Predictive Link Following for Accessible Web Browsing

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ABSTRACT

Users of mouse-replacement interfaces can have difficulty navigating web pages. Small links may be difficult to click, and cluttered pages can result in following an incorrect link. We propose a predictive link-following approach for web browsing that intercepts mouse click signals and instead follows links based on analysis of the user's mouse movement behavior. Our system can be integrated into web page scripting to provide accessibility without needing to install separate software. In a preliminary experiment, users were able to click particularly small targets more accurately with our system compared to traditional mouse clicks.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces; K.4.2 [**Computer and Society**]: Social Issues—*assistive technologies for persons with disabilities*

General Terms

Human Factors

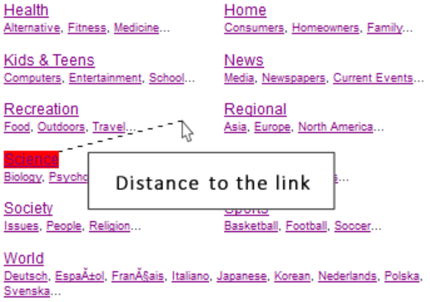
Keywords

Accessibility, Web Browsing, Mouse Replacement Interfaces, Camera Mouse, Target-Aware Pointing

1. INTRODUCTION

Point-and-click interfaces present users with the task of positioning a pointer over a user-interface element, and then performing a selection operation. Users with typical motion abilities using traditional interface devices such as mouse or touchpad have good results with this model. For web browsing, clicks are treated as a command to follow a link.

Users with low dexterity, involuntary movements, or tremors; or users of alternative interfaces such as accessible joysticks, trackballs, or computer-vision based interfaces can have difficulty with this interaction model. For example, it may be difficult for some people to stop the pointer motion over a link while they activate the click. This problem is especially evident in dwell-time selection interfaces [7]. Small links can be difficult to select, resulting in the user "missing" the link. Closely clustered links make the problem worse: users may unintentionally follow a nearby link.



Health
Alternative, Fitness, Medicine...
Kids & Teens
Computers, Entertainment, School...
Recreation
Food, Outdoors, Travel...
Science
Biology, Psycho
Society
Issues, People, Religion...
World
Deutsch, EspaÃ±ol, FranÃ§ais, Italiano, Japanese, Korean, Nederlands, Polska, Svenska...

Home
Consumers, Homeowners, Family...
News
Media, Newspapers, Current Events...
Regional
Asia, Europe, North America...
Basketball, Football, Soccer...

Figure 1: Mouse pointer distance to bounding box of all links. Selection normally requires clicking within the bounding box, our system can take into account near-misses.

Assistive pointing systems can be target-aware (e.g., [3]) or target-agnostic (e.g., [8]). Click actuation can be physical, manual, or inferred (e.g., [4, 7]). Mouse tracking techniques have been used for activity analysis [1, 9], psychological analysis [6], studying mental processes [5], and behavioral biometrics, among many others.

2. PREDICTIVE LINK FOLLOWING

We propose to analyze the mouse movement and clicks before instructing a web browser to follow a link. Our algorithm is implemented as a script that can be embedded in a webpage - so it can work with any general pointer interface and does not require any software installation. The system parameters allow it to be configured for different user's abilities and preferences. The proximity of a mouse movement, hovering, and clicking activities to every link on a web page contribute to its prediction score that is used in deciding if the link should be followed (see Fig 1). In this way, clicks are no longer *commands* to follow a link, instead becoming one of several pieces of evidence indicating a user's intention. A click that barely misses a link can still cause the link to be followed.

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Each link a at time t has a prediction score $P_t(a)$:

$$P_t(a) = \tau * P_{t-1}(a) + \texttt{pointer}(a)$$

Where τ is a time decay factor, and $\texttt{pointer}(a)$ is a function related to the action of the mouse pointer in the current time instant:

$$\texttt{pointer}(a) = \begin{cases} \frac{1}{\texttt{dist}(a,\texttt{clickpoint})^{\beta}} * \gamma & \text{if clicked on the page} \\ \texttt{hoverScore} & \text{if hovered over link} \end{cases}$$

where β affects how much the distance from a link to the click increases the score, and γ weights the click score. `hoverScore` is a constant value added to a link's prediction score when the mouse hovers over the link. These parameters were found experimentally but will be learned in a future system.

At any time instant, if $P_t(a) > \texttt{threshold}$, the link a is followed and all scores reset to zero.

3. EXPERIMENTAL EVALUATION

We conducted a preliminary experiment to evaluate our prototype system.

3.1 Apparatus, Procedure, and Users

The Camera Mouse[1][2], a computer-vision based mouse-replacement interface was used as the interaction modality for the experiment. The following settings were used: horizontal and vertical gain were *medium*, and dwell-clicking was selected with *normal* radius and *1.5 second* dwell-time.

The system was configured with Logitech C270 HD Webcam. The parameters chosen for our system were $\tau = 0.99$, $\gamma = 40$, $\beta = 2$, and $\texttt{hoverScore} = 0.4$. The `threshold` was 0.9.

Testing consisted of two conditions, performed in alternating order: normal dwell-time clicking and predictive clicking. Users are presented with a web page consisting of a section of links from the directory section of `myway.com`. This page is a representative of pages with dense groupings of small links. Users were asked to conduct ten trials as follows: control of the system is turned over to the user, the web page highlights a link in red (Fig. 1). When the user either successfully follows the link, unintentionally follows an incorrect link, or 5 seconds elapses, the trial ends and the system pauses for 1.5 seconds before starting the next trial. We recorded whether or not the user successfully followed the link.

A total of 7 participants were enrolled in the experiment. In this preliminary experiment, none of the participants identified as having any motion impairments. Overall, the experiment consisted of 7 users × 2 conditions × 10 links = 140 total trials.

3.2 Results and Discussion

Out of 7 participants, 4 were more successful in selecting links using predictive clicking, 1 had equal results, and 2 were more successful using traditional dwell-time clicking. Overall, users were able to correctly select 46/70 links with our system versus 37/70 links with dwell-time clicking.

Qualitatively, users often successfully selected links with our system that would be missed with dwell-time clicking. Some unintentional selections occurred in both systems, especially when the users did not move the pointer in between trials, triggering an accidental click at the beginning of the next trial. Our system did a better job selecting links that the user intended, but did not provide much benefit in preventing unintentional links from being followed. This could be mitigated in a real system by restricting clicks as pages load, or in a future experiment by repositioning the mouse pointer.

4. CONCLUSION

Development of our system is ongoing. We plan to learn parameters for a particular user's abilities. It is also possible to add other parameters beyond hovering and clicking. Our approach can be generalized beyond accessibility computing toward a system that can predict users' interaction with a web page. We will evaluate future iterations of the system with users with various motion abilities, involuntary motions, and alternative interfaces. We plan to include measurements of precision and completion time, perform statistical analysis, and normalize each trial by starting the pointer in a neutral position.

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