# GazeTheWeb: A Gaze-Controlled Web Browser

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## ABSTRACT

Web is essential for most people, and its accessibility should not be limited to conventional input sources like mouse and keyboard. In recent years, eye tracking systems have greatly improved, beginning to play an important role as input medium. In this work, we present GazeTheWeb, a Web browser accessible solely by eye gaze input. It effectively supports all browsing operations like search, navigation and bookmarks. GazeTheWeb is based on a Chromium powered framework, comprising Web extraction to classify interactive elements, and application of gaze interaction paradigms to represent these elements.

## CCS Concepts

**•Information systems → Browsers; •Human-centered computing → Interaction paradigms;** *Accessibility technologies; Web-based interaction;*

## Keywords

Web accessibility, eye tracking; gaze input; eye-controlled interfaces; Web browser; navigation

## 1. INTRODUCTION

Information access and communication are among the main challenges that people affected by severe disabilities have to face. World Wide Web provides a large amount of information to people, and it helps them to connect and communicate with society. In this regard, the *World Wide Web Consortium's Web Accessibility Initiative* (WAI) [2] states: *"Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web"*. However, these operations on Web interfaces are usually performed through conventional browser applications, controlled by input devices such as mouse or keyboard. In this regard, eye gaze interaction [3] provides a novel tool to build hands-free Web interfaces, and to increase Web accessibility for cases where motor impairments hinder easy hand and body motion.

Most graphical user interfaces (e.g., browsers) for Web access are not designed for use with eye tracking devices, which often have limited accuracy or may require unconventional selection techniques that interfere with access to information [6]. Different interaction techniques like reading, scrolling, and clicking have been studied for precise eye-based access [6, 7]. However a major challenge to imply these interactions on Web is to identify the interactive Web elements and to include eye tracking events with the Web technology. The Text 2.0 framework[1] provides a pertinent guideline for the Web developers to integrate eye gaze interactions in their Web application. But it does not resolve the problem of browsing the current Web with eye-based interactions. For this purpose, users have to rely on gaze emulation of mouse and keyboard [1] to operate current desktop browsers, which suffers from low usability in the sophisticated scenario of Web browsing. Furthermore, there have been some approaches to develop prototypes of gaze-controlled Web browsers [9] with very limited functionalities. To the best of our knowledge, there are no available browsers providing a wholesome gaze-adapted interface with automatic extraction and handling for complete and smooth Web access via gaze commands. In this work, we propose *GazeTheWeb*, an open source framework to adopt Web interfaces for gaze interaction, where the input events (which are typically composed of mouse and keyboard interactions in generic applications) are revised to eye movements. In comparison to current approaches of additional browser extensions to include eye gaze events, we peruse a novel methodology of expending *Chromium Embedded Framework*[2] (CEF), which provides more utility and control to build eye controllable interfaces.

## 2. GAZE THE WEB

GazeTheWeb supports unobtrusive gaze-based Web access by a browser incorporating efficient interface design and Web engineering. The browser interface is built upon gaze interaction paradigm, i.e., interface components such as size,

[1]https://text20.net

[2]https://bitbucket.org/chromiumembedded/cef



*W4A 2017 April 02-04, 2017, Perth, Western Australia, Australia*



ACM ISBN 978-1-4503-4900-0/17/04…$15.00

DOI: http://dx.doi.org/10.1145/3058555.3058582

shape, appearance and feedback, which are vital to compensate eye tracking accuracy for input control [5]. Additionally, the usage frequency of Web navigation (e.g., back, forward, click) [4] has been considered for placement and positioning of elements. The Web engineering aspect examines the location of selectable objects on webpages, such as text input fields, hyperlinks, scrollable sections, select fields, etc. The extracted elements are then represented with explicit/implicit indicators to be accessed by eye gaze input. GazeTheWeb browser has been released under an open source license, available on GitHub[3].

## 2.1 Functionality

We describe some of the essential browsing features in the following. The detailed functionality of GazeTheWeb can be seen in the online demonstration[4]:

- **Scrolling** reveals content that overflows the available screen height. We offer scrolling sensors on top and bottom of the page for manual scrolling. The sensors directly react to focus and accelerate scrolling on further fixation. A progress bar embedded on the sensor provides visual feedback about the current scroll position. Optionally, an automatic scrolling approach is available, which centers the content beneath gaze coordinates.
- **Navigation** of hyperlinks is an essential tool for Web browsing. We employ a combination of link extraction and click emulation to provide high compatibility. Since eye tracker accuracy is not sufficient of direct link selection, we apply continuous zooming while highlighting extracted links. When the dynamic zooming process surpasses a threshold to identify a precise coordinate, a click is performed.
- **Text Input** fields on webpages are extracted and gaze-controllable indicators are displayed for gaze-based activation. A virtual keyboard supports generic gaze-based text entry with dwell time activation.
- **Tab Management** is completely adapted to gaze input and features adding, removing, bookmarking, reloading of tabs, and editing of the URL.

## 2.2 Implementation

GazeTheWeb is developed using C++ and OpenGL, and utilizes the Chromium Embedded Framework for webpage rendering. This is based on the Chromium project[5], which also serves as foundation of the popular Google Chrome[6] browser. It enables us to adapt functionalities like text input or select field interaction for gaze input. Furthermore, it allows the possibility of extracting interactive webpage elements with JavaScript induced callbacks containing DOM nodes. We implemented an extentable pipeline system containing a linear series of atomic actions like zooming on a webpage to obtain an accurate pixel coordinate, or the virtual keyboard for eye typing. Interface element rendering and interaction is delegated to the eyeGUI [8] library, which provides gaze-controllable user interface elements that can be composed using a XML-based layout language.

[3]https://github.com/MAMEM/GazeTheWeb
[4]https://youtu.be/x1ESgaoQR9Y
[5]https://www.chromium.org
[6]https://www.google.com/chrome/browser/desktop

## 2.3 Performance

GazeTheWeb browser functionalities were compared with OptiKey [1], which represents the conventional approach of mouse and keyboard emulation with eyes. The participants (4 female, 7 male) were asked to perform the specified browsing tasks [4] of search, navigation and bookmarking using GazeTheWeb browser and Google Chrome browser, controlled by OptiKey emulation. All measured aspects like average task completion time: 252.18 and 424.15 seconds for GazeTheWeb and OptiKey respectively (p-value 0.0023), SUS usability analysis scores (83.86 and 57.96) and NASA-TLX workload scores (43.0 and 54.5) signifies the efficiency of GazeTheWeb browser.

We are currently carrying out clinical studies with the user group of *Neuromuscular Disease* (NMD), *Spinal Cord Injury* (SCI) and *Parkinson's Disease* (PD) patients to evaluate GazeTheWeb usability and impact for people with physical impairment, who have limited or no access to Web as they can not operate conventional input devices.

# 3. ACKNOWLEDGMENTS

This work is part of project MAMEM[7] that has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number: 644780.

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