SENIOR DESIGN PROJECT

Horus

Project Analysis Report

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TABLE OF CONTENTS

1. Introduction

The initial research for human-machine interactions was examined through speech. Unfortunately, these researches led to a dead-end "because the machine does not understand the emotional state of the speaker. Thus, researchers have introduced a newer research field compared to others, emotion recognition" [1]. Emotion recognition is the process of identifying human emotion [2]. People can have various amounts of success in identifying human emotions. For computers, emotion recognition involves face detection that leads us to the computer vision area. Computer Vision is one of the most popular computer science topics of the last decade. New technologies of computer vision such as face recognition, defect detection, intruder detection, etc. are highly invested in these days. There are a lot of applications of emotion recognition. However, there are no significant examples of multi-person emotion recognition. Our project will focus on that area, combining emotion recognition with human face recognition in crowded areas. Furthermore, Horus will have a deception detection mod. To obtain such functionality, we will use emotional cues described in psychology articles. Some research shows that emotional cues can be used as a diagnostic tool to detect deception [3]. We will use these emotional cues decoded through Horus to detect deception.

The goal of Horus is to recognize human emotions. Horus will detect the emotions of a single person or a group of people. The detection can be done with a camera or multiple cameras rapidly taking images/video in real time. Horus will first detect the faces and then analyze their emotions. Horus will be able to analyze the emotions of the user from saved videos or images besides real time detection.

In the single user mode, Horus examines a saved video or real time footage over a time period, it will report the various emotions detected from a single person. So it will attempt to give the mood of the subject from long term analysis of his emotions with respect to time. For Horus to analyze a user's face, there shouldn't be any obstacles, so if the user wears a mask, hat, etc. Horus will warn the user to remove any such obstacles. Horus will also have a crowd control mode where it will analyze the emotions of a group of people such as stand-up, movie, art activity audiences, or students in a classroom through multiple cameras or a single camera to provide feedback to show organizers, who can look at audiences' moods and decide on which content to keep and which to discard. Horus will also detect emotions on video conference calls such as Zoom. For this option, Horus will contain a screen capturing mode. It will analyze the emotions of the participants on the conference call and provide feedback to the organisers. Horus will also have a deception detection mode to tell whether a sentence told by the user is a lie according to the micics and the tone.

The results will be shown in realtime on the desktop app with a small window or on the mobile app with audio or visuals in various types of graphs that are selected by the user. The

graphs will contain detailed information about the scan such as average, time analysis, camera statistics etc. to give an appropriate result to the user.

Horus will have many usages. For example, a street artist can place a camera nearby and get feedback from the Horus according to the emotions of the audience by using a mobile application that shows the general mode of the crowd. Another use case can be handling tension and preventing aggression. For example, Horus can be used in a prison's common areas to keep an eye on prisoners. If Horus detects multiple nervous, angry prisoners, it will alert the guards.

2. Current System

Lately, computer vision is developing in a considerably fast manner. This allows people to develop new technologies related to human behaviors, feelings and emotions. Therefore, in the market there are various applications which contain some features of the Horus such as emotion recognition. However, Horus differs from those applications by consolidating various features of them, and by adding many ultimate features. Although Horus uses the same base with those applications, it has a unique aim, and unique features. The most significant features of Horus, making the difference, are:

- Capability of emotion recognition of a group of people in real time video record and in online conferences,
- Opportunity to make inferences according to results by using charts,
- Multi-camera support,
- Mobile application connection with audible warning for feedback.

Some current applications:

- FaceReader powered by Noldus: A desktop application to detect the facial expressions of the people. Although it can generate detailed charts after the analysis of a video containing one face, it cannot detect the average mood of a group of people [4].

- Morphcast: It is an emotional AI that can detect the gender, emotions, attention of the user. However, unlike Horus it cannot give solutions to the user, and it is not possible to use it in different fields such as video conferences, security cameras. It can only be used for testing purposes [5].

- F.A.C.E API from Sightcorp: It is a close purpose application to Horus. It can be thought of as an all-in-one program that contains various features including some features of the Horus. However, It mostly focuses on face detection in crowded areas, and measuring crowd demographics such as calculating age or gender of people in a group. This makes Horus different from the F.A.C.E API [6].

3. Proposed System

3.1. Overview

Horus mainly consists of 4 modes which are the single user mode, crowd control mode, deception detection mode and the screen capture mode and an option to view the results of older scans. The scans can be done by using an input from a single camera, multiple cameras, uploaded photos/ videos or capturing screen. The multiple camera option can only be used in the crowd control mode and uploading from a local device can be only used in crowd control and single user modes. The deception detection accepts only real time input and capturing screen mode can be chosen for only real time screen capturing.

The results of the scan are available at realtime and the user can see them while making the scan. After the scan is finished the scan is saved to the local device of the user and the user can view older scans. There are multiple graph alternatives which the user can view the results and it is possible to download the results in the desired format.

Moreover, a mobile application to track the current scan or to view older scans is available. The device can be connected with bluetooth. Audible and visual feedback are possible within this mobile application.

3.2. Functional Requirements

3.2.1 System Functionalities

- The system should give an opportunity to the user to select in which mode the data will be analyzed.
- The system should request permission to access the local storage of the user to access videos or images or to save downloaded results from Horus.
- The system should request permission to access the camera of the user’s computer.
- The system should give feedback to the user according to the analysed data which contains the emotions of the surrounding people, both visual and with the aid of an audible warning.
- The phone app should be able to be connected to the desktop app via bluetooth.
- The systems should be able to get inputs from multiple cameras at the same time.

3.2.2 User Functionalities

- The user can choose between single user mode, deception detection mode, screen capture mode and crowd control mode. Also to see the old results the user can choose the list last analyses option.
- In the single user mode, the user can see both the real time and cumulative results on the same page while the data is being analyzed.
- In the crowd control mode, the user can get both the real time and cumulative feedback from Horus according to the crowd's emotions.

- In the crowd control mode, the user can connect more than one capturing device.
- In the deception detection mode, the user can get positive or negative results about whether it is a lie or not, after the scanning and composing a sentence tasks are finished.
- In the screen capture mode, the user can see the real time and cumulative results from Horus according to the people's emotions.
- In the single user and crowd control modes the user can upload an image or video from their devices instead of getting input by camera.
- The user can change the type and the colors of the graphs in both real time analysis and in the old analysis section.
- The user can download a result to his/her device in the desired format.
- The user can connect to Horus via smartphone and earphones to get feedback remotely in single user, crowd control or screen capture mode or to see the results of the older scans.
- The user can control whether s/he wants to get audio feedback while using the smartphone app.

3.3. Nonfunctional Requirements

3.3.1 Reliability

- Horus should detect the faces as correctly as possible.
- Horus should detect the emotions as correctly as possible.
- Horus should determine deception as much as possible.

3.3.2 User-Friendliness

- The user interface of our app should be simple and easily understandable.
- It shouldn’t require any pre-education to use it.
- The user should get the audible feedback easily from his/her smartphone.
- The user should change the colors and types of the resulting graphs as s/he desires.
- The user should see the real time and cumulative results at the time of scanning easily on the same screen or from his/her phone.
- The user should reach old results and view them easily.

3.3.3 Efficiency

- It should detect the general mood of the user with a long enough video.
- In crowd control mode, Horus should calculate the average emotion of the crowd.
- The results of the detection should also be given according to time.
- Regardless of the type of the video conference app, Horus should start scanning with screen capture mode.

3.3.4 Performance

- Horus should use the resources (such as CPU, RAM etc.) of the computer which it runs on to give accurate results in real time with minimal delay to give immediate feedback to the user.

3.3.5 Security

- The photos/videos that our app captured will not be shared via any third parties by Horus.

3.3.6 Extendibility

- Horus can be extended to involve different types of scans (modes) in the future.

3.4. Pseudo Requirements

- The language of Horus will be English.
- The application will be written in Python programming language.
- The mobile application will be cross platform.
- The version control will be dealt via Git and all the versions will be uploaded to GitHub.

3.5. System Models

3.5.1. Scenarios

Scenario #1

Use case	View One of the Last Analyses
Participating Actors	User
Entry Conditions	- The user is in main menu
Exit Conditions	- None
Flow of Events	1. The user clicks on the List Last Analyses button. 2. The user chooses the analysis that s/he wants to view. 3. The user chooses the output graph type.

Scenario #2

Use case	Download the analysis results as a Line Chart in Single User Mode in PDF
Participating Actors	User
Entry Conditions	- The emotion detection has completed without any interruption and “Go To Results” button has been clicked
Exit Conditions	- The results successfully imported to the Line Chart - The output file is successfully downloaded in the desired format
Flow of Events	1. The user selects the “Single User Mode”. 2. Program scans the face. 3. Program starts to capture the face for emotion detection. 4. The user ends the capturing by pressing the “Go To Results” button. 5. The user selects the resulting graph type as Line Chart. 6. The user presses the “Download” button and chooses the PDF format from the dropdown menu. 7. The result is downloaded as a Line Chart.

Scenario #3

Use case	Connect to mobile application in Crowd Control Mode and view real time results there
Participating Actors	User
Entry Conditions	- Mobile application should be installed - Mobile phone should be connected to the computer via Bluetooth - The user should select Crowd Control Mode
Exit Conditions	- Deception detection is successfully completed - The results successfully sent to the mobile phone via Bluetooth
Flow of Events	1. The user establishes a bluetooth connection between the mobile phone and the computer. 2. The mobile application connects to the program. 3. The user selects the “Crowd Control” Mode on his/her computer and the current analysis on his/her mobile application. 4. Program scans for the faces. 5. Program starts to capture the faces for emotion detection. 6. Program shows results in the desktop app and also sends them to the mobile application synchronously. 7. Mobile application shows results to the user.

Scenario #4

Use case	Detect whether a someone is telling a lie or not in Deception Detection mode
Participating Actors	User
Entry Conditions	- The deception detection has completed without any interruption
Exit Conditions	-The result (lie or not) is successfully given.
Flow of Events	1. The user selects the “Deception Detection” Mode. 2. Program scans the face. 3. Program asks the user to compose a sentence. 4. The user composes a sentence. 5. The user composes a sentence. 6. Program accepts the sentence. 7. Program shows the result.

3.5.2. Use Case Model

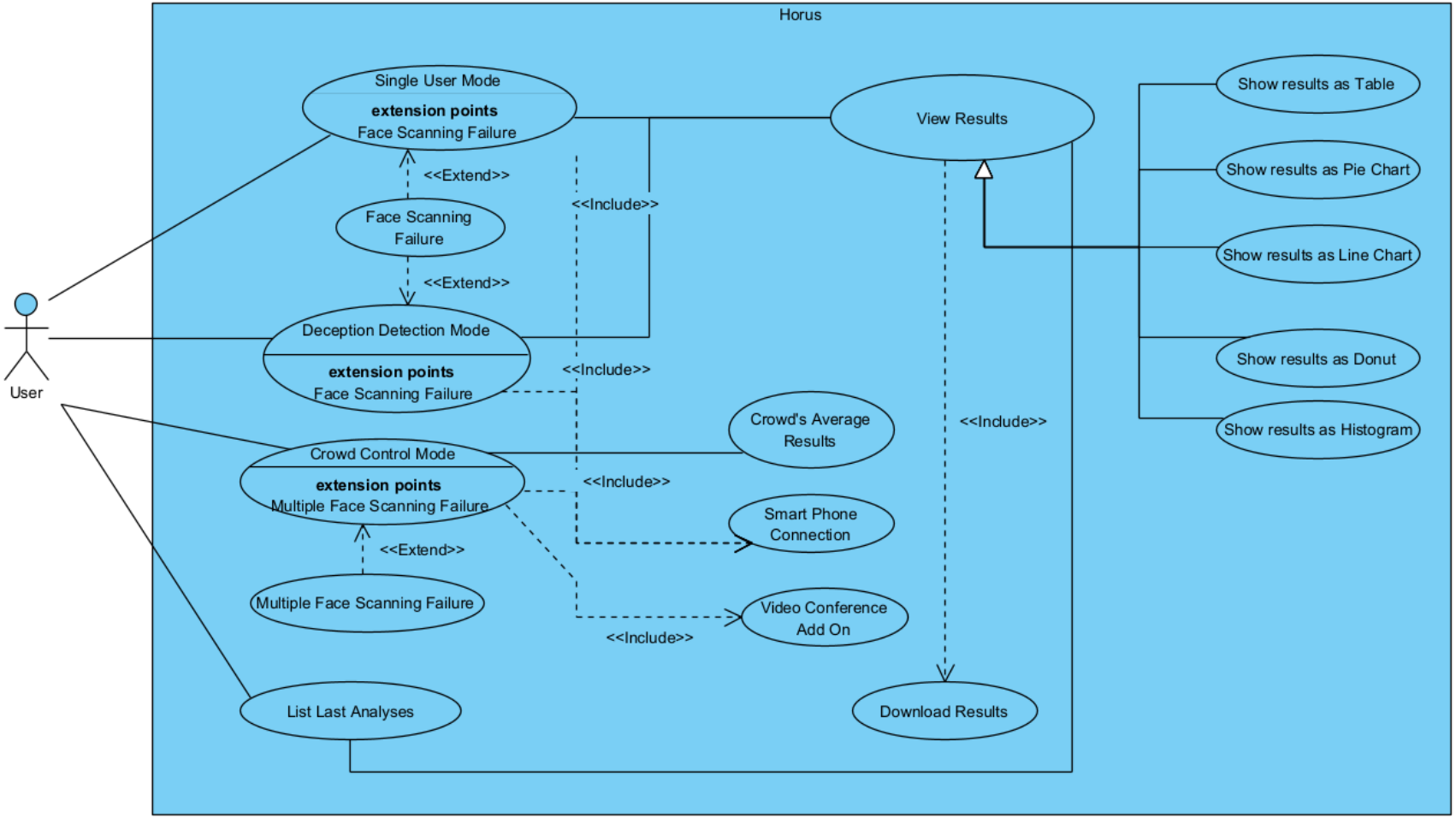

Figure 01: Use case model

3.5.3. Object and Class Model

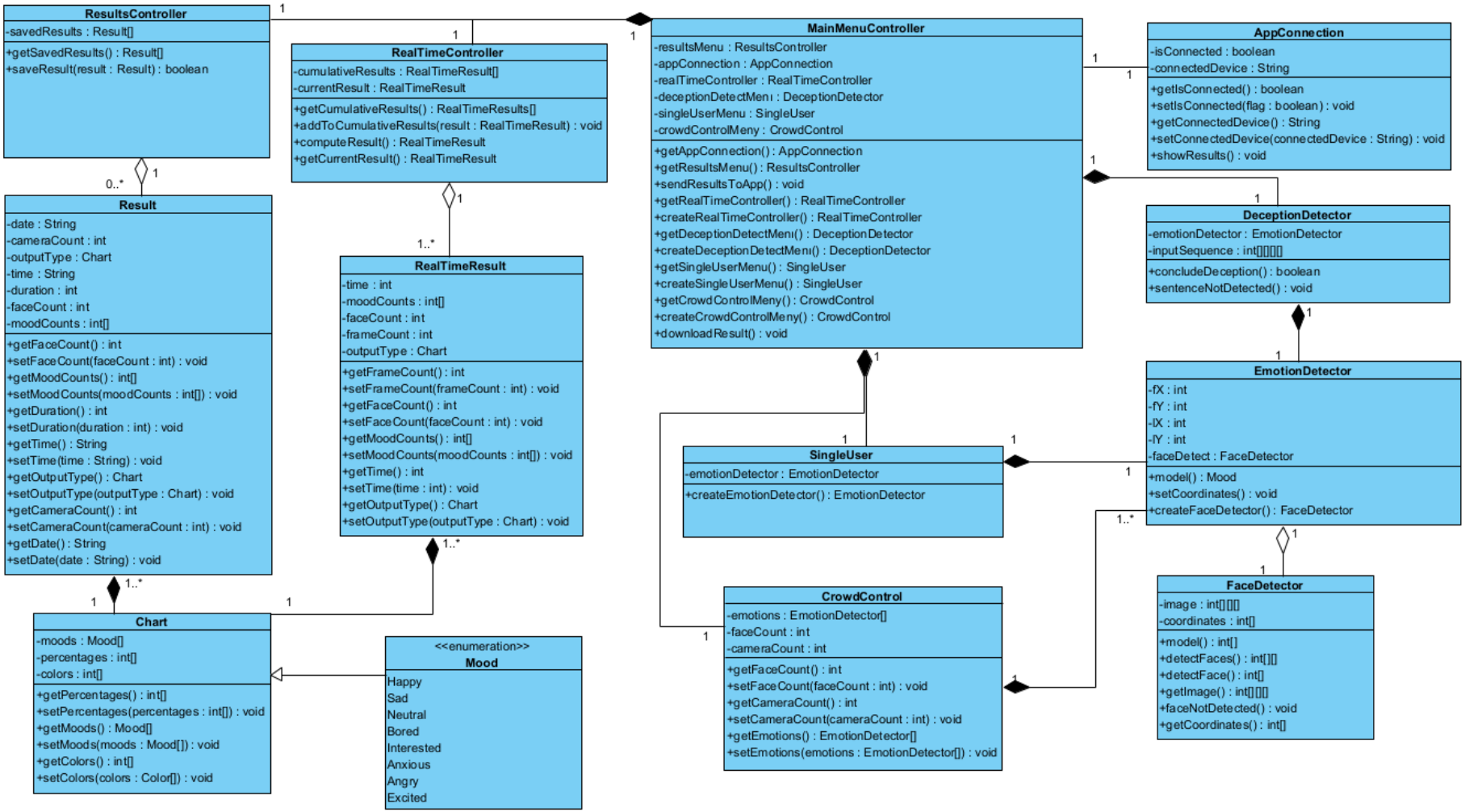

Figure 02: Object and Class Model

3.5.4. Dynamic Models

3.5.4.1. Deception Detection Mode Activity Diagram

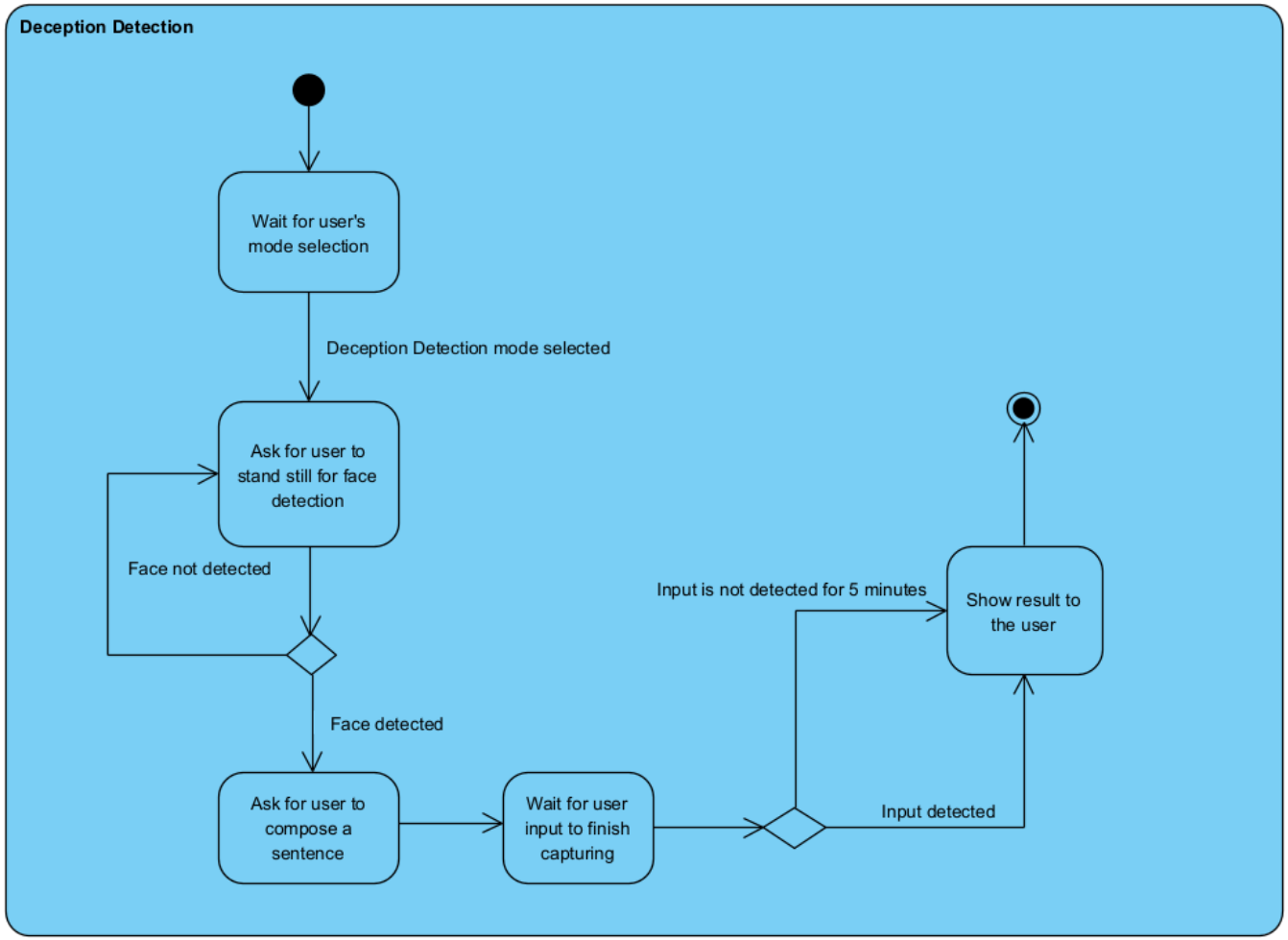

Figure 03: Deception Detection Mode Activity Diagram

3.5.4.2. Crowd Control Mode Activity Diagram

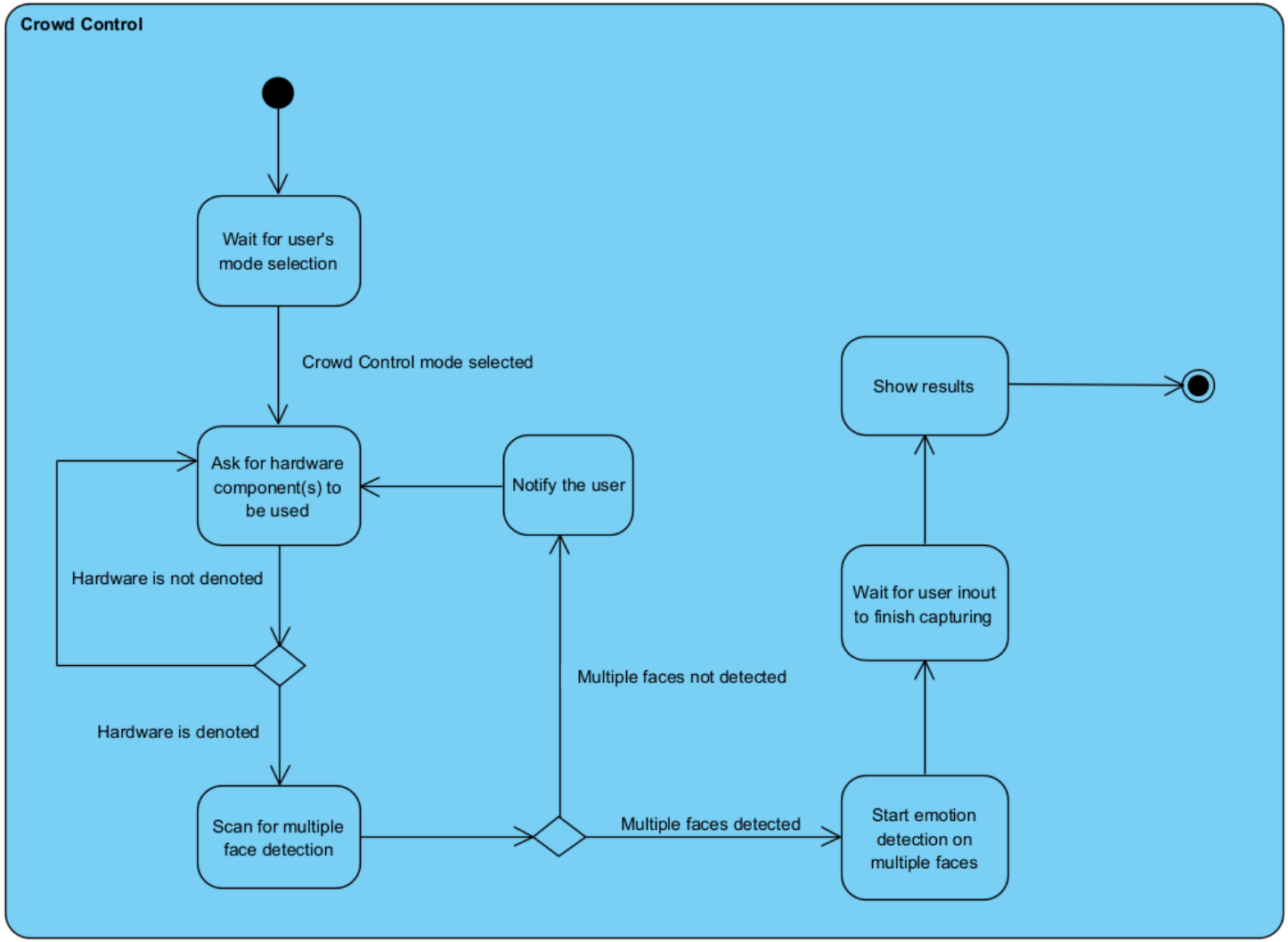

Figure 04: Crowd Control Mode Activity Diagram

3.5.4.3. Crowd Control State Diagram

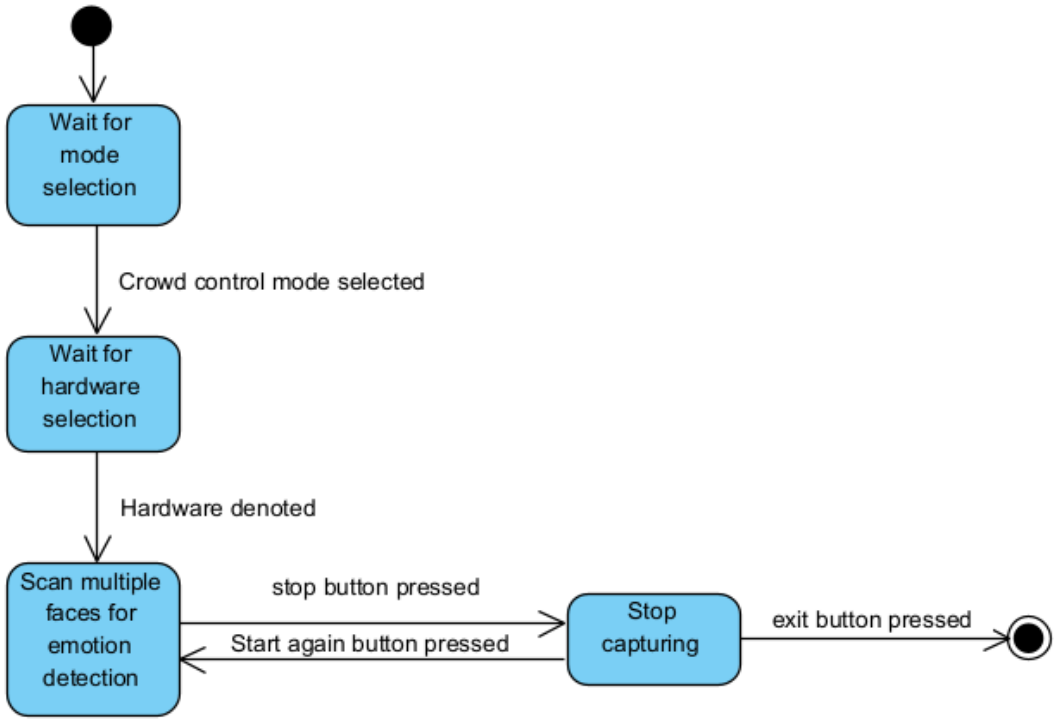

Figure 05: Crowd Control State Diagram

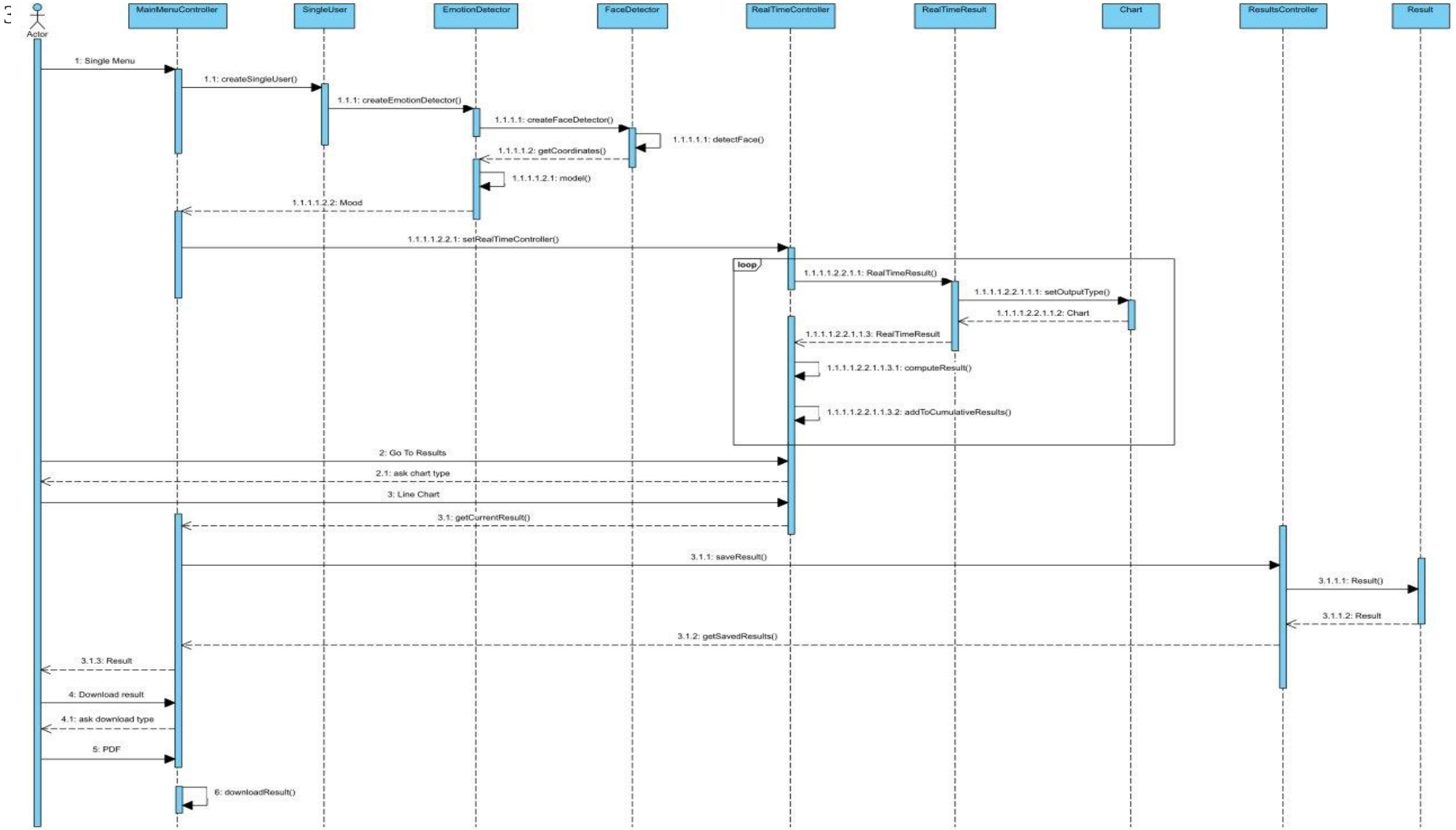

Figure 06: Sequence Diagram

3.5.5. User Interface- Navigational Paths and Mock-ups

3.5.5.1. Desktop App

3.5.5.1.1. Start Screen

Figure 07: Start Screen. Courtesy of Author unsplash.com [7]

This is the screen that the user encounters when s/he first opens the application. By clicking on “start”, they will be directed to the screen that they will choose the mode.

3.5.5.1.2. Choose Mode Screen

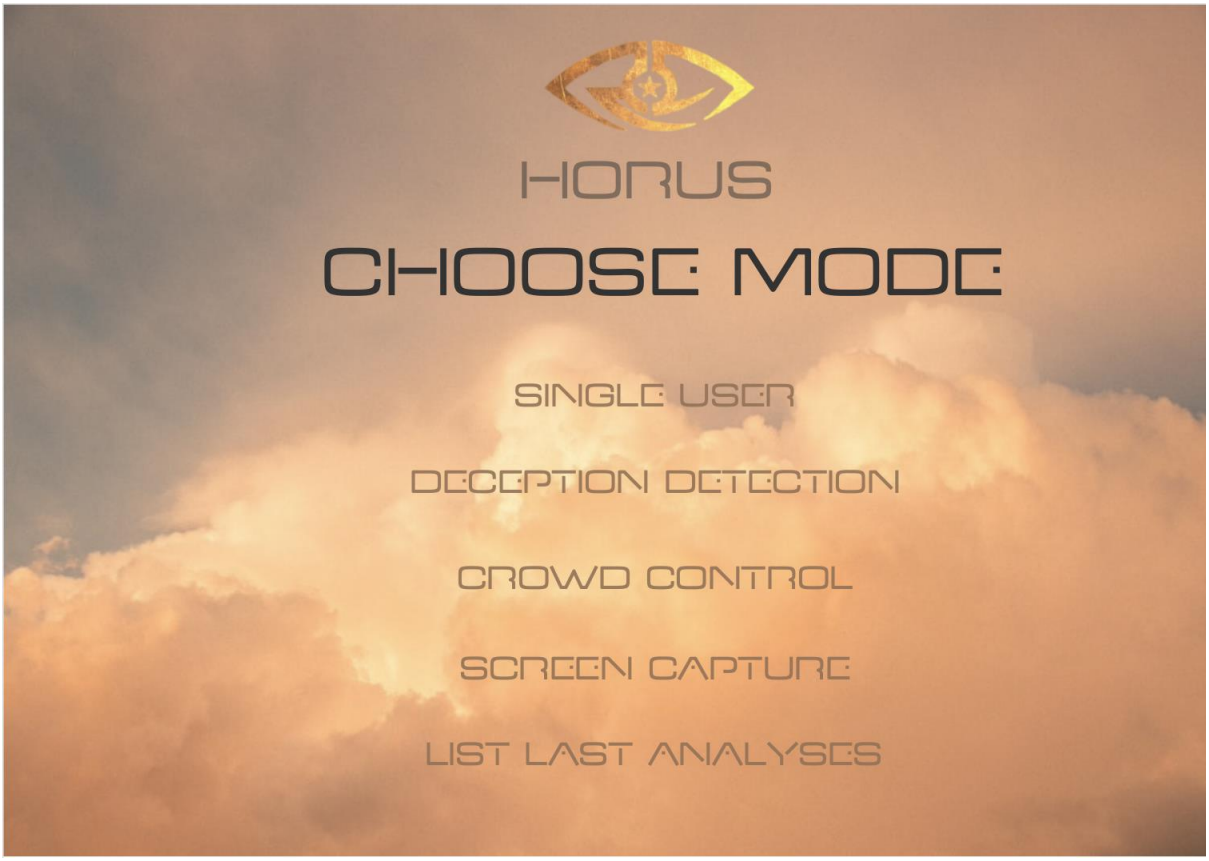

Figure 08: Choose Mode Screen

This is the page that the user will choose the mode that s/he wants to use. “Single user”, “deception detection”, “crowd control” or “screen capture” modes can be chosen for starting a new detection or “list last analyzes” mode can be chosen to see the old results.

3.5.5.1.3. Single Person Mode Screen

Figure 09: Single Person Mode Screen. Courtesy of Author ABC News[8]

This screen comes up if the “single person” mode is selected. The user can go back to the mode selection menu by clicking on the “back” button. The camera needs to be open for the analysis. When clicked on the replay button, the analysis starts from the beginning, when the pause button is clicked, the analysis stops and the analysis continues when the play button is clicked. If the “go to results” button is pressed, the analysis stops and the results are saved. With the upload from the computer button on the top right corner, videos or photos can be uploaded for scan instead of using the camera. The drawer menu on the left bottom corner can be clicked and opened whenever wanted. It shows the real time results in the selected format. The top button is for switching the current graph type, the middle button is for changing the colors and the button at the bottom is for adjusting sound volume. An error message is shown if a face cannot be detected after some time.

3.5.5.1.4. Crowd Control Mode: Selecting Camera Screen

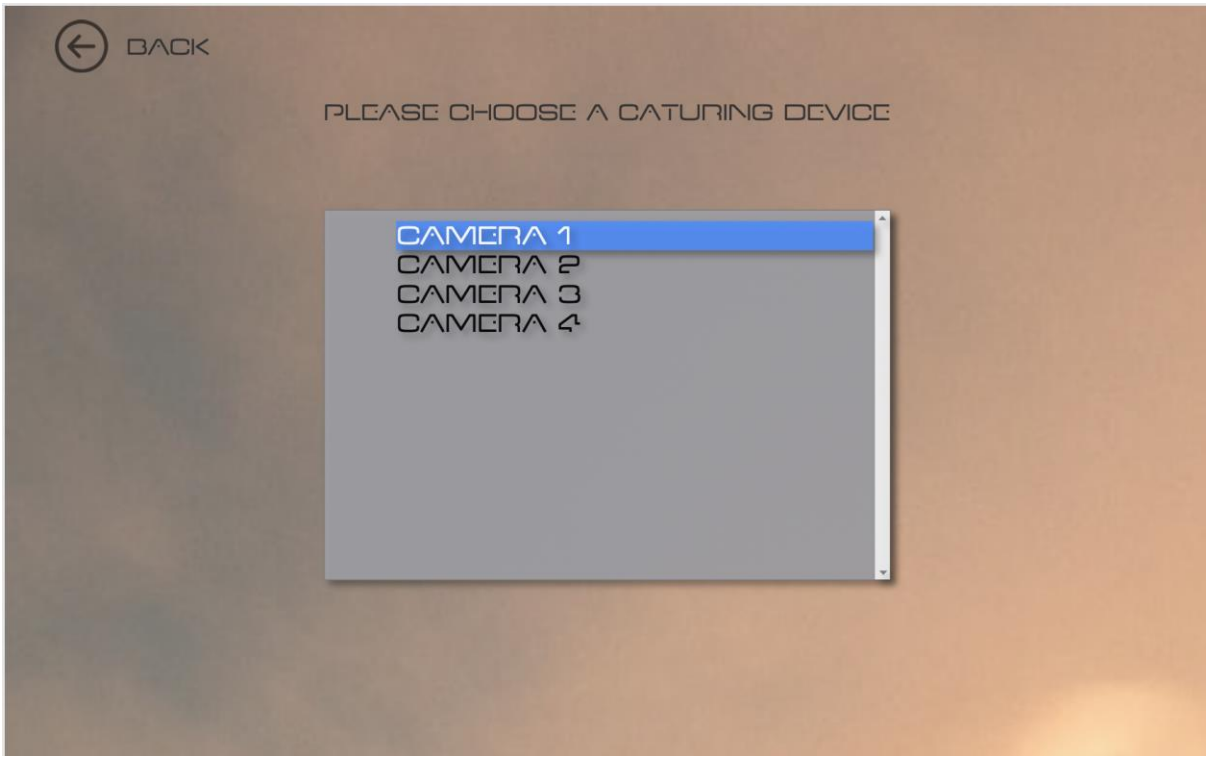

Figure 10: Crowd Control Mode: Selecting Camera Screen

This is the screen where the user chooses the hardwares that s/he wants to use as cameras. It comes after selecting the “crowd control” mode. Multiple devices can be chosen by clicking on.

3.5.5.1.5. Crowd Control Mode Screen

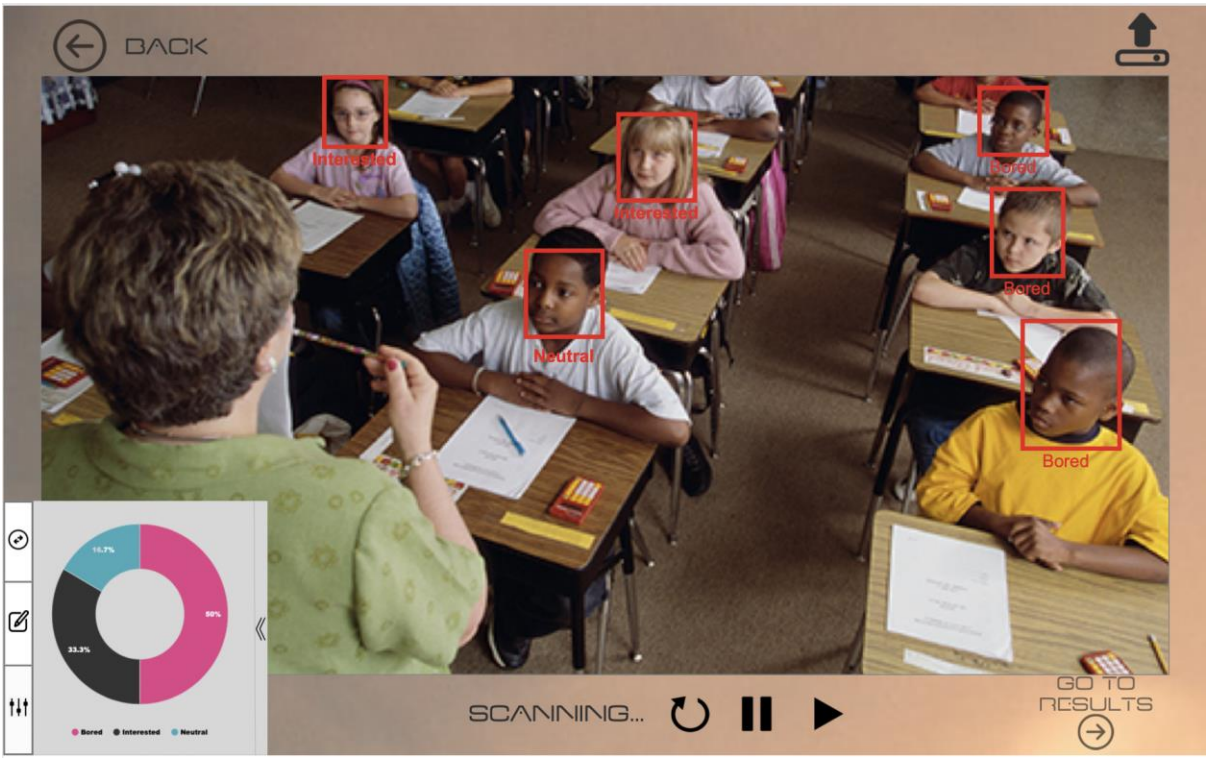

Figure 11: Crowd Control Mode Screen. Courtesy of Author thepsychologist.bps.org.uk [9]

This screen comes up if the “crowd control” mode is selected. The user can go back to the mode selection menu by clicking on the “back” button. The camera needs to be open for the analysis. If multiple cameras are selected, the screen splits into the number of cameras selected. When clicked on the replay button, the analysis starts from the beginning, when the pause button is clicked, the analysis stops and the analysis continues when the play button is clicked. If the “go to results” button is pressed, the analysis stops and the results are saved. With the upload from the computer button on the top right corner, videos or photos can be uploaded for scan instead of using the camera. The drawer menu on the left bottom corner can be clicked and opened whenever wanted. It shows the real time results in the selected format. The top button is for switching the current graph type, the middle button is for changing the colors and the button at the bottom is for adjusting sound volume. An error message is shown if a face cannot be detected after some time.

3.5.5.1.6. Deception Detection Mode Screen

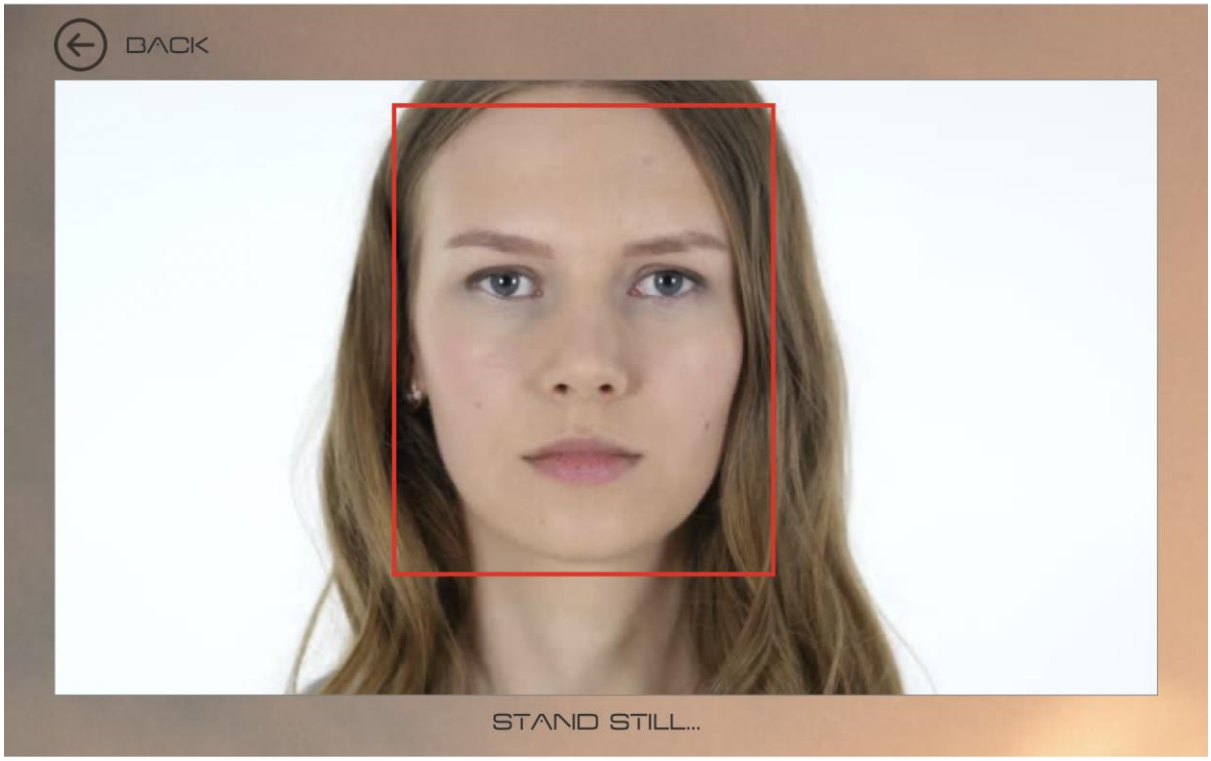

Figure 12: Deception Detection Mode Screen. Courtesy of Author Videohive.net [10]

This is the screen that comes up if the “deception detection” mode is selected. The user can go back to the mode selection menu by clicking on the “back” button. The camera needs to be open for the analysis. It waits for the user to stand still and after the face is detected it forwards the user to the next screen. An error message is shown if a face cannot be detected after some time.

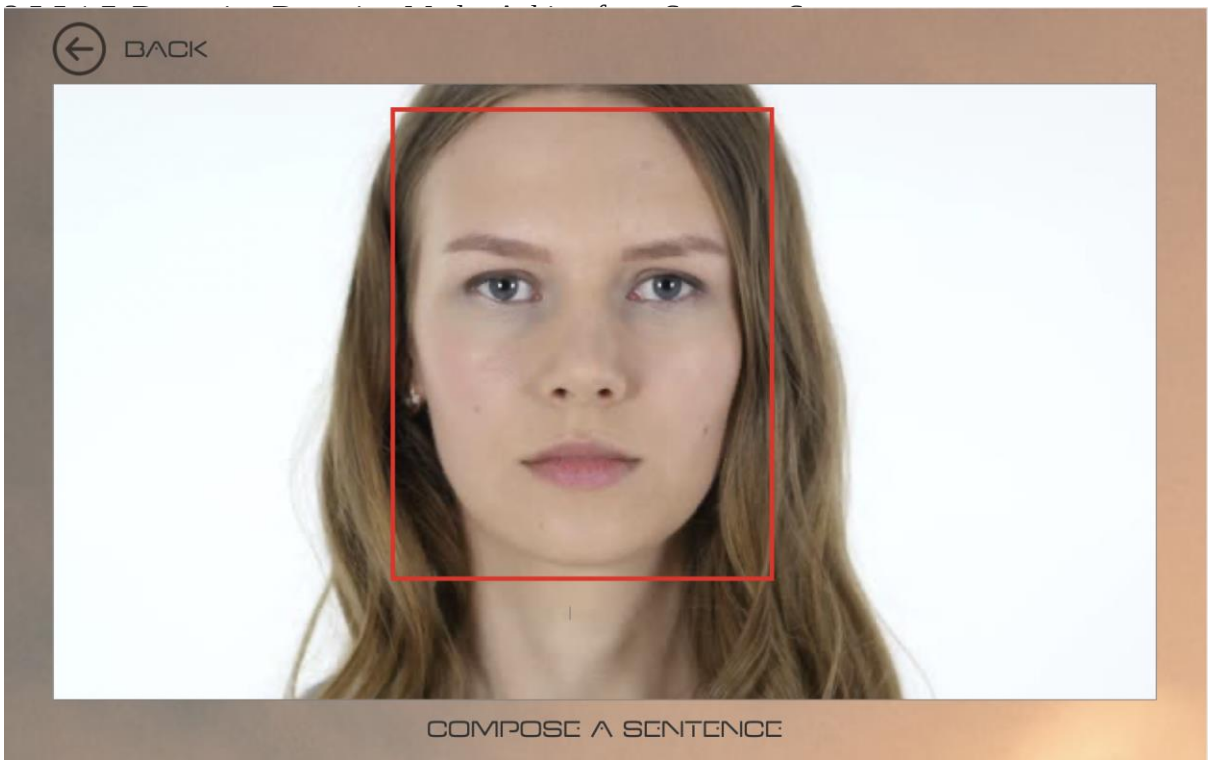

Figure 13: Deception Detection Mode: Asking for a Sentence Screen. Courtesy of Author Videohive.net [10]

This is the screen that comes up after the face is detected in the “deception detection” mode. The user can go back to the mode selection menu by clicking on the “back” button. The camera needs to stay open for the analysis. It asks the user to compose a sentence. An error message is shown if a sentence cannot be received after some time.

Figure 14: Deception Detection Mode: Result Screen. Courtesy of Author Videohive.net [10]

This is the screen that comes up in the “deception detection” mode after the sentence is accepted. The user can go back to the mode selection menu by clicking on the “back” button. The result is shown in a pop up. It can be either “A lie” or “Not a lie”. By closing the pop up, the user can remake a test.

3.5.5.1.9. Screen Capture Mode Screen

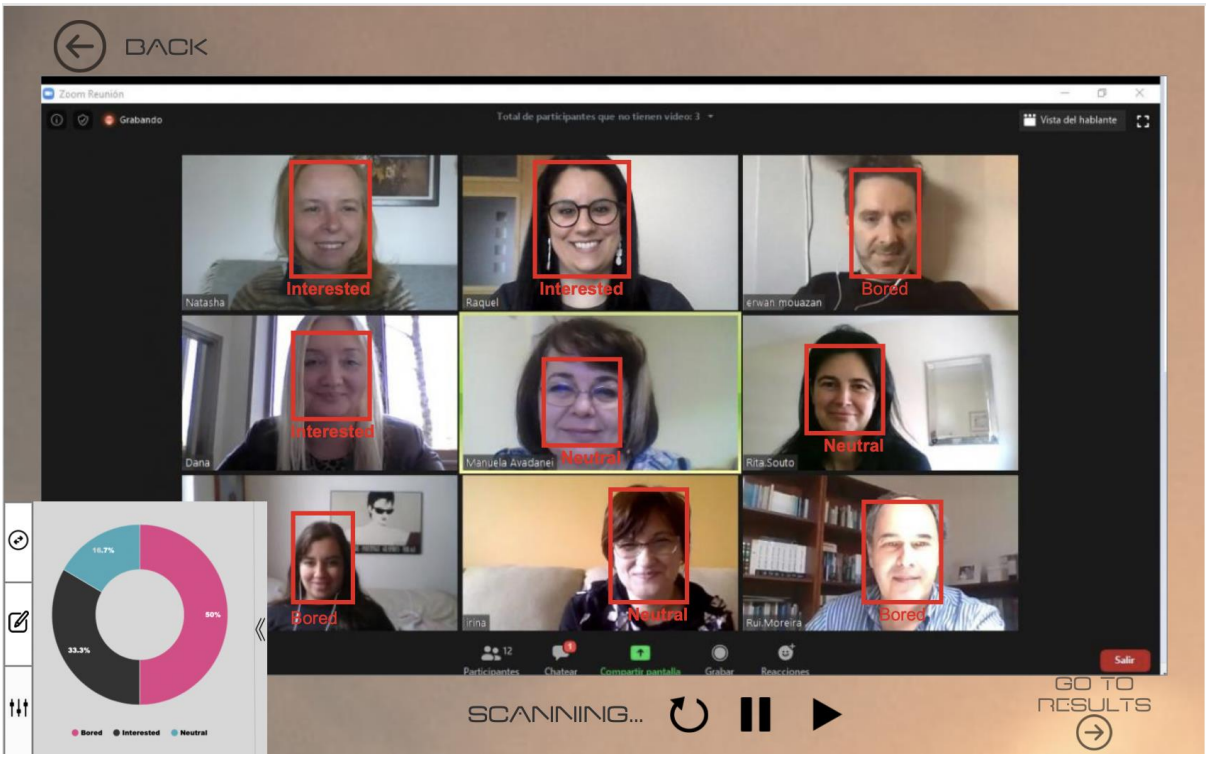

Figure 15: Screen Capture Mode Screen. Courtesy of Author Design4circle.eu [11]

This screen comes up if the “screen capture” mode is selected. The user can go back to the mode selection menu by clicking on the “back” button. The screen capture/share needs to be open for the analysis. When clicked on the replay button, the analysis starts from the beginning, when the pause button is clicked, the analysis stops and the analysis continues when the play button is clicked. If the “go to results” button is pressed, the analysis stops and the results are saved. The drawer menu on the left bottom corner can be clicked and opened whenever wanted. It shows the real time results in the selected format. The top button is for switching the current graph type, the middle button is for changing the colors and the button at the bottom is for adjusting sound volume. An error message is shown if a face cannot be detected after some time.

3.5.5.1.10. Choose Analysis Screen

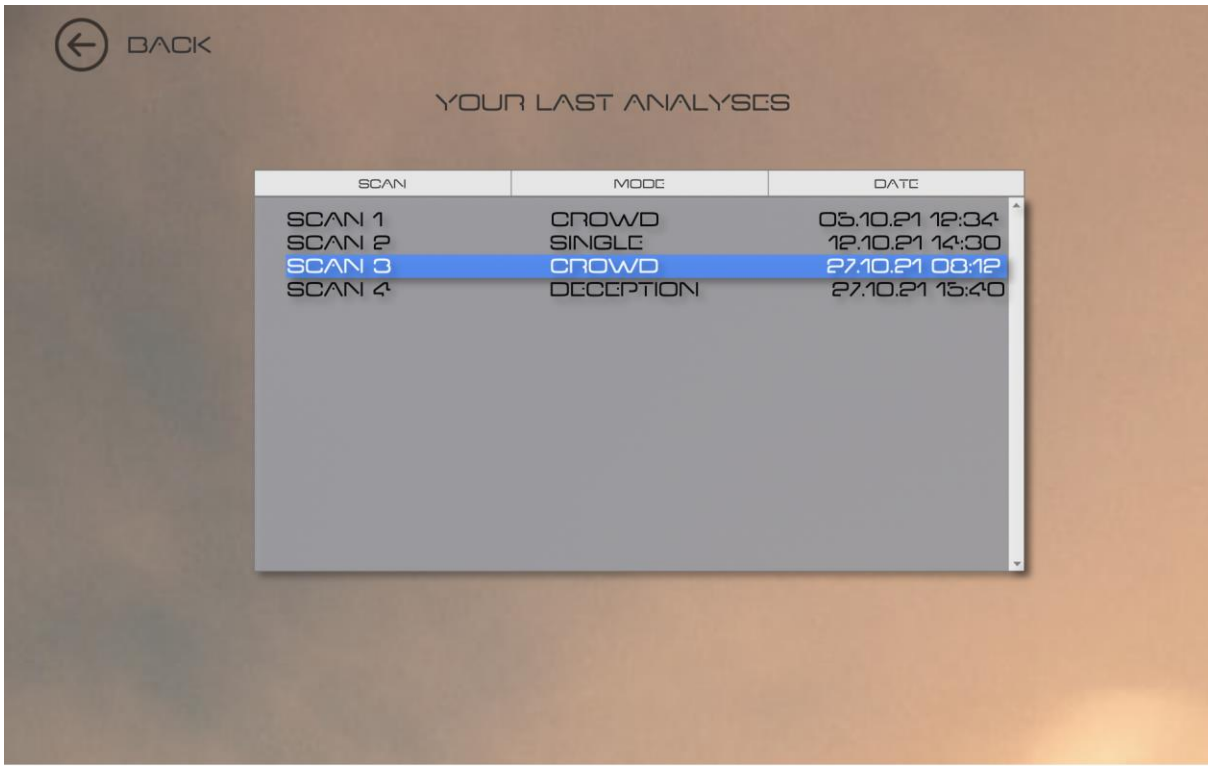

Figure 16: Choose Analysis Screen

This is the screen that comes up if the “list last analyses” mode is selected. The user can go back to the mode selection menu by clicking on the “back” button. The last analyses are shown with their type and dates. By clicking on one of the scans, the analysis can be viewed.

3.5.5.1.11. Choose Analyses Type Screen

Figure 17: Choose Analyses Type Screen

This is the screen that comes up after one of the analyses is chosen in the “list last analyses” mode. The user can go back to the mode selection menu by clicking on the “back” button. The output result can be chosen to be line chart, pie chart, histogram, table or donut chart.

3.5.5.1.12. Analysis Screen

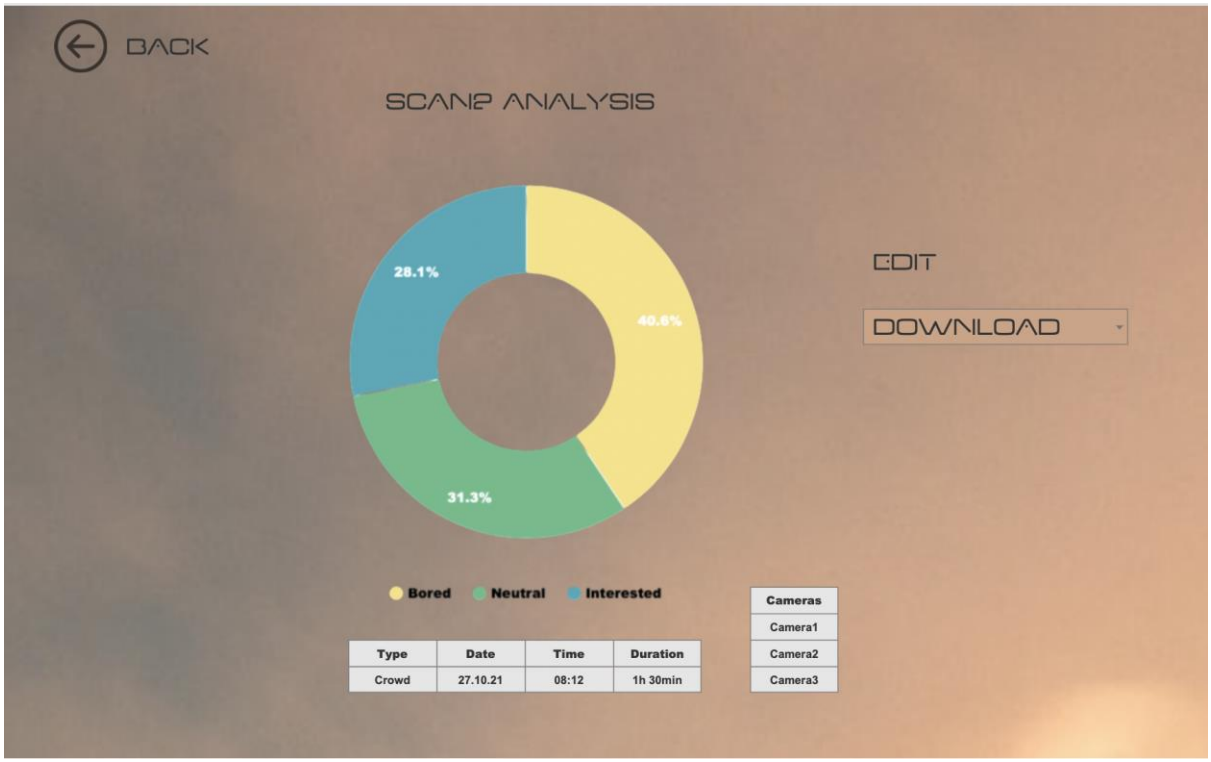

Figure 18: Analysis Screen

This is the screen that comes up after the analysis output type is chosen in the “list last analyses” mode. The user can go back to the mode selection menu by clicking on the “back” button. The result is shown with the selected graph type. The devices used for capturing that scan are listed and the details of the scan which are the type, date, time and the duration are also shown. By clicking on the edit button the colors can be changed or the tables can be removed or added. By clicking on the download button with a drop down menu, the output type (pdf, excel, etc.) can be chosen and then the results can be downloaded.

3.5.5.2. Mobile App

3.5.5.2.1. Start Screen

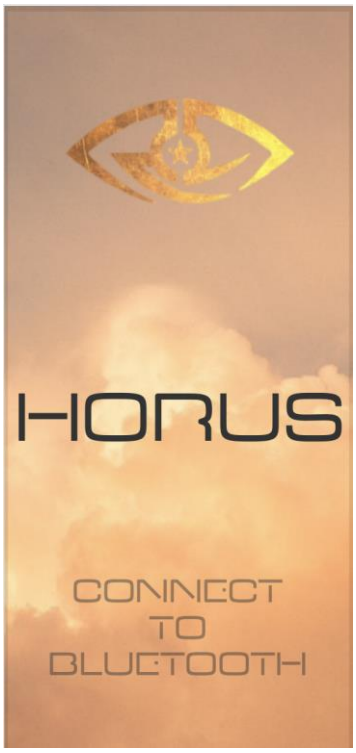

Figure 19: Mobile App Start Screen

This is the screen that the user encounters when s/he first opens the application. It waits for the user to connect to the desktop device via bluetooth, then, they will be directed to the screen that shows the menu.

3.5.5.2.2. Menu Screen

Figure 20: Mobile App Menu Screen

This is the menu screen that the user will choose what s/he wants to do. “Current analysis” can be chosen to track the current analysis in real time, “list last analyses” can be chosen for viewing the analyses of the scans done before and “settings” can be chosen to adjust sound or bluetooth settings. If there is no current analysis at the moment, that option cannot be chosen.

3.5.5.2.3. Current Analysis Screens

(a) (b)

Figure 21: Caption (a) Mobile App Current Analysis Screen (b)Mobile App Current Analysis Screen with Settings

This screen comes up if the “current analysis” option is chosen. It shows the graph of the current analysis in real time if there is an analysis running at the moment. The user can go back to the main menu by clicking on the “back” button. With the switch button below, the type of the graph can be switched between other types of graphs. When the settings button on the top right corner is clicked, the drawer menu comes in. In that menu, the user can change the color of the graph or adjust the volume.

3.5.5.2.4. Choose Analysis Screen

Figure 22: Mobile App Choose Analysis Screen

This screen comes up if the “list last analyses” option is chosen. The user can go back to the main menu by clicking on the “back” button. The scans made before are listed and the user can choose one of them.

3.5.5.2.5. Analysis Screens

(a) (b)

Figure 23: Caption (a) Mobile App Analysis Screen (b) Mobile App Analysis Screen with Settings

This screen comes up after the analysis is selected if the “list last analyses” option is chosen. The user can go back to the main menu by clicking on the “back” button. It shows the graph of the chosen analysis in real time if there is an analysis running at the moment. The devices used for capturing that scan are listed and the details of the scan which are the type, date, time and the duration are also shown. When the settings button on the top right corner is clicked, the drawer menu comes in. In that menu, the user can change the color of the graph, add and remove the tables or change the type of the graph.

4. Other Analysis Elements

4.1. Consideration of Various Factors in Engineering Design

4.1.1 Public Health

Horus has no positive or negative impact on public health. Horus will be used by clients only when they need to observe the person/people in front of them. So, Horus will not require looking at the screen constantly. With this advantage, Horus aims to not affect physical and psychological health.

4.1.2 Public Safety

The data that is acquired during the usage of Horus such as videos and photos will not be shared via any third parties by Horus.

4.1.3 Public Welfare

Horus will be free to both download and use. In addition to this, Horus will not contain any paid services. So, if a client has a PC or a mobile phone, they can use Horus freely. Additionally, Horus might have a positive impact on public welfare. To give an example, at the above we said that Horus might be used in stand-up shows to see how happy the audiences are. So that, the people who organize the show can make future plans about the show. To conclude, we do not think Horus will have a negative impact but positive impacts.

4.1.4 Cultural Factors

Horus neither will affect the cultural differences nor be affected by the cultural differences, since Horus will not show any difference between the cultures according to its usage. So, there is no cultural factor which should be taken into consideration while using the Horus.

4.1.5 Environmental Factors

Horus neither will affect the environment nor be affected by the environment. Since Horus will use cameras to gather data and software to process the data, it will not have any positive or negative direct impact on the environment.

4.1.6 Global Factors

Horus can be used by any country as long as the place it will be used agrees to put a camera(s) and set the software properly. Also, since the main language of Horus is English it can be adapted to other countries without any problem.

4.1.7 Social Factors

Horus will be able to be used by any person without looking at his/her age, gender, race etc. So, Horus will not be affected by social factors.

Table 02: Factors that can affect analysis and design.

	Effect level	Effect
Public health	0	Horus has no effect on this factor.
Public safety	8	Horus will not share any data to any other third parties. So, Horus will not affect the safety negatively.
Public welfare	9	By observing the audiences, organizations like stand-up might change their content to make more profit. Also, Horus is completely free.
Cultural factors	0	Horus has no effect on this factor.
Global factors	7	Horus is feasible for almost every country as long as the place satisfies the requirements.
Social factors	0	Horus has no effect on this factor.

4.2. Risk and Alternatives

Horus requires to process the video in place. In other words, we need to capture the data via a camera(s) , then send the data to our software to process the data and store it in a local database. To make the system more effective, the way in general to achieve this communication between a camera(s), local database, PC and mobile device needs to be stable and reliable. Since the data will be analysed later or in an instant, there shouldn't be any data loss.

It is obvious that Horus is a computer vision project which relies on video and image processing. Such computations require high computation powers of hardware it works on. This is one of the risk factors of this project. Hence, Horus may give different performances on different devices. In some devices, the low performance may risk instant video analysis. Furthermore, Quality of the records is another risk factor for Horus. Because in case of low quality data recorded in a crowded area, it would be a problem to detect both faces and the emotions of people who stand far from the camera.

4.2.1 Computational Power of the Used Device

Horus is an application that requires intensive computation of visual data. At the same, there will be various tasks that are working in parallel. Some examples of these tasks are creating interactive charts, getting instant video data from the camera, and sending the results to the mobile application. Used low powered hardware may cause a bottleneck for the functionality of the application. This can be reduced by closing some of the features from settings by the user whose device could not fulfill the performance requirements. To avoid this problem, Horus will use the most efficient algorithms for both data analysing and the other features.

4.2.2 Low Video Record Quality

In some cases such as an analysis in a theater, video record quality may be low due to some outer factors such as darkness, usage of low quality cameras, or positioning of the camera. Horus application has various features to prevent such technical problems by supporting multiple camera systems and calculating the crowd's average mood according to the mood's of a small group of people recorded by different cameras. So in such cases the user can open a mode in which the program can automatically ignore the data which is not possible to process and make inferences by using inductive reasoning. Furthermore, Horus will be using some datasets that contain real examples of such problems so that Horus will have the ability to detect even in those cases as much as it can.

4.2.3 Data Privacy Issues

Although Horus uses various private data of the users such as facial image, location, mood etc... while analysing the data, it does not store any personal information on cloud or on any other device than the user's personal information. The data can be stored only on a local database to access analysed or raw data. Therefore, Horus is not going to have any permission to share the data with third party applications or third person. Nevertheless, Horus is going to

avoid any violation of law regulations by finding solutions to some possible bugs that can cause data leaks.

4.2.4 Low Connection Quality

While transferring recorded data from camera to the personal computer of the user, or transferring the results from user's computer to mobile device, Some data losses can be occured due to physical or technical reasons. In such cases, if the users can not access the requested Horus data from their mobile devices, Horus will store the information in the local hardware and send it as soon as the connection is reestablished. Horus is going to be able to continue analysis although there are data losses, and it will continue analysis with ultimate data.

4.2.5 Inaccurate Results

Horus will work on top of 3 machine learning models which aim at positioning face, emotion recognition and deception detection in scenes. The emotion detection task will depend on the face detection algorithm therefore the accuracy of the face detection will also affect the correctness of the emotion detection. The deception detection will be depending on the emotion detection in the same way. So the chance of the inaccurate actual result will be increased as a chain. This may be a problem considering the satisfaction of the user if the accuracy is too low.

4.2.6 Plan B Solutions

The plan B of Horus is considered to solve the issues that will cause unfavorable user experience, low accuracy and data privacy issues. Within this focus we will look at computational power of the used device, low video record quality, data privacy issues, low connection quality and inaccurate results respectively.

- **Computational Power of the Used Device:** If the device that is used to run Horus has inadequate computing power, the computations may take too long to complete or not be completed at all. If the process takes too long, the user will be alerted of the problem and be advised to allocate more resources for Horus to run properly.
- **Low Video Record Quality:** If the camera setup does not provide high quality video, Horus will not be able to provide accurate emotion detection information. This can only be solved by reconfiguring the camera setup. Multiple camera setups can be used to increase video quality.
- **Data Privacy Issues:** Horus will be aware of the legal consequences and privacy issues.
- **Low Connection Quality:** In case of connection issues between the main system and the user's mobile device, the user will be alerted and the data will be stored in the local hardware which will be sent to the device as soon as the connection is reestablished. If there is a camera connection problem, the system will wait for a suitable amount of time before shutting down.

- **Inaccurate Results:** The accuracy of the models developed for detecting the position of the faces, the emotions and the lies may be not high enough to satisfy the user. If the accuracy is very low, the models will be retrained with different datasets or new models will be developed. If not, the user will get the accuracy of the results besides the results itself.

Table 03: Risks

Risk	Likelihood	Effect on the project	Plan B Summary
Computational Power of the Used Device	4/10	Horus's functionality will be terminated or delayed. As a result, users will have unfavorable experience	In case the program takes too long to provide results, Horus will warn the user that there are not enough computing resources available.
Low Video Record Quality	7/10	Due to the low count of pixels, Horus might interpret the emotions incorrectly.	If possible, by using multiple cameras from different angles, Horus will try to increase the accuracy.
Data Privacy Issues	1/10	Legal consequences and privacy issues due to sensitive data obtained from the user	The sensitive data is going to be encrypted and work on the internal system.
Low Connection Quality	5/10	The reception of information will be delayed.	The user will be informed about the delays.
Inaccurate results	5/10	The user will get wrong results.	New models will be developed, or the user will be given accuracy information.

4.3. Project Plan

The main goal of the Horus project is to implement a desktop application that is able to analyse various types of visual data (crowded area, single person, conference call record) for different purposes such as mood detection or emotion recognition etc. In addition, Horus project contains a simple mobile application that gives opportunity to users to see instant results on different devices.

Project plan is arranged according to the CS 491/2 course structure, and divided into multiple parts. In the first semester deeper and fundamental features such as face detection will be researched and started to be implemented. However, we will not work on the mobile application in the first semester. In addition to these, user interface and testing will be done as we progress step by step during both semesters. In the second semester the remaining parts will be completed, as well as the mobile application. As a last, developed parts during both parts will be reunited and accuracy will be increased.

After indicating the development cycle and steps of the project. The project is divided into 7 parts: Face detection, emotion detection, deception detection, user interface (front-end development), reports, mobile application and testing. These parts will be composed into a single point at the end. During the development Github will be used for collaboration and project management. The source code, documentation and the website of the project will be stored on a private Github repository.

WP#	**WP title**	**Leader**	**Members**
WP1	Face Detection	Asya Doğa Özer	Asya Doğa Özer, Ufuk Palpas
WP2	Emotion Detection	Ufuk Palpas	Ufuk Palpas, Furkan Demir, Muzaffer Köksal
WP3	Deception Detection	Furkan Demir	Furkan Demir, Muzaffer Köksal
WP4	User Interface	Asya Doğa Özer	Asya Doğa Özer, Can Kılıç
WP5	Reports	Can Kılıç	Can Kılıç, Asya Doğa Özer, Furkan Demir, Ufuk Palpas, Muzaffer Köksal
WP6	Mobile Application	Muzaffer Köksal	Muzaffer Köksal, Can Kılıç
WP7	Testing	Can Kılıç	Can Kılıç, Furkan Demir

4.3.1. Work Packages

Details of the work packages are explained in more detail under this header.

WP1: Face Detection			
Start Date: *06.11.2021* **End Date:** *13/03/2022*			
Leader:	Asya Doğa Özer	**Members Involved:**	Asya Doğa Özer, Ufuk Palpas
Objectives: *This package ensures that the face detection algorithm is successfully implemented and it is ready to be used in emotion detection in the latter work package so it should be a basis for the next work package.*			
Tasks: **Task 1.1 Creating the model:** *The model will be developed to recognize the faces in both multi-person and single person scenes.* **Task 1.2 Deciding on the dataset:** *The exact training set and the test set will be chosen.* **Task 1.3 Training the model:** *The model will be trained by using the training set.* **Task 1.4 Testing the model:** *The model will be tested using the test set.*			
Deliverables: **Deliverable 1.1:** *A fully working model that detects the locations of the faces in a given scene.*			

WP2: Emotion Detection			
Start Date: *21/11/2021* **End Date:** *20/03/2022*			
Leader:	Ufuk Palpas	**Members Involved:**	Furkan Demir, Muzaffer Köksal
Objectives: *This package ensures that the emotion detection algorithm is successfully implemented and it is ready to be combined with the UI to give the user a proper experience. Also, emotion detection will be used in deception detection in the latter work package so it should be a basis for the next work package.*			
Tasks: **Task 2.1 Creating the model:** *The model will be developed to guess the emotions of the given faces.* **Task 2.2 Deciding on the dataset:** *The exact training set and the test set will be chosen.* **Task 2.3 Training the model:** *The model will be trained by using the training set.* **Task 2.4 Testing the model:** *The model will be tested using the test set.*			
Deliverables: **Deliverable 2.1:** *A fully working model that classifies emotions of given faces*			

WP3: Deception Detection			
Start Date: *05/12/2021* **End Date:** *27/03/2022*			
Leader:	Furkan Demir	**Members Involved:**	Muzaffer Köksal
Objectives: This package includes the deception detection functionality of the project. It requires the emotion detection package.			
Tasks: **Task 3.1 Creating the model:** *The model will be developed to guess the probability of the deception.* **Task 3.2 Deciding on the dataset:** *The exact training set and the test set will be chosen.* **Task 3.3 Training the model:** *The model will be trained by using the training set.* **Task 3.4 Testing the model:** *The model will be tested using the test set.*			
Deliverables: **Deliverable 3.1:** *A fully working model that classifies the given face and the sound (sentence) as lie or not.*			

WP4: User Interface			
Start Date: *13/11/2021* **End Date:** *17/04/2022*			
Leader:	Asya Doğa Özer	**Members Involved:**	Can Kılıç
Objectives: *This work package's goal is to create a user-friendly, easy to learn user interface for the project for both Mobile and Computer platforms and to convert the models into a usable form .*			
Tasks: **Task 4.1 Designing an outline:** *A design outline will be designed for the user interface of the project as the theme of the project.* **Task 4.2 Applying the models:** *The models will be given an interface to be involved in the application.* **Task 4.3 Implementing the outline:** *The outline's theme will be implemented for the whole project interface.*			
Deliverables: **Deliverable 4.1:** *Outline Theme* **Deliverable 4.2:** *User Interface*			

WP5 Reports			
Start Date: *02/10/2021* **End Date:** *08/05/2022*			
Leader:	Can Kılıç	**Members Involved:**	Asya Doğa Özer, Furkan Demir, Ufuk Palpas, Muzaffer Köksal

Objectives: *To make sure that all the requirements excluding the implementation of the project such as reports, and webpage will be prepared before their deadlines.*

Tasks:

Task 5.1 Website design of the project : *The project website is going to be designed. It is going to include the reports of the project.*

Task 5.2 Writing Project Specification Report : *Determining the specification and requirements of the project.*

Task 5.3 Writing Analysis Report: *Determining the analysis of the project. It consists of system models, mockups, project and team working plans.*

Task 5.4 Writing High-Level Design Report: *Specifying the design goals of the project and having a well-designed plan, and hence we can divide the project systems into subsystems and work more efficiently. It also includes software / hardware platforms and other technologies, system requirements, boundaries and other conditions.*

Task 5.5 Writing Low-Level Design Report: *Stating the structure of the implementation as packages and classes.*

Task 5.6 Writing Final Report: *The report of the complete system includes revised requirements, design details, development and implementation details and process, project and team work features, maintenance plan and test details.*

Task 5.7 Presenting Demo I: *The demonstration that is going to be completed on the last day of the first semester in order to present the major points of the project.*

Task 5.8 Presenting Demo II: *The demonstration that is going to be completed on the last day of the second semester in order to present the completed work of the project.*

Deliverables:
Deliverable 5.1: *Website*
Deliverable 5.2: *Project Specification Report*
Deliverable 5.3: *Analysis Report*
Deliverable 5.4: *High-Level Design Report*
Deliverable 5.5: *Low-Level Design Report*
Deliverable 5.6: *Final Report*
Deliverable 5.7: *Demo I*
Deliverable 5.8: *Demo II*

WP6: Mobile Application			
Start Date: *30/01/2022* **End Date:** *01/05/2022*			
Leader:	Muzaffer Köksal	**Members Involved:**	Can Kılıç
Objectives: *To make sure the users can receive the emotion detection information on their mobile devices.*			
Tasks: **Task 6.1 Data transmission to the mobile device:** *A suitable data transmission method will be implemented to transfer data from the emotion detection and deception detection packages to the designated mobile device.* **Task 6.2 Applying the user interface:** *A user friendly UI will be implemented to visually and audibly present the transmitted data.*			
Deliverables: 6.1: *The mobile app*			

WP7: Testing			
Start Date: *13/11/2021* **End Date:** *08/05/2022*			
Leader:	Can Kılıç	**Members Involved:**	Furkan Demir
Objectives: *This work package's goal is to make sure that the program does not have any kind of error or bug. These testing includes both the program's algorithm and the user interface.*			
Tasks: **Task 7.1 Testing the emotion detection algorithm:** *Throughout the project development process, the algorithm for emotion detection will always be tested every time it has upgraded. Testings will be done by both the developers and testers outside of the development team.* **Task 7.2 Testing the deception detection algorithm:** *After the emotion detection algorithm successfully implemented, it will be used to detect deceptions. Again, the deception detection algorithm will be tested for accuracy repeatedly.* **Task 7.3 Testing the crowd control algorithm:** *The crowd control mode will be tested for accuracy continuously. To test this mode, the program will be implemented in mildly crowded areas.* **Task 7.4 Testing the user interface:** *The user interface will be tested for various bugs, errors and exception handlers.*			
Deliverables: **Deliverable 7.1** *Bug-free program* **Deliverable 7.2** *Bug-free interface*			

4.3.2. Gantt Chart

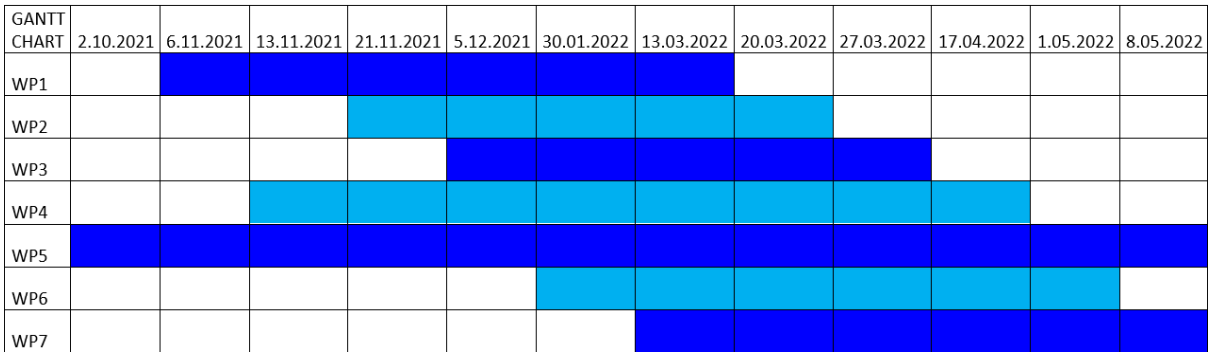

Figure 24: Gantt Chart

4.4. Ensuring Proper Teamwork

In order to make the Horus successful, reliable and good looking, teamwork is one of the significant parts of the project. During the project we have chosen different leaders for the different sections of Horus. However, since we are only one group everyone might work on every part. Having different leaders will just focus on improving the efficiency and have a clear mind about what that section is about. During the project GitHub will be used to track group members and current progress. As a main meeting area online platforms such as Zoom or Discord are used.

4.5. Ethics and Professional Responsibilities

Undoubtedly, as an application that uses visual data and being a computer vision project there are various professional and ethical issues. These issues are prominent for both the development and usage of the application.

We will consider several professional and ethical issues during and after the development process of Horus. One of them is data security. We have to get video input from the user to do emotion recognition and that video input should not be shared with any kind of third party. Furthermore, we will ensure that the stored video and image data are not leaked. We will also ensure that user data will not be disclosed to anyone unless there is a security concern.

For the sake of professionality, the group meetings will be arranged each week. What has already been done and what will be done until the next meeting will be determined and implemented in the closest time span. The source code of the horus will be private and stored on Github servers. Contribution of the group members will be one of our main concerns.

4.6. Planning for New Knowledge and Learning Strategies

Emotion detection is a complex topic and it requires many new skills to be developed before we can start full development of the project. To this end, we will research computer vision and emotion detection techniques from various resources, including web articles, books and videos. These areas of study will likely be distributed to team members according to their aptitude and interest in the topic.

Due to the multi-layered nature of the project, we can proceed with development as we learn. For example, before we can work on emotion detection, we will need to complete our work on computer vision so we will be learning as the project moves along.

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