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NEO TANDEM TECHNOLOGIES



Eye Tracking User Manual

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DOCUMENT REVISIONS

Github Link: <https://github.com/MichaelNunes/Neo-Tandem-Tech-Eye-Tracking>

Version: 0.0 Initial creation of document

Version: 0.1 Added basic content relating to Introduction, Processes and Appendix.

Version: 0.2 Basic requirements

Version: 0.5 Added content

Version: 0.7 Added more content for all sections as well as updates and corrections .

Version: 0.9 Added in-depth content

Version: 1.0 Stable release (version 1) requirements

1 Introduction

1.1 Scope and Purpose

The purpose of this eye-tracking software is to provide the user with a eye-tracking software which will allow for the tracking of the eye on 2D and 3D models and videos. The system is centred around making eye-tracking possible for all media types.

The Geo-Informatics Department of the University of Pretoria wanted us to develop this software to help enable further research into how people view geological locations and what stands out to them when they view it. That is why we had decided to give the option of three different types of eye-tracking; namely video, two dimensional and three dimensional. This software will thus aid them in their research and help provide the data that they need to perform greater research in this field.

1.2 Process Overview

The Eye-tribe as a system comes with the infra-red camera which is used to track the eyes as well as a SDK that will allow you to develop programs to be used with the camera. There is also access to a few sample programs on the Eye-Tribe website. These can be downloaded and then they can be used with the camera to see all the functionality their devices provide.

These items can be found when purchasing The Eye-tribe camera. They also detail the full capabilities and features of the camera on there website. We have taken these elements and expanded them and integrated them with aspects such as 3D modelling and enabled eye-tracking on this and other media formats.

There are a few core process that have been implemented and that will allow for more effective eye-tracking across mediums. The process are as follows:

- Eye tracking on 2D models, 3D models and videos.
- Creation of heat maps from eye-tracking data.
- Saving heat map on specific media.
- Creating Statistics on information gathered.

The eye-tracking on the various models uses the camera to track the eyes of the user and then saves the data into a file so that it can be processed at any later stage.

The data that is saved is then used to create heat-maps. The heat-maps come in two forms: as an overlay and as an overlay applied over the image. The overlay shows the points of the heat-map on a blank background. This can then be overlaid onto the desired media and shows where on the user has viewed the model.

The recorded data is also used to create a statistical report of the test. This report includes meta-data about the media recorded and then actual data from the stored points. The data on the recorded points includes data such as time, points gathered

and a map that shows which sections where most looked at. The report is created in PDF format and although it does not have the most conclusive data we hope to improve it in the future to over a very in depth analysis and aid researchers in making conclusions and decisions.

The following process listed are the core of this program as they carry out the basic and most important functionality of this software.

2 Configuration

2.1 System Configuration

2.1.1 Minimum Hardware requirements

- 1.6 GHz or faster processor
- 4GB of RAM
- 1GB of available hard disk space
- 5400 RPM hard drive
- DirectX 9-capable video card
- USB 3 port or better(camera requirement)

2.1.2 Recommended Hardware requirements

- 2.6 GHz or faster processor
- 8GB of RAM
- 2GB Graphics Card
- 1GB of available hard disk space
- 5400 RPM hard drive
- DirectX 9-capable video card running at 1024 x 768 or higher display resolution
- USB 3 port or better(camera requirement)

2.1.3 Required Software requirements

- Windows 7/8/8.1 or 10 is required to run the application.

2.1.4 Recommended Software requirements

- The Eye Tribe software. That comes with the Eye Tribe camera.
- Windows Media Player Version 12.
- Any PDF reading software such as Adobe Reader.

2.1.5 Recommended External Devices

- The Eye Tribe eye-tracking camera.The camera can be purchased at The Eye Tribes website (<https://theeyetribe.com/>).

2.1.6 Connecting the camera to the computer

Below is a picture of the eye tribe camera.



Figure 1: Camera

The camera uses a USB 3.0 connection to connect to the computer.This is due to large amounts of data that needs to be transported quickly.Below shows two pictures of how the eye tribe is connected to the computer.

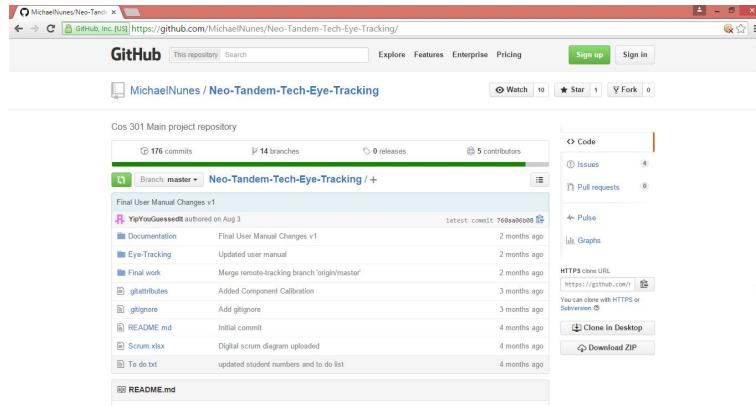


Figure 2: Camera

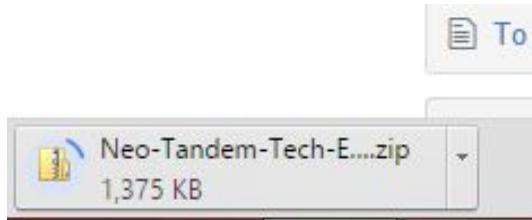
2.2 Installation

Please ensure that you meet the minimum requirements. It is recommended that you meet at least the recommended requirements as this will ensure that a better experience is achieved. The software can be downloaded from Github. At the moment it is only an executable file but a full installation onto your computer will be developed soon. Follow the steps below to install the eye tracking software on your computer.

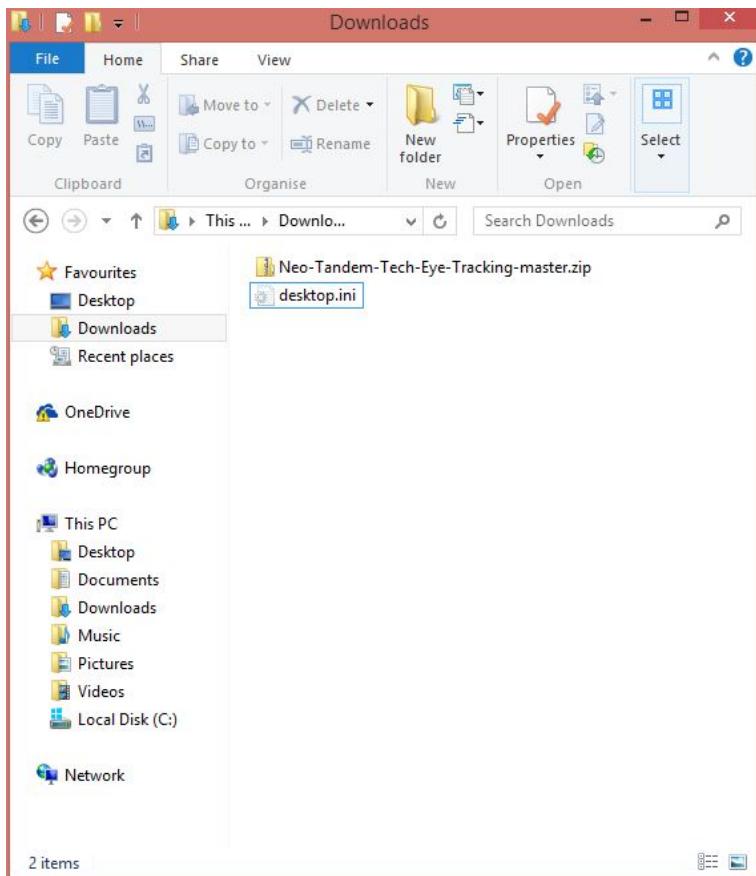
- 1) Navigate to <https://github.com/MichaelNunes/Neo-Tandem-Tech-Eye-Tracking> and then click on the download as zip button.



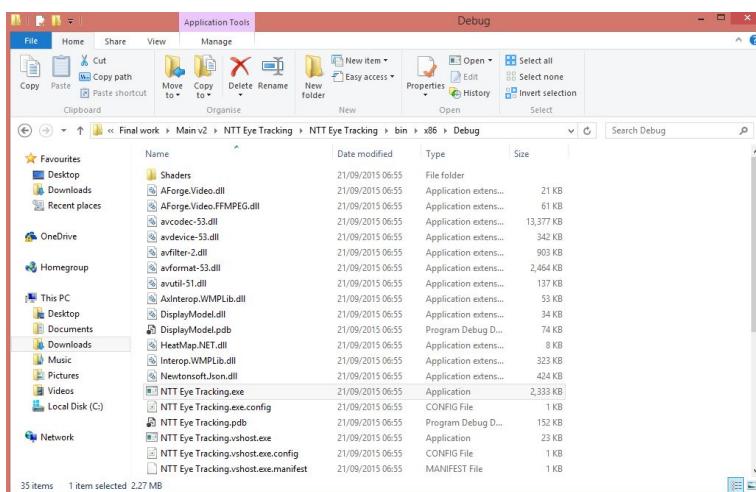
- 2) Unzip the archive using software of your choice to a folder of your choice



- 3) Navigate to the following directory: filename/Neo-Tandem-Tech-Eye-Tracking/Final work/Main v2/NTT Eye Tracking/NTT Eye Tracking/bin/Debug.



4) Here you can run the executable called NTT Eye Tracking.exe and the program is run.



3 Getting Started

The program is made to run with as little configuration as possible. There are no authentication processes that are associated with the program. The user will be able to just run the application and use it if the minimum requirements have been met and required hardware and software have been acquired.

3.1 Basic use

Once the application is run the user will be presented with a screen which will allow them to select the option to start a new or created project. The user will then be prompted to select the type of recording which will then close the current form and prepare the application for the chosen type. The recording page will allow for recording on the selected media. You would select the appropriate media and then start the recording. The data will then be saved and then used to make the heat-maps and all the associated files.

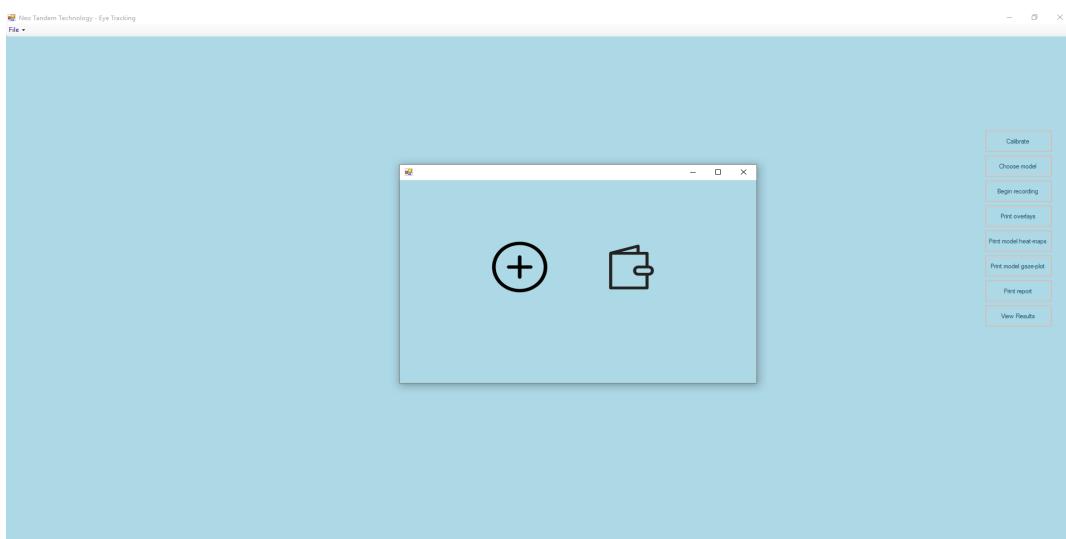
The application can be exited easily by just pressing the exit button (red cross) on the top right of the application. This will end the application and end all its accompanied processes.

4 Using the System

The following section will go in to in depth detail about the system and how to use it. This section of the user manual will show you how to perform actions throughout the application. There will also be sections on what to expect from each action. Certain troubleshooting sections will be referenced in this text and if you encounter any of these errors please refer to the troubleshooting section to try and resolve the problem.

4.1 Starting the program

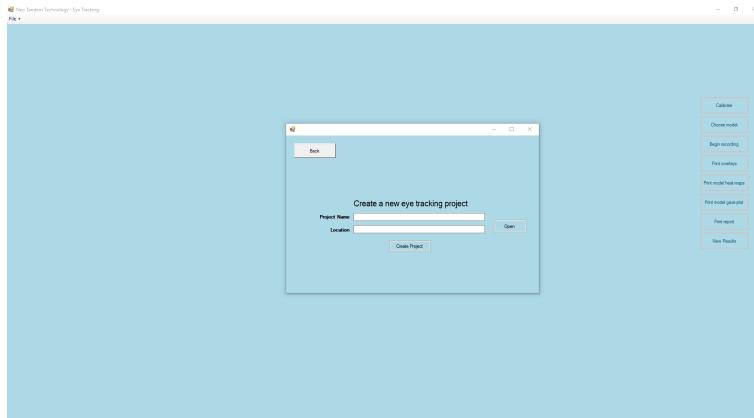
The program will allow you to perform eye-tracking on different kinds of media. Different media can be recorded and so the program will allow for multiple recordings' of the same or different media. The program allows you to create what is known as a eye-tracking recording project. This project is used to keep all the information of your recordings' for a specific project. You can always return to the session and continue recording in the desired project if required. Switching of projects is possible and thus allows you to easily switch between recording projects or create new ones.



When the user runs the Eye tracking software a selection form will appear. The form contains two options, namely start a new recording or to open a existing project. Below are the execution of both methods.

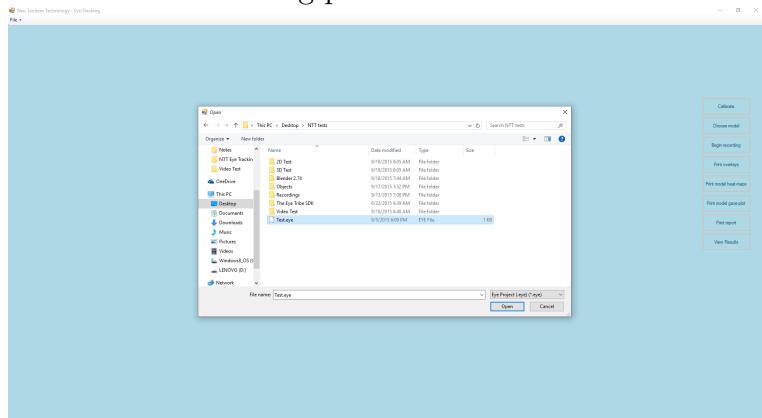
4.1.1 Start a new project

To start a new project you will need to specify the name for the project and location to store all the files. A default name will be given to the project called "project" in the event that no name is created. This will create three special files and a series of folders in the selected location. The files created are the main project file, containing the ".eye", which contains all the information about the recording project. This information is all that is needed to continue recordings'. The two other files that are created are the settings files used to record general user settings and settings for three dimensional recordings. When the project is created a new directory will be created named "Recordings". With in this directory multiple sub-directories will be created detailing each model types name and where all their data will be saved. The user will now be prompted to create a new recording detailed further below.



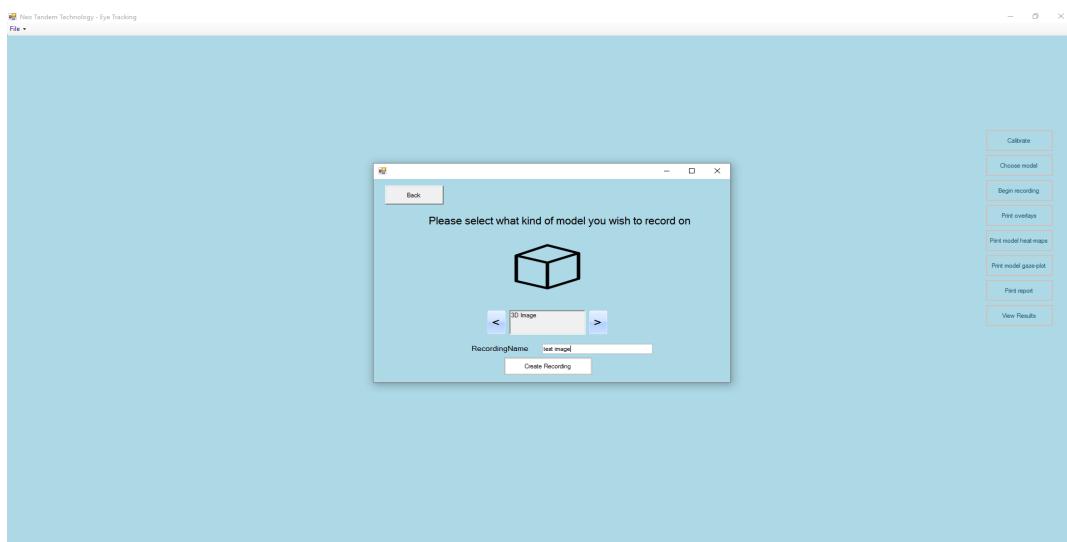
4.1.2 Open existing project

This will allow you to select an existing project and continue recording. Press the open button to select a file. The only file that will be accepted are ".eye" files. Once you have selected the file the settings are loaded the program moves to the work space to continue the recording process.



4.2 Recording Set-up Screen

When you are done opening an existing project or starting a new one you will be navigated to the screen shown below. This screen is used to set-up the recordings'. This screen will allow you to do multiple recordings' of different types. These recordings' can not be performed at the same time and thus only one type can be chosen at a time. Models can be chosen by navigating through the model types using the right and left arrows. You will also be allowed to name the recordings, this will create new folder in the recordings directory. The folder will be placed in the appropriate recording type sub-folder of the recordings folder. The folder will house all the information about the recordings such as eye-tracking data and also the resulting heat maps.



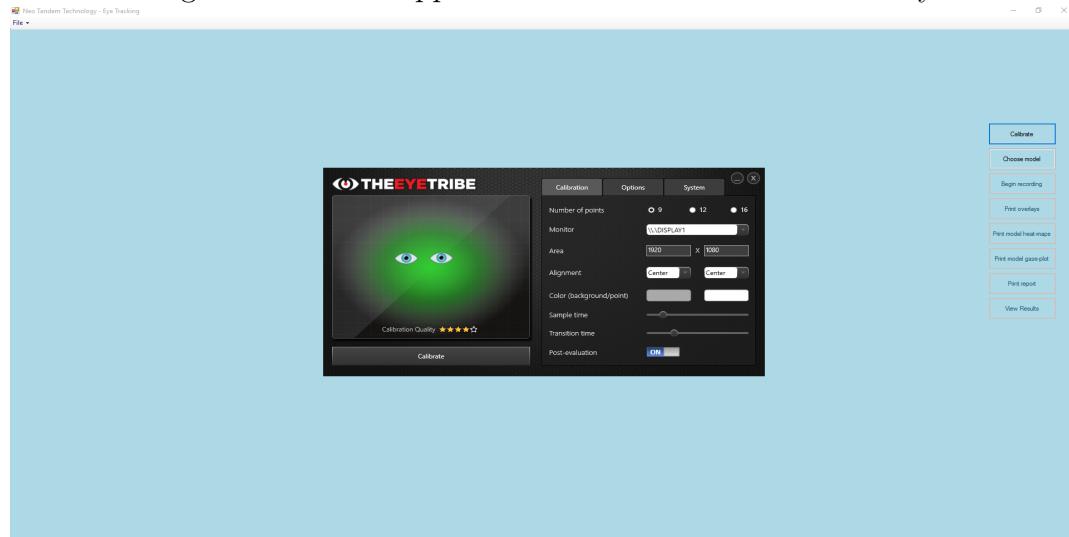
The screen has a text box for the user to enter the name of the recording. The name should contain only alphanumeric characters so that when the folder is created it will not fail. If it does not follow these rules then it will not be allowed to continue to the next section of the application. Once ready then press the "Create Recording" button to proceed to the recording preview page. You will be greeted to either of three screens: 2D recording screen, 3D recording screen or the video recording screen with a host of option on the right side of the form.

4.3 Calibration Screen

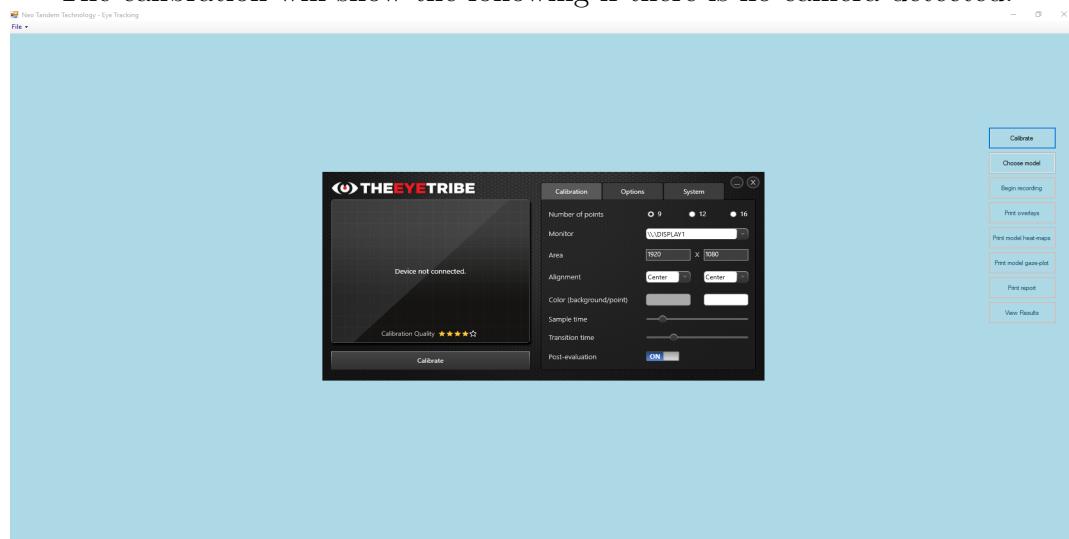
When navigating to a recording screen there will be a button to navigate to the calibration screen. The calibration of The Eye Tribe camera is vital as this will ensure that the program will accurately create results for the media that the recording is performed on. This will also allow the user to configure the settings of the recording to their needs. The pressing of the calibration button will open the "EyeTribeUIWin" program which initiates the server and opens up the calibration. Use the calibration to calibrate the camera. Leave the server window open as this is what will transfer the data from the camera to the program. Once you have calibrated you may then proceed back to the

menu screen and then start recording.

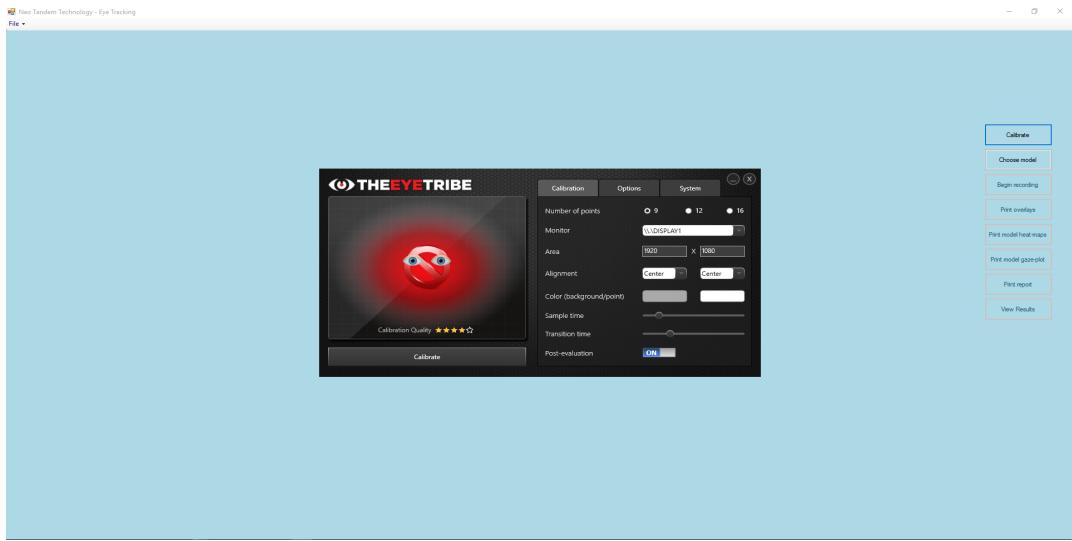
The following screen should appear if camera is connected correctly.



The calibration will show the following if there is no camera detected.

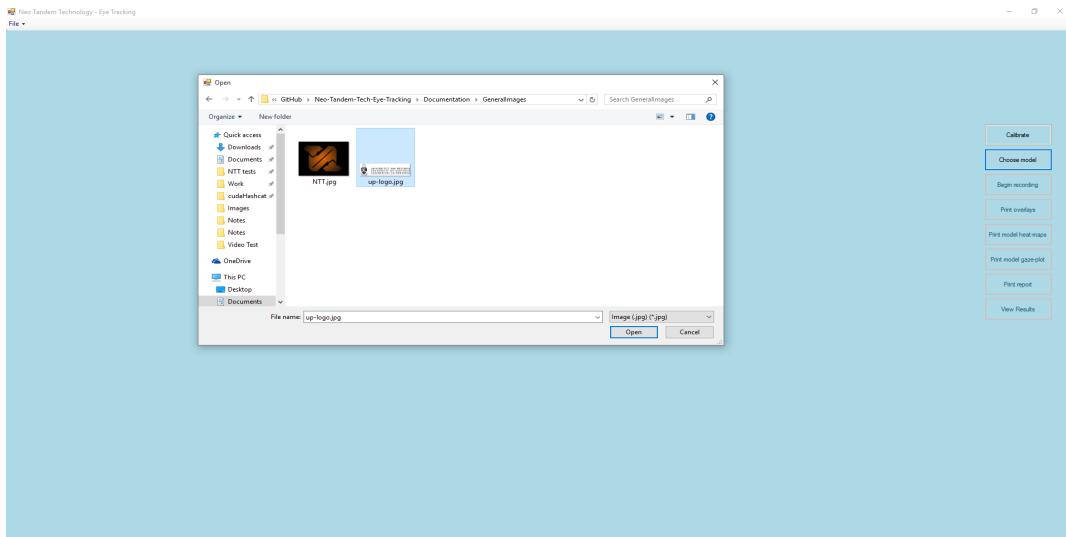


The calibration will show the following if there is no eyes detected.



4.4 Choosing model

The user must select the model they wish to do recording on by pressing the choose model option. This will open up a dialogue for the user to select their model. Note that if a 2D recording is chosen then it will not be possible to choose a model of a different type such as video and vice-versa for all model types that are catered for.

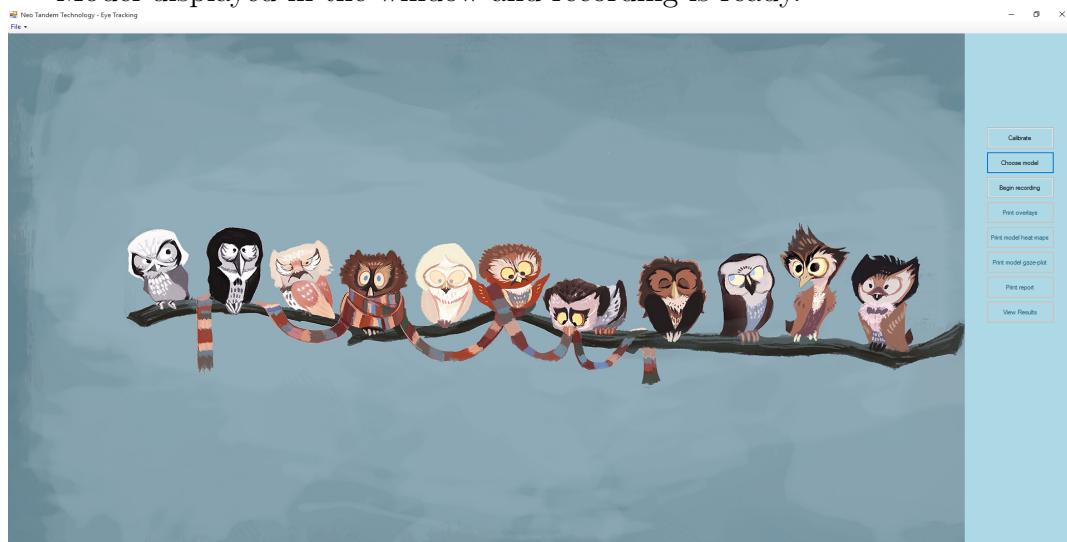


4.5 Recording 2D model

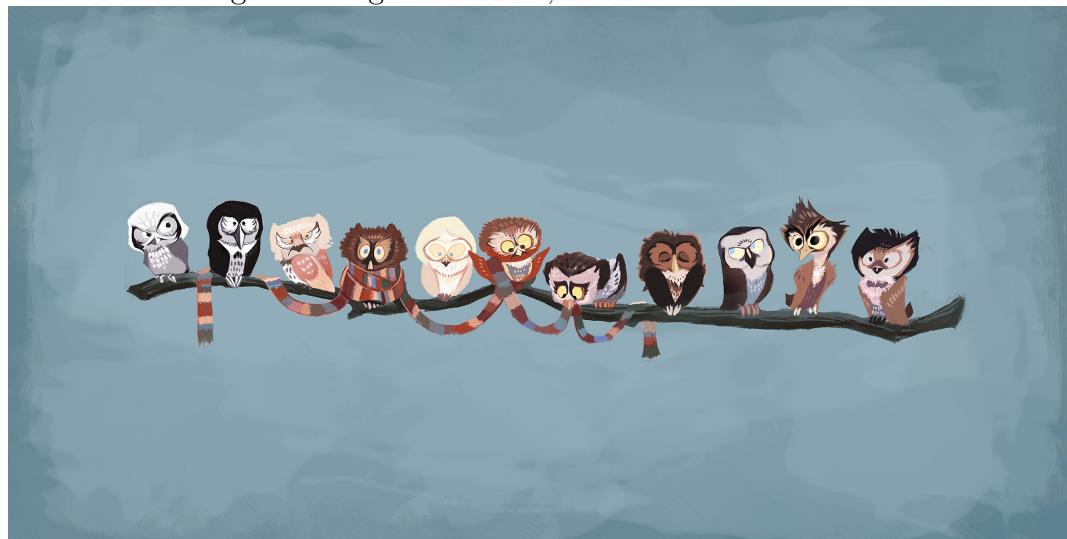
The 2D model recording form is navigated after the 2D model is selected in the recording set up. The page has a list of buttons that will perform all the tasks that need to be performed. The open model button when pressed, will allow the selection of a 2D model to be chosen. The 2D models are often just images and any image is allowed to be chosen. The quality of the image will improve the results from the eye tracking recording. When an image is selected then the record button can be pressed. When

the record button is pressed, the screen is filled with the image. The image is expanded to fit on the entire width and height of the screen and thus an image of higher quality will provide a crisper and more clear image. The recording also starts once the image is made full screen. During this process it is recommended that the subject moves as little as possible as the data that is recorded could be tampered with or come out incorrectly. Once you are done with the recording press the escape (Esc) key. You are then able to find the results of the recording in the project location in the relevant recordings folder, and finding the recording name as a folder. When you are done recording the data you can then exit the application or restart the recording. Restarting the recording will continue the recording for that model. The exiting of the application is done through the pressing the red X in the top right corner of the form.

Model displayed in the window and recording is ready.



The recording occurring on a model, 2D in this case.



4.6 Recording 3D model

The 3D model recording form is navigated after the 3D model is selected in the recording set-up. The page has a list of buttons that will perform all the tasks that need to be performed. The open model button when pressed, will allow the selection of a 3D model to be chosen. The 3D model will need to be in the format of a object file. These files have the extension ".obj". When an 3D model is selected then the record button can be pressed. When the record button is pressed. The 3D model then has snapshots taken and a slide-show is created of the model that can then be shown. The slide-show is expanded to fit on the entire width and height of the screen. The recording also starts once the slide-show the images are made full-screen. During this process it is recommended that the subject moves as little as possible as the data that is recorded could be tampered with or come out incorrectly. The recording process will end when all the slide-show images have been shown. You are then able to find the results of the recording in the project location in the relevant recordings folder, and finding the recording name as a folder. When you are done recording the data you can then exit the application or restart the recording. Restarting the recording will continue the recording for that model. The exiting of the application is done through the pressing the red X in the top right corner of the form.

4.7 Recording 3D model flythrough

The 3D model fly-through recording form is navigated after the 3D model is selected in the recording set-up. The page has a list of buttons that will perform all the tasks that need to be performed. The open model button when pressed, will allow the selection of a 3D model to be chosen. The 3D model will need to be in the format of a object file. These files have the extension ".obj". When an 3D model is selected then the record button can be pressed. When the record button is pressed. The 3D model then is rendered and then the user is placed inside of the model and is then free to roam the model using either the keyboard or a game-pad. The 3D render is expanded to fit on the entire width and height of the screen. The recording also starts once the 3D render starts the is made full-screen. During this process it is recommended that you move as little as possible as the data that is recorded could be tampered with. The recording process will end when all the slide-show images have been shown. You are then able to find the results of the recording in the project location in the relevant recordings folder, and finding the recording name as a folder. When you are done recording the data you can then exit the application or restart the recording. Restarting the recording will continue the recording for that model. The exiting of the application is done through the pressing the red X in the top right corner of the form.

4.8 Recording Video

The video recording form is navigated after the video is selected in the recording set-up. The page has a list of buttons that will perform all the tasks that need to be performed. The open video button when pressed, will allow the selection of a video to be chosen. The video that is chosen needs to be a ".wmv" file as it uses and extension of the

Windows Media player. The length of the video can be any length but the longer the video is the longer it will take to be processed. When a video is selected then the record button can be pressed. When the record button is pressed, the screen is filled with the video and the video will then start playing. The video is expanded to fit on the entire width and height of the screen. The video is recommended to be a medium quality one as the video might show signs of pixelation if it is any lower. The recording also starts once the video is made full screen and begins to play. During this process it is recommended that you move as little as possible as the data that is recorded could be tampered with. The recording will end when the video has stopped playing. Once you are done with the recording process you are able to find the results of the recording in the project location in the relevant recordings folder, and finding the recording name as a folder. When you are done recording the data you can then exit the application or restart the recording. Restarting the recording will continue the recording for that model. The exiting of the application is done through the pressing the red X in the top right corner of the form.

4.9 Report summary creation

Once a recording has been completed on a model a statistical report is then generated with various details on the recording. The report is in a PDF format so a PDF reader such as Adobe reader is required to be installed on the computer to view the report. The report is located in the folder specified for the model. The statistical report contains three types pages. The first page type is a cover page with a generic heading, the second page type will contain data of the selected model. This information is basic meta-data such as the models name, the models location and various other details about the model recorded. The third and final page type contains all the data for the recording that is then summarised. This data includes the number of points used and how many points where known as "lost points". Lost points are points that have been discarded as they are not in the bounds of the screen. These points have no impact on the creation of the heat-maps. The data also tracks the time of the recording based on the amount of points that are recorded.

The pdf also contains a grid of where the points are mapped on the grid. The grid is a three by three(3X3) grid and each section represent a part of a screen. The grid is also used to determine a point of interest which is a section that has been looked at the most. All this information is written to the PDF and then saved for later reading and to easily and quickly view what happened in the recording. An example of how a report may look is located below.

Recorded Data Summary

The following will show the data that is recorded.

Total points: 167

Total invalid points: 0

Total time of recording: 5.57 seconds

5	101	0
55	6	0
0	0	0

Point of focus: Top center with 101 points

4.10 Heat Maps

Heat maps show how the eye is moving around the recorded media by painting different colours at points that are being looked at. These points change colour the more often that they are viewed with red points being the most viewed. These create results that can be easily compared to others of the kind to see where users have looked most and how attractive the point was compared to any others.



4.11 Gaze Plot Maps

Gaze plot maps show how the eye is moving around the recorded media. This records the fixations in the eyes as the move from one location to another. This differs from the heat-map in that it shows where the eyes fixate in order and for how long the subject fixates on a specific point by making use of circles are placed on the eyes location and will grow longer the eye is near to the same location. When the eye moves far enough away from the point it then stops growing and moves to the next point. This gaze plot

can be created by pressing the create gaze plot button which then creates a video which can then be viewed.



5 Troubleshooting

This section of the user manual is dedicated to showing the errors that can occur on the system. This will also provide possible solutions to problems that you may encounter. Please note that version 1.0, our first stable release, should have a concise guide of errors you may encounter during using the application. If you find any errors, that are not mentioned in this documentation then please do not hesitate to contact Neo Tandem Technologies and we will do our best to try and solve the issue.

The system is split into many subsections thus the section below has also been broken up to try ease the process of solving problems and queries.

5.1 Starting the program

5.1.1 String is not a path

This error occurs when starting a new recording project and the path in the path text-box does not follow a natural path structure. The program will not continue if this error occurs and is not fixed. This can be fixed by ensuring that the text inside is a actual path such as: C:/User/[MyPath].

5.1.2 The path does not exist

The following error occurs when the path that is selected no longer exists on the computer. This can be resolved by doing one of two things:

1. Ensuring that the path specified is correct.
2. Creating the file path to match the selection.

Any one of these solutions can help fix the problem and will allow the user to continue normally.

5.2 Calibration

5.2.1 Could not find EyetribeWinUI.exe

The program requires that The Eye-Tribe calibration software be installed on the users system and thus occurs when the software can not be found on the system. The solution is simply to install the software which can be found on The Eye-Tribe website after you have purchased the camera.

5.3 Naming

5.3.1 Name is too long or contains an invalid character

This error can occur when the name for the recording contains invalid characters. All naming is required to only contain alphanumeric and thus can not contain any symbols. If this requirement has been met then please ensure that all names do not have any more than 40 alphanumeric characters.

5.4 General recording errors

5.4.1 Could not locate file

When a recording has been completed and this error occurs it means that the file that stores the eye tracking data may never have been created, thus it can not create heat maps for the desired model. This error can occur due to multiple factors such as:

1. The eye-tracking camera has not been connected or calibrated correctly.
2. The port used to connect the camera is faulty or does not comply with the specifications.

The solution would simply be to check that The Eye-tribe is connected to the computer properly and also that it is connected to a USB 3.0 port.

5.5 Heat-map

5.5.1 Heat-map could not be created

The heat map is created using a text file created when a recording has been done. This text file is then used in the heat-map production process. This error occurs when the text file is no longer available. The solution for this is to restart the recording process and ensure that the text file appears in the recording directory. If the file does not

appear in the directory then it is recommended that you restart the application, if this fails then please restart the computer.

5.5.2 Video could not be created

When the video is created an error can occur due to the following factors:

1. The required image is in use.
2. The required image has been deleted.

The solution is to re-run the creation of the video and avoid doing the above so that the video can be processed and created properly. Note viewing created images or deleting any created files can potentially cause this error to appear as thus it is recommended to only view these files once completed.

5.6 Statistics

5.6.1 Could not create statistical report

The statistical report is created using the recorded eye tracking data file created by the application after recording has been completed. This error occurs when the text file is no longer available when trying to create the report. The solution for this is to restart the recording process and ensure that the text file appears in the recording directory. If the file does not appear in the directory then it is recommended that you restart the application, if this fails then please restart the computer.

5.6.2 Report could not be saved

The report will be saved to the directory of the relevant model type. If you recreate the report an error can arise as it needs to save the report. The reason for this error is that the report is either open already or the directory has been deleted. This can be resolved by closing the report and then creating the report once more and ensuring that the directory still exists.

6 Appendices

6.1 EyeTribe

The Eye Tribe is a low cost development kit which can be used by various languages such as C# projects to track the movement of the eye. The Eye Tribe eye tracker includes a SDK (Software Development Kit) that allows the integration of eye tracking on multiple applications on multiple platforms. More information on the Eye Tribe and its various components can be found at <http://www.theeyetribe.com>.