Predictive Link Following Plug-In For Web Browsers

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ABSTRACT

We demonstrate a target-aware pointing assistance software plug-in for web browsers. Web browsing can be difficult for people with motor impairments because of small links and cluttered web pages. The lack of high-precision movements presents a challenge for such interfaces because clicks may miss a link, or links may be followed unintentionally. Our approach is based on Predictive Link Following which alleviates the difficulties with link selection when using mouse replacement interfaces by predicting which link should be clicked based on the proximity of the cursor to the link. We previously presented and evaluated this method as lab-based experiments that were restricted to our custom web pages. We here demonstrate a plug-in for web browsers that allows our method to work on any web page. This publication accompanies the public release of the software as a freely-available download.

CCS Concepts

•**Human-centered computing** → **Accessibility systems and tools;** *Accessibility technologies;*

Keywords

Accessibilty; web browsing; mouse replacement interfaces; target-aware pointing

1. INTRODUCTION

People with motor impairments may use adaptive mouse devices or mouse replacement interfaces to control the pointer in point-and-click computer interfaces. Example adaptive devices include modified mice, trackballs, mouth joysticks, and touchpads. Mouse-replacement interfaces can include Computer Vision based systems allowing control via head movements or other body parts, and eye-gaze systems that control a pointer based on where the user looks at the screen.

However, many point-and-click tasks can be difficult due to low dexterity, limited mobility, involuntary motions, or the nature of the interface. Particularly with dwell-time based selection interfaces, it can be difficult to stop the pointer motion over a link to activate a click in the precise spot. Small links are especially difficult to select, resulting in the user "missing" the link. Closely clustered links make the problem worse: users may unintentionally follow a nearby link. A low threshold for dwell-time selection can also cause unintended link selection, a phenomenon known as the "Midas Touch" problem.

The aforementioned difficulties have been observed by the second author and his collaborators in Camera Mouse[1] [1], users over a period of many years. The Camera Mouse is a computer vision mouse replacement system intended for people with severe motion impariments. It allows the control of a mouse pointer through head motion or other body motion. These observations have been the primary inspiration for the creation of the predictive link approach to assist users with web browsing.

Assistive pointing systems can be target-aware or target-agnostic. Click actuation can be physical, manual, or inferred. Target-aware pointing systems are difficult to generalize because the pointing interface needs to be informed of the locations of each of the targets. This is a problem because the pointing device is typically controlled by the operating system and sends mouse events to the software application to make interaction decisions.

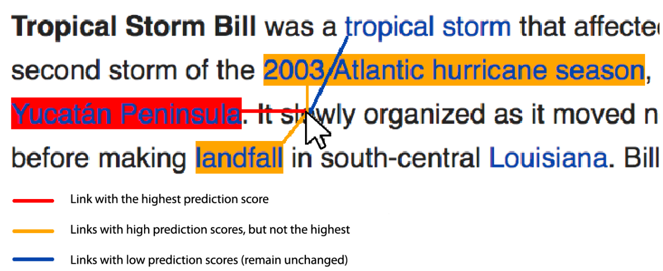

Figure 1: The distance from mouse pointer to bounding box of all links is calculated and contributes to the current link score. Selection normally requires clicking within the bounding box; our system can take into account near-misses. The link with the current highest score is highlighted red, while nearby links with high scores are highlighted orange.

[1] Available at: http://www.cameramouse.org

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Our approach is a plug-in for a web browser that intercepts mouse click signals and instead follows links based on analysis of the user's mouse movement behavior. The software accumulates a score based on pointing *near a target* to assist in selecting the target even when the user is unable to actually click on it.

Many applications such as email and social media are now "web based", meaning they run as web pages within a web browser. The way web browsers render web pages exposes the location of all links to scripts and plug-ins. Therefore, our application can retrieve the location of all links on a page and will work with most web pages and applications. This approach thus opens a wide range of applications to target-aware pointing techniques.

2. PREDICTIVE LINK FOLLOWING

Our algorithm analyzes mouse movement and clicks before instructing a web browser to follow a link. Our software is implemented as plug-in for web browsers. This allows it to work with most web pages and with hardware or software that controls the pointer. The system parameters allow it to be configured for different users' abilities and preferences. The proximity of mouse actions to every link on a web page contribute to its prediction score which is used to decide if the link should be followed (see Fig 1). In this way, clicks are no longer *commands* to follow a link, instead becoming an indicator of the user's intention. A click that barely misses a link can still cause the link to be followed.

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:

$$\text{pointer}(a) = \frac{1}{(\text{dist}(a, \mathit{mousepoint}) + 1)^{\beta}} * \gamma$$

where β affects how much the distance from a link to the click increases the score, and γ weights the click score. These parameters are configurable by the user. The function is used to accumulate a score for how likely a user is trying to click on a particular link a based on the distance from the pointer to the link.

When a click is detected, if $P_t(a) > \texttt{threshold}$, the link a is followed and all scores reset to zero.

3. EXPERIMENTAL EVALUATION

The authors and their collaborators previously reported experimental evaluations of two iterations of the Predictve Link approach.

In the first study [2], seven participants used the Camera Mouse to control the mouse pointer with their heads. Four of the seven participants experienced better performance with the predictive algorithm, while one reported equal performance and two reported worse performance. Qualitatively, the participants noted that they were able to click links that they would have missed with traditional dwell-time. Many of the errors in the initial trial were caused by links being followed unintentionally as a new page loaded. The current software can prevent this by disabling clicking while the page is loading.

In the second study [3], an improved algorithm was tested using an eye-gaze system, the Tobii EyeX. Seven new participants conducted trials comparing predictive link clicking and blink clicking. All participants in this trial reported better performance with predictive link than with the blink-clicking condition. Qualitatively, it was observed that the additional jitter present in eye-gaze control seemed to favor the preditive-link approach since a score is accumulated over time rather than a link being selected by an instantaneous click.

4. DEMONSTRATION CONFIGURATION

The accompanying demonstration at ASSETS '17 consists of a laptop configured with several input devices: laptop touchpad, external mouse, the Camera Mouse, and Tobii EyeX devices. A web browser with the predictive-link plug-in will be running with several popular web pages for the participants to try.

A short interactive demonstration typically involves the Camera Mouse for pointer control. Attendees are invited to sit or stand at the laptop and control the pointer using their head motion as captured by the computer-vision based system. They may try traditional dwell-time clicking and our predictive-link clicking approaches on several web pages. If time allows, additional input devices and configurations may be tested by attendees.

A task to follow a series of links on Wikipedia will also be offered so that participants may time themselves and compare their performance using dwell-time versus predictive link.

We will solicit feedback from people at the demo, and invite them to leave their contact information. We will also provide cards with software download instructions.

5. CONCLUSION

This publication represents the first public release of our software as a freely available download. Development of our system is ongoing and feedback from those who try our system will be incorporated into future versions. Future plans include using machine learning to set the system parameters for a particular user's abilities. We also plan an opt-in to participate in research data collection based on crowd-sourced usage. We will continue to evaluate future iterations of the system with users with various motion abilities, involuntary motions, and alternative interfaces.

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