

Microsoft Eye-Tracking Game Development

The MS Eye Tracking Game Project's goal is to develop a video game where the player is able to play the game exclusively with eye movements. This game must teach the user how to use the basic gestures of eye tracking technology.

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I. Introduction

Many people are unable to use computers due to physical disabilities. One such disability is ALS. Also known as Amyotrophic Lateral Sclerosis or Lou Gehrig's disease, ALS is a neurodegenerative disease that affects as many as 30,000 people in the United States with 5,000 new cases diagnosed each year. ALS causes the degeneration of upper and lower motor neurons, in the brain and spinal cord, respectively. Muscles begin to atrophy as they are no longer receiving impulses. There are three typical presentations of ALS onset. These are Bulbar, Limbic and Diaphragmatic. Each onset of ALS is characterized by muscle weakness and atrophy in different muscle groups, however all tend toward eye movement as being the last voluntary movement available to the patient [8].

Individuals living with ALS are unable to do many of the daily tasks that people who do not live with the disease can do with ease [2]. One of these activities is the interaction with computers and other devices. Most ALS patients retain control of their eyes for the arc of the disease. Eye tracking technology is of interest because it offers a potential low-energy medium of communication and interaction between patients and their caregivers, friends, loved ones, or even other patients.

One of the goals of this project is to demonstrate how eye tracking technology works for any potential user, physically impaired or not. An easy way to conceptualize the scope of the project is to look to the example set by games included in early versions of Windows. The true purpose of games like Solitaire and Minesweeper were to teach a broader audience of consumers how to interact with a computer by using the mouse [3]. By expressing the basic operations the mouse interface was capable of in a simple and intuitive way, a new market of users was able to interact with computers because the barrier for entry had effectively been lowered.

Another project goal is to intuitively teach the end user how to operate the eye gaze user interface in a way that is fun and accessible to a broad range of potential users. To accomplish this, Team Crios will design a video game that can be played exclusively with gaze interaction. The intended outcome is to help contribute to lowering the barrier to access for not only the average user, but the physically impaired user as well.

To accomplish this, many forms of interaction offered by eye tracking technology must be explored. Features must be designed around saccade, fixation, dwell and enter/exit actions. The application of each of these gestures should be clear to the user.

Eye tracking has been explored as a potential solution for facilitating communication between ALS patients and their surrounding network of friends, family and caregivers. However, the barrier for entry has been too high for most people to harness its full potential. Old eye tracking devices were expensive, bulky (often too heavy for an ALS patient to use for very long) and

generally not very user friendly. Team Crios is excited to contribute to a future where this is no longer the case.

II. Background and Related Work

One of the Microsoft Research Enable Group's many goals is to "create technology innovations that improve the lives of people with disabilities" [5]. Overall, they aim to bring new experiences to all of their users. Microsoft's gaze interaction technology can be used to play video games and even take the place of game controllers, keyboards or a touch interface for many other technological features. This technology can be used for everyday use for anyone, whether you can't use your voice because you're sipping at your coffee or your hands are full while you're eating lunch. Eye tracker technology and eye trackers are not new, however. Eye trackers of various kinds have been around since the 1800s. [6] A popular eye tracking technique from the 1960s is what today's eye trackers are based off of. Yarbus, a Russian psychologist, wrote a book on eye movement and found that the person's eye movement and fixation depended on their interest in a given task. His book was called *Eye Movements and Vision*. [4]

Tobii Gaming currently lists 132 video games that are able to use their eye tracking technology [7]. These games range in complexity and include both indie games, that generally don't have a large financial backing by a major publisher, and major AAA games, made by well known studios with large budgets. Indie games include the likes of Unknown Fate by Marslit Games and Through The Woods by Antagonist, while AAA games include Shadow of the Tomb Raider by Eidos Montreal (published by Square Enix) and Far Cry 5 by Ubisoft. In these games, eye tracking is meant to enhance but not to replace traditional methods of game interaction such as a controller, keyboard, or mouse. These features aren't marketed or designed for the accessibility market, but more so for the avid and hardcore gaming enthusiast. One of the most common controls, Extended View, allows the player to move the in-game camera using their eyes and head, replacing mouse movements that would usually rotate that camera. Another common control, Target at Gaze, allows the player to select their target, whether it be an enemy or an item, simply using their eyes, replacing mouse movement, clicks and sometimes keyboard input.

A game called Look to Learn is one game that is fully controlled by eye trackers. One of the goals of the project is to make a game that is played solely with the eye tracker. Overall, eye tracking technology has yet to reach its full potential in terms of accessibility due to its high barrier to entry. In addition, not many video games that are currently available for purchase are compatible with the eye trackers. That being said, we believe that the unique accessibility features specific to eye trackers could be harnessed to create a unique gaming experience that is not only inexpensive, but also fun and easy to use.

III. Project Overview

- **Problem:**

- Many impaired individuals struggle to cope with certain scenarios due to their limited physical capabilities, which restrict common activities.
- These physical limitations may include paralysis, amputation of limbs, movement disabilities, and other conditions like ALS that may prevent a user from accomplishing everyday tasks.
- Restricted activities may include using a computer, driving, writing, playing video games, and enjoying other activities that they were once able to do.

- **Objective:**

- Create a video game for the Windows 10 Operating System that utilizes the eye-controlled functionality of an eye tracking device to allow the user use their eyesight to interact with and play the game.
- Create a game that is accessible and enjoyable for individuals with ALS and other disabilities as well as those without.
- Allow users to communicate with others through the use of multiplayer features
- Take advantage of Gaze interactions (the basic gestures of eye-tracking technology)
 - Detect a user's gaze to tell whether a user has entered or exited the range of the eye tracker.
 - Capture the gaze and convert it into a form that allows the user to interact with objects.
 - Use the Dwell function to allow users to make selections and further interact with the virtual environment.
 - Allow user to focus on one specific area to interact with an object while maintaining the ability to skim and read over any miscellaneous objects (Text, background, etc.)

- **Outcome:**

- Develop a functioning, fluid gaming experience that utilizes the core features of the gaze interaction API and the eye tracking device.
 - Such core features allow the user to easily learn the basic controls of the eye-controlled interface.
- Create a higher standard for what eye-tracking games are capable of.
- Support the Microsoft Research Enable Group by adding a new tool for users to learn how to use their eye-controlled user interface.
- Publish and release the game to the Microsoft Store.
- Lower the entry barrier for using eye tracking peripherals, helping to make the technology more accessible.

IV. Client and Stakeholder Identification and Preferences

This project was created by our client and mentor, Jon Campbell, a member of the Microsoft Research Enable Group. We were tasked with the development of a game that uses existing eye-tracking APIs that can teach people the means of interaction in an intuitive way, similar to the way that minesweeper and solitaire taught users to interface with a computer mouse. Our major stakeholders are the ALS community and the Microsoft Research Enable Group. Other important stakeholders are anyone who may have difficulty using a computer in traditional (keyboard/mouse) ways and in a more minor way, anyone who is interested in trying out or using eye tracking including casual users and gamers.

The primary needs of our clients are that we use the Microsoft Gaze Interaction Library APIs and that our game be able to be played with eye-control alone. Being that the Enable Group is very vested in the ALS community, their primary preference is that our game help teach disabled users how to use eye tracking interfaces and technology

Our first major stakeholder is ALS patients. Our game must be able to teach how to use eye gaze interaction as simply as possible. People living with ALS expend more energy than people living without on bodily functions such as breathing. As a result, ALS patients have a very limited amount of energy to expend on most activities. Teaching an ALS patient how to use an AAC device (augmentative and alternative communication device) is often a taxing experience for not only the patient but the caregiver of the patient as well. Our game will serve as a simple and cheap alternative, as most patients will not have access to AAC devices until the advanced stages of ALS. By offering a simple way to teach gaze interaction to ALS patients, we effectively minimize the amount of energy needed to learn the interface and maximize the potential for communication. A secondary preference is that the game allow those same users to communicate with others, with similar disabilities and without

Another Stakeholder for our project are typical computer users. Eye gaze interaction has the potential to impact the way most users interact with technology. A couple of potential useful advantages are displays that can be used hands-free, or applications that combine more traditional means of interaction with eye gaze interaction. The game will help those users understand the interface. They also may benefit from the game if it provides them with entertainment.

The last stakeholder is video game developers. There aren't many games that are built from the ground up with eye-tracking interaction as the entire means of interaction. Our game will explore some of the possible game mechanics that can be built around gaze interaction. This has the potential to create new innovation in the industry, as studios will have the option to explore what a gaze interaction game looks like. Other potential outcomes include more support for accessibility-driven games. By supporting eye-tracking technology, team Crios helps contribute to the overall effort to create games for physically handicapped people.

V. Glossary

A

AAA: (Also known as AAA Games or Triple A Games) A classification term for video games with the highest development budgets and levels of promotion. A game that is considered Triple A is expected to be a high quality game and among the year's best selling video games.

AAC device: Augmentative and alternative communication device. A device used to facilitate communication with a nonverbal patient.

ALS: (Amyotrophic Lateral Sclerosis) A progressive neurodegenerative disease that affects nerve cells in the brain and the spinal cord

API: (Application Performance Interface) A set of commands, functions, protocols, and objects that programmers use to create software or interact with an external system

Animation: A medium in which images and/or objects are manipulated to look like they are moving images. Traditional animation is drawn by hand. Today, most animation is created with computer-generated imagery.

C

Compatible: Refers to hardware or software system that can successfully use interfaces and data without modification

Computer Graphics: Images generated by a computer

D

Dialogue: A voice recording where two or more characters are conversing

Dwell: A conscious fixation on a point. Intentionally looking at an object for an extended amount of time. (In this case an extended amount of time is just over 200ms, however this can be adjusted as necessary)

E

Effects: Also known as EFX, FX, or Special Effects (SFX). Any animation that is not a character or prop, such as smoke, water, fire, explosions, ect

Extended View: An eye tracking control in video games that allows the user to move the in-game camera with their eyes and head.

Eye Tracking: Is a sensor technology that enables a device to know exactly where your eyes are focused

Enter/Exit: Used to describe when a user looks at or looks away from a point.

F

First Person (Point of View): Refers to a graphical perspective rendered from the point of view of the main character's perspective

Frames per second (FPS): The rate at which images must be displayed in order to achieve real time playback

Fixation: A term used to describe a quick focus on a point. Not to be confused with dwelling, which implies a longer gaze.

G

Game Controller (or controller): A device used with video games or entertainment systems to provide input for a video game, where it typically controls an object or character in the game

Graphics: Images generated by a computer. In the context of video games, graphics are generated in real time, and often dynamically change according to different circumstances.

Gaze interaction: The basic gestures of eye-tracking technology. These gestures are defined for our purposes as the following; saccade, fixation, dwell and enter/exit.

I

Indie: An independent video game. Usually developed without the financial backing of a publisher during development, but may still be distributed by one.

L

Lighting: The process of lighting an environment in a program, like Autodesk Maya, is to create a sense of atmosphere and to bring life to the scene

M

Microsoft: A leading global vendor of computer software; hardware for computer, mobile and gaming systems; and cloud services. Microsoft's corporate headquarters is located in Redmond, Wash., and it has offices in more than 60 countries.

Multiplayer: A mode of playing a computer game or video game where two or more players can play in the same game at the same time, cooperatively as a team, head-to-head competitively, or using a leaderboard.

Minesweeper: A single player puzzle game where the objective is to clear a board containing bombs without causing them to detonate.

O

Operating System: The software that supports a computer's basic functions, such as scheduling tasks, executing applications, and controlling peripherals.

P

Pan: A camera movement where the camera moves along a horizontal axis. The camera pans to the right or left.

R

Rendering: The process involved in the generation of a two-dimensional or three-dimensional image from a model by means of application programs. Rendering can be done in applications like Autodesk Maya and some Adobe Products

Rigging (3D): The process of creating a skeleton for a 3D model so that it can move. Characters are often rigged before they are animated because if a model does not have a rig, then they cannot be moved.

S

Scenario: The first draft of a story that outlines the plot and is usually one page in length.

Solitaire: A card game where the objective is to sort cards together from king to ace.

Saccade: A rapid movement of the eyes from one point of focus to another.

T

Target at Gaze: An eye tracking control in video games where a player can target an enemy or item with their gaze.

Third Person (Point of View): A perspective in which the player can visually see the entire body of the character they're playing

Tobii Gaming: A Swedish high technology company that sells products for eye tracking and eye control

U

UI: User Interface

Unity: A cross-platform game engine developed by Unity Technologies

V

Video game: A game played by electronically manipulating images produced by a computer program on any sort of display screen, such as a television or computer.

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