Eye-Clicker

Hazard Analysis

SFWR ENG 4G06 / MECHTRON 4TB6
GROUP 8

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1 Purpose

1.1 Document Purpose

The Hazard Analysis document's purpose is to find the possible hazards that are present in the design of the Eye-Clicker and then implements precautions to mitigate the risk. Because there are no physical dangers the Eye-Clicker can bring upon the user, the hazards discussed in this document will not be referring to physical hazards that the user of the system may face. The hazards that are discussed in this document are risks that the system introduces that cause unintended effects.

The Hazard Analysis document will be revised multiple times throughout the design process of the Eye-Clicker.

1.2 Scope

The project will be based around tracking the user's eye movements to move the cursor. The project will also allow for voice control to activate mouse actions, including but not limited to moving the cursor, left-clicking and right-click. Moving the cursor will be achieved through image processing, more specifically, human eye recognition.

1.3 Definitions

Landmark Points: Points around the user's eyelids to be detected and recorded by the Eye-Tracking System
Pupil Points: The points in the center of the user's pupils to be detected and recorded by the Eye-Tracking System
Gaze Position: The spot that the user is looking at on the display

2 Components

2.1 Eye-Tracking System

Responsible for detecting and recording the landmark points and pupil points.

2.2 Cursor System

Responsible for receiving predicted cursor position and moving the cursor to the corresponding location as well as sending the cursor's current location up receiving the signal of getting the cursor position.

2.3 Voice System

Responsible for detecting voice commands from the user and initiating the response.

2.4 Mouse Action System

Responsible for executing mouse click actions.

2.5 Calibration System

Responsible for matching the user's pupil and the cursor's location

2.6 AI System

Responsible for predicting the user's desired cursor position based on a machine learning algorithm

2.7 GUI System

Responsible for interacting with users, such as displaying objects that convey information and representing actions

3 Safety Consideration

3.1 Eye-Tracking System

Software Issues:

- Not able to detect the user's landmark points and/or pupil points.
- Filtering webcam frame data can malfunction and crashes the entire system

Hardware Issues:

- Web camera crashes
- Web camera disconnects

3.2 Cursor System

Software Issues:

- Not able to move the cursor to the location predicted by the AI model
- Not able to provide the cursor's current location in real-time

Hardware Issues:

- Software is not able to interact with the OS to move the cursor

3.3 Voice System

Software Issues:

- Not able to distinguish the user's voice under a noisy environment
- Not able to recognize what the user says
- The required pause between voice commands inhibits the user from making quick consecutive voice commands

Hardware Issues:

- The user's voice is not captured or recognized due to broken microphone

3.4 Mouse Action System

Software Issues:

- Performs unintended cursor actions

Hardware Issues:

- Software is not able to interact with the OS to perform mouse clicks

3.5 Calibration System

Software Issues:

- Not able to save the calibration data
- User does not follow correct instructions resulting in a bad calibration that lowers accuracy

Hardware Issues:

- None

3.6 AI System

Software Issues:

- Not able to predict the cursor location within the error margin
- The program crashes while making predictions

Hardware Issues:

- CPU is unable to compile the software

3.7 GUI System

Software Issues:

- The GUI crashes while unhandled actions being executed by users.
- The GUI displays undesired feedbacks or ambiguous information while actions being executed by users.
- The GUI is unable to provide actions to allow users to connect each module's interface.

Hardware Issues:

- The GUI has a sizing issue caused by the different resolutions of the monitor.

4 Correlation Between Hazard Functions and Requirements

Hazard Function:	**Performance Requirement:**
F1: Initiate EyeClicker	Performance Requirement 1
	Performance Requirement 2
	Performance Requirement 3
	Performance Requirement 4
	Performance Requirement 5
	Performance Requirement 6

Hazard Function:	**Performance Requirement:**
F2: Calibration	Performance Requirement 1

Hazard Function:	**Performance Requirement:**
F3: Eye Detection	Performance Requirement 1
	Performance Requirement 2
	Performance Requirement 3
	Performance Requirement 4

Hazard Function:	**Performance Requirement:**
F4: *Gaze position* on screen detection	Performance Requirement 1
	Performance Requirement 3

Hazard Function:	**Performance Requirement:**
F5: Move cursor	Performance Requirement 1
	Performance Requirement 3

Hazard Function:	Performance Requirement:
F6: Record Voice Commands	Performance Requirement 5
	Performance Requirement 6

Hazard Function:	Performance Requirement:
F7: Perform Voice Commands	Performance Requirement 5

5 FMEA Worksheet

5.1 Hazards Considered out of Scope

- Hardware wiring fails and causes one or more components not being able to function
- Eye-Tracking algorithm recognizing something else as user's eye (images on his T-shirt, or anything similar to an eye in the background) rather than the users
- User issuing consecutive voice commands too quickly which results in one long unusable voice input
- Accidentally deleting files or shutting down your computer due to any combination of misuse and poor tracking accuracy

5.2 Failure Modes and Effect Analysis Table

Function	Failures	Unacceptable Event	Severity of Failure (0-100, 100 being the most severe)	Cause of Failure	Likelihood of occurrence (0-100, 100 is most likely)	Recommended Action	Likelihood of failure detection (0-100, 100 being most likely)
F1: Initiate EyeClicker	Software unable to start	EyeClicker does not run	100	Computer setup has errors that prevent the execution of EyeClicker	6	Resolve the error messages that occur when running EyeClicker	100
F2: Calibration	Software unable to calibrate	The eye tracking will not be accurate	86	Software bug or system error	18	Reattempt the calibration or restart EyeClicker	90
	Calibration did not train correctly	The eye tracking will not be accurate	86	The user did not follow instructions precisely or the data didn't train properly in the AI algorithm	35	Repeat calibration and follow the instructions with more accuracy.	7
F3: Eye Detection	Camera stream unable to connect to EyeClicker	No video stream to process	99	The camera is not connected properly, or the software cannot recognize the camera source.	5	Check the camera connection and test if the camera is operational.	90
	Cannot detect pupil and landmark points	Unable to track eye movements	99	Resolution of video stream is not clear, or user's eyes are not sufficiently visible	24	Change to a better camera or have the user sit closer to the camera.	90

Figure 1: FMEA Table

F4: Gaze Detection	AI position prediction is inaccurate	Cursor will be moved to seemingly random locations	96	AI model is not optimized for the environment	43	Perform another calibration to improve the accuracy	98
F5: Move Cursor	Cannot move the cursor on the screen	Unable to move cursor to the predicted location	93	OS not supported, permission not granted, or software unable to connect to the OS's cursor module.	14	Check if there are any OS settings that prevent unrecognized apps from accessing the cursor	82
F6: Record Voice Commands	Unable to record voice commands	Will not be able to analyze and perform voice commands	68	Unable to detect microphone	46	Check system to see if there is an existing audio input source. Attempt to connect EyeClicker to that audio input source	50
F7: Perform Voice Commands	Does not perform action upon valid voice command	Cannot perform mouse clicks when requested	58	Converting voice command text failed or text comparison resulted in a wrong decision.	35	Repeat the command with more volume and more clarity	50
	Performs invalid action or actions on invalid commands	Mouse clicks without the predetermined command	78	Converting voice command text failed or text comparison resulted in a wrong decision.	11	Terminate EyeClicker and restart the software	100

Figure 2: FMEA Table Continued