EyeClicker

System Requirements

**SFWR ENG 4G06 /
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1   Purpose

The purpose of the EyeClicker is to give our users an alternate method to use their computer. With our device, a user will be able to control their computer or laptop without having to use a mouse, and instead use their eyes. This is especially helpful to users who have limited mobility with their arms, those who are injured, or simply someone who wants to rest. Given an alternate method of using a computer, our device can help more people use a computer comfortably and be connected to the digital world we live in. Eye tracking has become fairly popular over recent times, and our EyeClicker will utilize this concept to provide a full user experience that mimics the behavior of a mouse. The EyeClicker will identify where the user is looking at to position the cursor to that spot on the screen. It will also track a unique set of simple eye movements/actions as well as certain voice commands to deliver the appropriate response. Whether the user wishes to click, drag or enter text the EyeClicker will provide all those functionalities simply though tracking the eye and voice control.

2   Scope

The project will be based around tracking user's eye movements and making the cursor react, including but not limited to moving the cursor, left-clicking and click and dragging. This will be achieved through image processing, more specifically, human eye recognition and a well-developed algorithm to control mouse actions.

In-scope functionality items for the EyeClicker including the following:

- Calculate the position the user is looking on the computer display.

- Calibration system to increase the accuracy of the EyeClicker

- Allows user to perform a left-click as well as dragging with certain special actions that can be performed with eyes (e.g. blink an eye, staring, etc.)

- Be able to let user disable the EyeClicker system to prevent misoperation.

- Voice control is available to allow the user to quickly and ergonomically execute commands such as enabling the EyeClicker.

The following items are out of scope: Allows user to control the cursor with voice input

3   Context Diagram With Boundaries
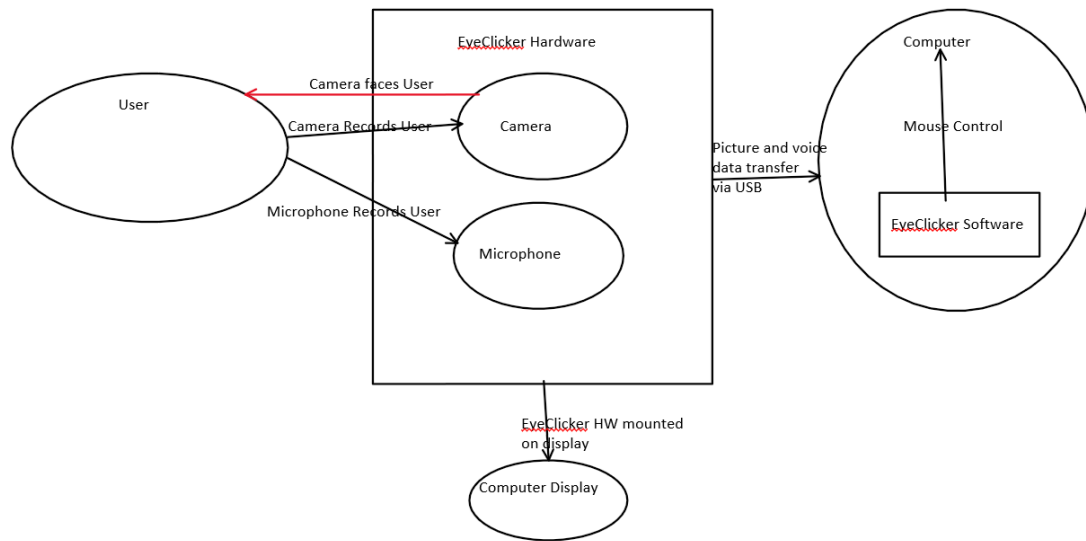
Figure 1: Context Diagram

4   Monitored and controlled variables (with units)

Monitored Variables

Variable	Unit	Description
eyePosition*	(x, y)	The position of the user's eye with respect to the screen resolution
eyesClosedTime**	Seconds	The time that the user spends when closing their eyes **
blink	boolean	Whether the user is blinking

* where x=0 at the left edge of the screen and x=screen'sResolutionX at the right edge of the screen and where y=0 at the top edge of the screen and y=screen'sResolutionY at the bottom edge of the screen
** used to measure if the user has blinked

Controlled Variables

Variable	Unit	Description
cursorPosition	(x, y)	The position of the cursor with respect to the screen resolution
waitTimeForClick	Seconds	Time user needs to look in the same spot to perform a mouse down action (compared against eyesClosedTime)

5   Constants

Constants

Constant	Unit	Value
Camera Frequency*	Pictures / Second	10
calibrationCoordinates[5]**	(x%,y%) ***	(0,0), (1,0), (0,1), (1,1), (0.5,0.5) where 1 = 100%

* Camera Frequency is the frequency the camera will take pictures and feed it to the computer.
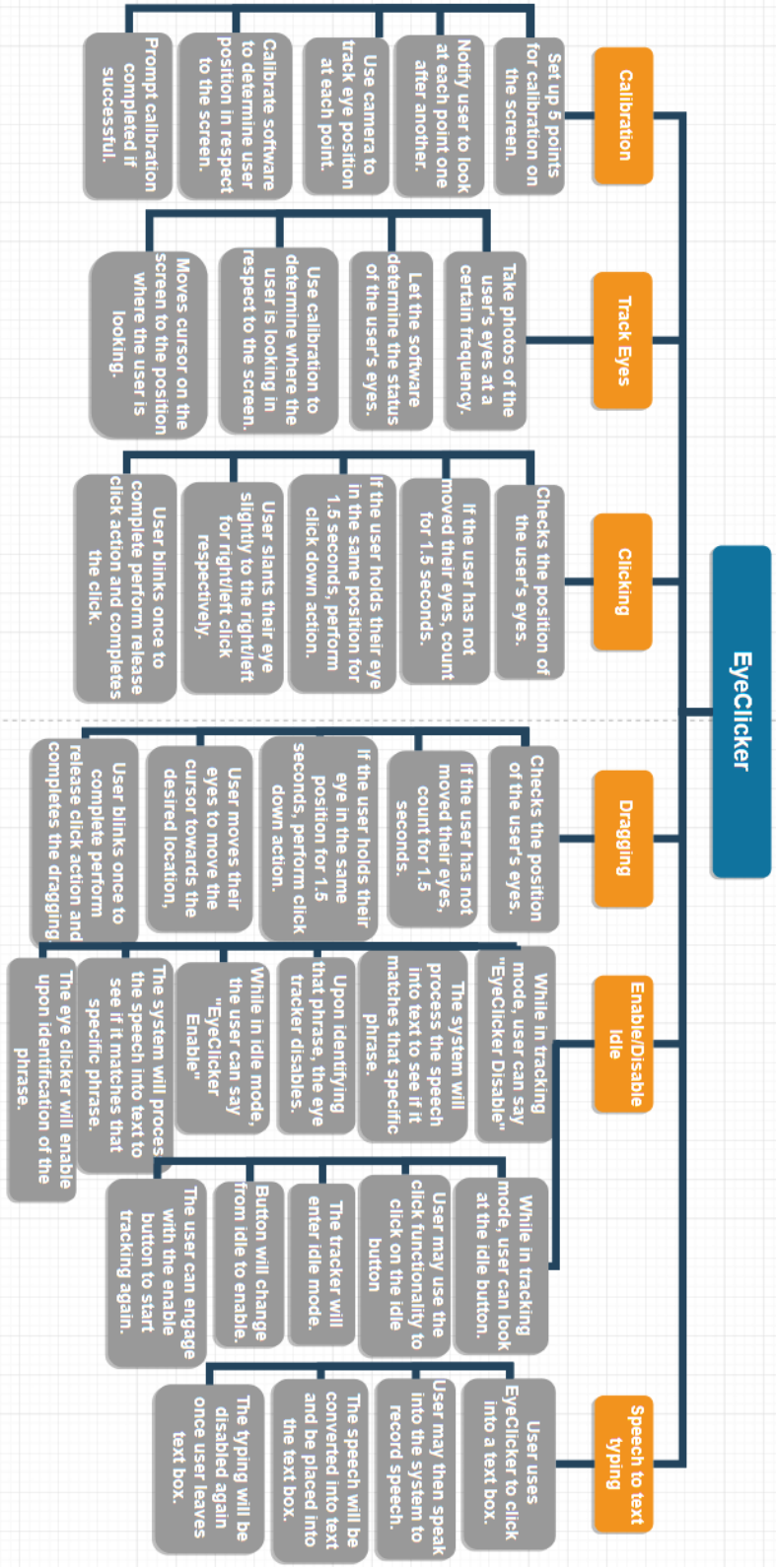
** Five coordinates used during the calibration procedure

*** x% is percentage is the horizontal percentage of the screen you are looking at where the left edge is 0% and the right edge is 100%. y% is percentage is the vertical percentage of the screen you are looking at where the top edge is 0% and the bottom edge is 100%

6   Behaviour Overview

The user will connect the device to the computer via USB and mount the device onto the screen/monitor (facing the user). The user will then open the EyeClicker software to calibrate the system to improve accuracy. The calibration will be done by having the user look a predetermined point on the screen and confirm they are doing so. This will be repeated for 5 predetermined points. They can now enable the EyeClicker tracking through the GUI or voice control. The user can left click or drag while the EyeClicker is enabled by focusing on a spot on the screen for 1.5 seconds. After the 1.5 seconds the EyeClicker will send a left mouse down event. The user is now free at this time to move his eyes to perform a drag and to blink to perform a left mouse up event. Therefore, if the user desires to perform a left click on a certain spot they will simply focus on the spot for 1.5 seconds and blink. The user also has the option to input text by clicking into a text box at which point the EyeClicker will listen to the users voice and translate it into text. At any time the user can disable the EyeClicker through the GUI or by voice control.

7   Diagrams Showing Functional Decomposition

EyeClicker

Calibration
- Set up 5 points for calibration on the screen.
- Notify user to look at each point one after another.
- Use camera to track eye position at each point.
- Calibrate software to determine user position in respect to the screen.
- Prompt calibration completed if successful.

Track Eyes
- Take photos of the user's eyes at a certain frequency.
- Let the software determine the status of the user's eyes.
- Use calibration to determine where the user is looking in respect to the screen.
- Moves cursor on the screen to the position where the user is looking.

Clicking
- Checks the position of the user's eyes.
- If the user has not moved their eyes, count for 1.5 seconds.
- If the user holds their eye in the same position for 1.5 seconds, perform click down action.
- User slants their eye slightly to the right/left for right/left click respectively.
- User blinks once to complete perform release click action and completes the click.

Dragging
- Checks the position of the user's eyes.
- If the user has not moved their eyes, count for 1.5 seconds.
- If the user holds their eye in the same position for 1.5 seconds, perform click down action.
- User moves their eyes to move the cursor towards the desired location.
- User blinks once to complete perform release click action and completes the dragging

Enable/Disable Idle
- While in tracking mode, user can say "EyeClicker Disable".
- The system will process the speech into text to see if it matches that specific phrase.
- Upon identifying that phrase, the eye tracker disables.
- While in idle mode, the user can say "EyeClicker Enable"
- The system will process the speech into text to see if it matches that specific phrase.
- The eye clicker will enable upon identification of the phrase.

- While in tracking mode, user can look at the idle button.
- User may use the click functionality to click on the idle button
- The tracker will enter idle mode.
- Button will change from idle to enable.
- The user can engage with the enable button to start tracking again.

Speech to text typing
- User uses EyeClicker to click into a text box.
- User may then speak into the system to record speech.
- The speech will be converted into text and be placed into the text box.
- The typing will be disabled again once user leaves text box.
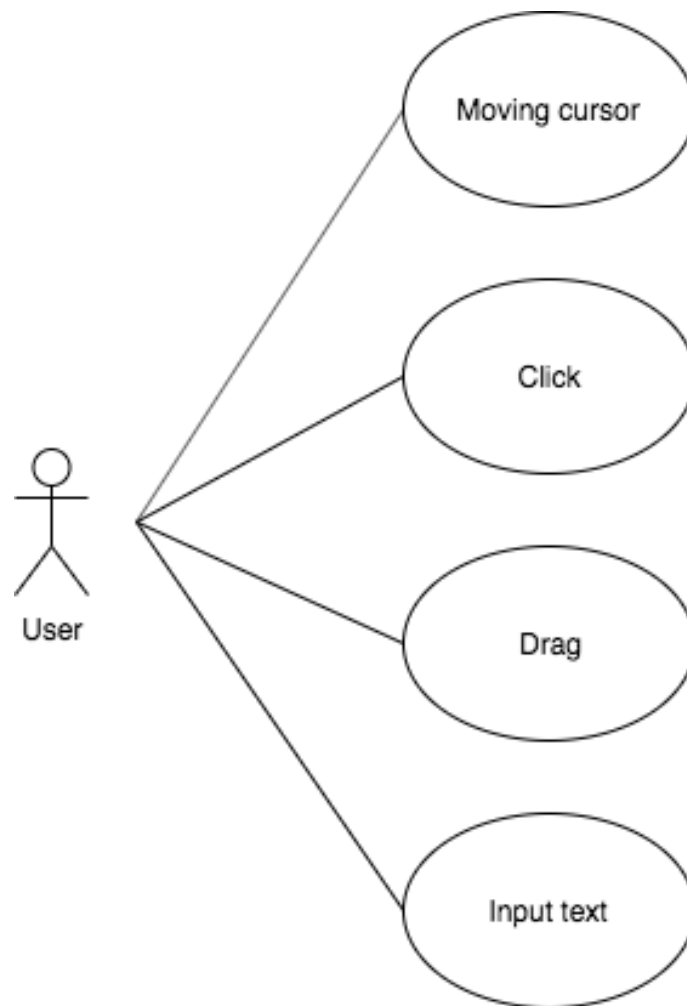
8   Behaviour Description

Figure 2: Use Case Diagram

9   Rationale

No additional rationale.

10   Performance Requirements

- The deviation of detecting where the EyeClicker thinks user is looking compared to actual position the user it looking at must be smaller than 1cm while within effective working distance of the EyeClicker (60cm from the screen).

- The latency of detecting whenever users' eyes are moving must be shorter than 150 milliseconds.

- The latency of detecting whenever users' eyes are blinking must be shorter than 150 milliseconds.

- The latency of receiving, translating, and executing users' voice command must be shorter than 3 seconds.

- The accuracy of speech recognition must be greater than percentage 80

11   Normal Operation

During the calibration stage, the user should be within the effective working distance of the EyeClicker (60cm of the screen). Sitting too far away from the camera causes inaccuracy or worsens the ability of EyeClicker to locate users' eyes and to control the cursor accurately.

During the working stage after calibration, the user now can navigate the cursor using their eye movements. Left-clicking and dragging are the basic functions the user can operate. These functions operate at the optimal level when the user is sitting at a stable position and as close to the position that the system was previously calibrated in.

Speech recognition is one of the solutions to help the user have more capability to do a task. When using speech recognition, the user should speak at a steady pace to obtain optimal performance. When the user wants to type something after clicking into a text box, it allows the user to speak to the system and the system will convert the speech into text. It can also activate "reading mode" by saying the command "Disable Eyeclicker (Disable mouse clicking and dragging)" to avoid unintended actions when the user is staring at a spot for a long time (reading an article or watching a TV show).

12   Handling Undesired Event

- Unable to click the desired point on the screen. When the user is having trouble clicking the desired item, one should redo the calibration to improve the accuracy. To access the calibration test during run time, simply activate speech recognition and say "Recalibrate".

- Staring at the screen and accidentally activate clicking or dragging. When the user wants to read an article or watch a TV show, one might accidentally activate undesired actions like mouse left-clicking and mouse dragging. To solve this issue, utilize EyeClicker's voice commands and say "EyeClicker Disable". When the user wants to use the EyeClicker again, say "EyeClicker Enable" to continue controlling the cursor with eyes' movements.

- EyeClicker cannot locate the user's eyes after turning his/her head away from the screen. When the user looks away from the screen for too long, EyeClicker might lose track of the locations of the user's eyes. To solve this problem, one should get closer to the camera and stare closer into it for a few seconds and then one can get back to the normal sitting position and possibly recalibrate.

13   List of Requirements (Likely to Change)

1. The system shall enable the user to left click by speech recognition instead of focusing on a spot for 1.5 secs and blink.

    - Rationale: Allow the user to have a more ergonomic and quicker option to click.

2. The system shall notify the user if he is sitting too far away from the camera to get enough accuracy while calibrating.

   • Rationale: Sitting too far away from the camera causes inaccuracy or worsens the ability of EyeClicker to locate users' eyes.

3. The system shall be able to execute more speech commands to be more user-friendly.

   • Rationale: There are some limits for eyes to operate certain functionalities such as copy and paste.

14   List of Requirements (Unlikely to Change)

1. The system shall have enough accuracy to reasonably track where the users' eyes on the screen.

   • Rationale: Needed to allow for accurate cursor control for the user.

2. The system shall precisely calculate how long has users focused on one spot.

   • Rationale: The system should know how long has users focused on one spot to enable the clicking functionality.

3. The system shall precisely detect whenever users blink their eyes.

   • Rationale: The system should detect user whenever they blink eyes to enable the clicking functionality.

4. The system shall have 5 predetermined points for calibration.

   • Rationale: The system should have at least 5 predetermined calibration points to improve the accuracy of detecting where the user is looking at on the screen.

5. The system shall have the ability to translate the users' voice to text.

   • Rationale: The system should receive users' voice and use speech recognition to translate it into command that the system can understand or for inputting text.

6. The system shall translate users' voice correctly into system commands.

   • Rationale: The system should allow users to say commands while avoiding unintended actions.

7. The system shall stop controlling the cursor if the user says "EyeClicker Disable".

   • Rationale: Allows the user to quickly disable the EyeClicker which can be useful for reading so that the text is not blocked by the cursor.

8. The system shall provide the idle button for users to enable and disable the system.

   • Rationale: The system should enable users to enable and disable the system to avoid unintended actions.