Keywords. Computer access, accessibility, pointing devices, assistive technology

Introduction

Computer operating systems include a variety of user-adjustable settings designed to enhance accessibility. These include settings that control keyboard behavior (e.g., StickyKeys, repeat delay), mouse behavior (e.g., gain, double-click time), and display characteristics (e.g., object size, font color). While appropriate values for these settings can significantly enhance a user's ability to use the computer, users do not always know that the settings can be changed or how to change them [1]. A more automatic approach to setting appropriate values, based on the user's needs, could more fully realize the potential of these built-in settings. In this paper, we focus on enhancing a user's ability to double-click on targets by automatically adjusting the Windows double-click settings to accommodate user limitations.

1. Background

1.1. Windows Settings for Double-click

In a typical Windows interface, double-clicks are required to open files and applications and other functions. Some users with motor impairments have difficulty

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completing two clicks in the available time, or keeping the pointer still during a double-click, decreasing productivity and increasing frustration [2]. The Windows XP registry includes the following settings that control the temporal and spatial requirements for double-click:

1. DoubleClickSpeed – the maximum time interval between two clicks to be considered a double-click (in milliseconds). The default value is 500 ms.
2. DoubleClickHeight/Width – the maximum vertical/horizontal distance between two clicks to be considered a double-click. (The registry value is actually twice the maximum distance.) The default value is 4 pixels (px).

Even for users who know that these settings exist, adjusting them is not straightforward. The Accessibility Wizard in Windows XP does not include any adjustments to double-click settings. The Mouse Control Panel does provide adjustments to the DoubleClickSpeed setting, in a range from Slow (900 ms) to Fast (200 ms). However, the Height/Width setting is not available in any Control Panel. More advanced methods are available to adjust the time and space settings, but these require additional knowledge, skills, and time. Finally, with any form of manual adjustment, there is the question of exactly what the correct value should be, which generally requires some form of trial-and-error process. A more automatic approach to determining and activating appropriate values, based on the user's needs, could provide better accommodation for a user's limitations.

1.2. Approaches to Adaptation

To our knowledge, an approach to automatically adjusting double-click settings has not been previously developed. Several teams have been working on input device agents to recommend Windows keyboard and pointing devices [1,3,4]. Our previous work on pointing device settings has focused primarily on gain [3]. Others have designed completely new drivers that rely on knowledge of selectable targets. Balakrishnan reviewed a number of techniques for dynamically adapting the pointing device gain or target size based on cursor speed or position [5]. Some of these methods appear promising, but all appear to still be at the research stage.

2. Methods

2.1. IDA Software

The Input Device Assistant (IDA) recommends double-click settings based on measurements of the time interval and spatial gap between clicks during a task which asks the user to double-click on a series of targets. The basic principle behind each recommendation is to set DoubleClickSpeed and DoubleClickHeight/Width sufficiently large to accommodate almost 100% of the user's attempts at double-click based on a statistical model of the measured click intervals. A maximum value was also established for DoubleClickSpeed (5000 ms) and DoubleClickHeight/Width (64 px). The Windows default values defined the minimum possible recommendation. In these cases where the user required more than 2 clicks to successfully acquire the target, the algorithm processed the entire series of clicks for each target to discern which ones were most likely to be intended double-clicks.

2.2. Evaluation Study

2.2.1. Goals

The goal of this study was to evaluate the ability of the IDA software to make useful recommendations for double-click settings. Our primary hypothesis was that IDA recommendations would be effective, yielding improvements in speed, accuracy, and effort, as compared to the default settings.

2.2.2. Participants

12 experienced computer users participated: five women and seven men, ranging in age from 26 to 71 years old. Each participant had a motor impairment significant enough to affect their ability to use a mouse. Medical diagnoses included cerebral palsy (N=4), cervical spinal cord injury (N=3), brain injury (N=3), multiple sclerosis (N=1), and muscular dystrophy (N=1). Each participant used their preferred pointing device during the study, which included a mouse (N=7), trackball (N=3), joystick (N=1), and MouseKeys (N=1). While most subjects knew that some pointing device settings could be adjusted, 11 of the 12 used the default double-click settings and performed double-clicks in the typical way on their own computer.

2.2.3. Study Design and Procedure

The study design used double-click setting as a within-subjects factor. Subjects performed three target acquisition tasks that comprised an A-B-A design. In each task, subjects double-clicked to select 32 targets, presented one at a time by the IDA software. The two A conditions used the Windows default double-click settings, and the B condition used the IDA-recommended settings. Subjects were oriented to the task and selected 4 practice targets to be sure that they understood it. In each condition, the IDA system measured the timing and distance intervals between the user's clicks. The software used these measurements from the first A condition to recommend the specific double-click settings to be used in condition B. In all conditions, targets were 16px and 32px squares, with an equal number of each size in each condition. Target distances from the previous target were also equal across conditions, but targets were presented at random locations on the screen. This A-B-A design allowed each subject to be analyzed as a single case, as well as affording analysis of the group as a whole.

2.2.4. Data Collection

During each target acquisition trial, the following performance variables were measured and recorded by the software:
1. Selection Time – the number of seconds required to select the target using double-click.
2. Clicks – the number of clicks made during the trial
3. % of Error-Free Targets – an error-free target is one in which the target was selected with only 2 clicks. The percentage is the portion of error-free targets out of all 32 targets in the task.

2.2.5. Data Analysis

The effectiveness of the IDA recommendations was assessed by determining the extent to which using IDA settings resulted in faster performance, less effort, and better accuracy than the default settings. Analyses were performed on those participants for whom IDA recommended either double-click time or height/width different from the default. Single-case analyses were performed for each subject, by plotting each performance variable across the A1, B, and A2 conditions. A "meaningful effect" for each variable was defined based on a clear improvement from A1 to B followed by a clear reversal from B to A2. Specifically, A1 and A2 each had to be at least 15% different than the B condition to constitute a "meaningful effect." Group analyses were performed by averaging the performance variables for both A conditions, and comparing that pooled baseline to the B condition, using paired t-tests.

3. Results

3.1. Recommendations Made by IDA Software

DoubleClickTime recommendations ranged from 500 to 1557 ms, and DoubleClickHeight/Width recommendations ranged from 4 to 13 pixels. IDA recommendations differed from the default settings for 8 of 12 subjects. Of those, 3 had non-default recommendations for the time setting only; 2 for the spatial settings only; and 3 for both spatial and time settings.

3.2. Effectiveness of IDA Settings

Table 1 shows the results for all three performance variables. For the 8 individuals with non-default IDA settings, use of the IDA double-click settings led to an average of 33% fewer clicks per target, 17% faster target acquisition time, and a 29pp improvement in error-free targets (all significant at $p < 0.01$). The effect was very pronounced in some cases, such as Subject 5 who selected 97% of targets with no errors using IDA settings, but only 31% without errors using the default settings.

Table 1. Average performance measures using default and IDA settings. Values for default settings are averages of both A conditions. ** = IDA significantly better than Default at p<0.01.

Measure	Default	IDA
Time per Target (sec)	8.65	7.26**
Clicks (N)	4.16	2.64**
Error-free Targets (%)	36.52	65.24**

The single-case analyses were consistent with these results. 7 of 8 participants had a meaningful effect on at least one performance variable: 7 of 8 for Error-free Targets, 5 of 8 for Clicks, and 4 of 8 for Time. Figure 1 shows an example of a meaningful effect for Subject 9, in which IDA settings resulted in 49% fewer clicks than the first default condition, and 55% fewer clicks than the second default condition.
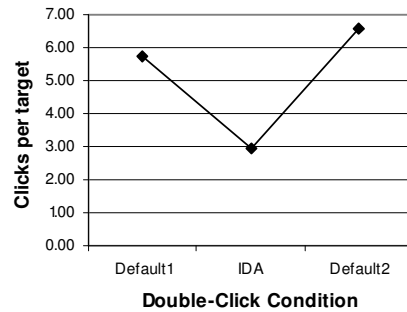
Figure 1. Example of single-case analysis, showing Subject 9's Clicks per target for each of the 3 conditions.

4. Discussion

For this group of 12 subjects, the IDA algorithm significantly enhanced their ability to execute double-clicks successfully. However, it should be noted that simply setting the values to their maximum value would also prevent double-click errors, but at the cost of practical feasibility. When the double-click settings are too high, two successive single-clicks can be mistakenly interpreted as double-clicks. Our approach is able to tailor the settings to each individual, for values that are not too big, but not too small.

There are, of course, other methods of accommodating user difficulties with double-clicking. The need for double-clicks can be significantly reduced, but not eliminated, by setting Windows Explorer to open files and folders with a single click. Our algorithm does suggest this setting if the double-click settings exceed their maximum value. Additionally, many trackballs and alternative pointing devices have buttons which can execute a "double-click" with one click. Our system will inform users of these options as well as presenting their customized double-click settings.

Our approach works with the existing operating system design and attempts to improve its ability to meet user needs. Changing the double-click settings alone accommodates some but not all limitations. This approach will eventually be used in concert with other algorithms designed to accommodate targeting difficulties via changes in objects size and pointing device gain.

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