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Review 3

Mouse Cursor Control Using Facial Movements

HUMAN COMPUTER INTERACTION (CSE 4015)

A1+TA1 Slot

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In partial fulfilment for the award of the degree of

B.Tech

In Computer Science and Engineering

SUBMITTED TO:

DR. MYTHILI T.

ACKNOWLEDGEMENT

This is to certify that the thesis entitled "Mouse Cursor Control Using Facial Movements" submitted by Ishitva Verma (18BCI0155), Akash Butar (18BCE2270) and Kanishka Solanki (18BCE2295) , SCOPE , VIT, for the award of the degree of Bachelor of Technology in Programme, is a record of bonafide work carried out by him / her under my supervision during the period, 13. July. 2020 to 6.Nov.2020, as per the VIT code of academic and research ethics.

The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university. The thesis fulfils the requirements and regulations of the University and in my opinion meets the necessary standards for submission.

Place : Vellore

Date : 1.Nov.2020 Signature of the Guide

Internal Examiner External Examiner

EXECUTIVE SUMMARY

We describe a system that presents a hands-free interface between human and computer. Our system replace conventional mouse in a new way that makes use of human facial features. It uses various image processing methods such as face detection, eye extraction. It uses a typical webcam to capture an input image. Controlling of mouse cursor is obtained by face movement as moving face up, down, left and right and mouse events are controlled through eye blinks. To perform these operations different algorithms like Haar Cascade algorithm, Template Matching and Hough transformation are used. Our system is mainly aimed for disabled peoples to have effective communication with computer.

Our system is real time which captures a movement of mouse cursor through face detection and facial features. It overcomes the existing system by avoiding the use of external hardware that caused serious eye damages. It uses a template matching method for eye extraction instead of using hardware, even as in previous system the short blinks of eyes were avoided or neglected. In this system the hard blink is only used for selecting particular file or folder .With eye detection it's first aim is to captured face for the movement of mouse cursor. Then it reacts as the mouse does.

Goal of the system

1. Hands-free mouse controlling

2. To establish vision based system

3. Controlling mouse motions using facial gesture

4. To eliminating the limitations of stationary head

5. To provide real time eye tracking

Mouse Cursor Control Using Facial Movements

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1. INTRODUCTION:

Recently there has been a growing interest in developing natural interaction between human and computer. Several studies for human-computer interaction in universal computing are introduced. The vision-based interface technique extracts motion information without any high cost equipment from an input video image. However, to develop a vision-based multimodal human computer interface system, an eye and face tracking and their recognition is done. All ordinary devices require manual control and cannot be used by persons impaired in movement capacity. There is a need for developing alternative methods of communication between humans and computers that would be suitable for the persons with motor impairments and would give them the opportunity to become a part of the Information Society. A vision-based system for detection of eye and face movements is presented, together with its implementation as a Human– Computer Interface for people with disabilities. The proposed work includes face detection, face tracking, eye blink detection and interpretation of a sequence of blinks in real time to control a non-intrusive human–computer interface. To replace the traditional mouse with the human face and eye movements to interact with the Computer. It is to assist the physically challenged persons without hands to use the computer efficiently and also easily.

1.1 MOTIVATION:

According to the previously invented mouse motion through eye blink was possible but the circumstances that occurred were the small blink or shorts blink were neglected. Even hardware was used for detecting eye blinks but it used to cause eye damage. Our system uses only a webcam for detecting face and eye movements and a microphone for voice recognition to give better output.

We intend to provide a better interaction mode for the disabled people so as to ease their interaction need with the system

1.2 PRIOR RESEARCH AND LITERATURE SURVEY

Paper 1 - Jilin Tu, Huang, T., & Hai Tao. (n.d.). Face as Mouse Through Visual Face Tracking. The 2nd Canadian Conference on Computer and Robot Vision (CRV'05). doi:10.1109/crv.2005.39

This paper investigated the state of the art of camera mouse techniques. In particular, the paper proposed the use of a 3D model-based visual face tracker to control the mouse. And perform mouse operations. Implementation of The face tracker is detailed. Based on the estimated hardness and Non-rigid face motion parameters, 3 mouse control modes, Direct mode(Mouse cursor is correlated with focus of attention), joystick mode (The cursor localization variance is small. The mouse cursor is still correlated with the direction of focus of attention, but not as strongly as direct mode) and differential mode (This mode is supposed to match most with human's mouse-control habit. However, this mode require user to move head frequently, and mouse cursor is not correlated with human's focus of attention) are implemented for mouse control. Verified experiments Effectiveness of our camera mouse system. Specially, The

accuracy of mouse navigation is evaluated numerically, and by the pros and cons, using 3 mouse control modes. Each control mode is summarized.

Paper 2 - (Vasanthan, M., Murugappan, M., Nagarajan, R., Ilias, B., & Letchumikanth, J. (2012). Facial expression based computer cursor control system for assisting physically disabled person. 2012 IEEE International Conference on Communication, Networks and Satellite (ComNetSat). doi:10.1109/comnetsat.2012.6380800)

This paper have successfully used four Sticker to control cursor speed in computer Application. The proposed methodology is very simple and Skilled in controlling cursor movement in a skilled Manner. The system is also intelligent enough Capturing users' images from webcam. this system Will replace the use of traditional head movement PC control by physically challenged people. However, it The system has the following disadvantages: (i) output Cursor control is very sensitive to light conditions (ii) Permanently wearing four markers on the user's face Response time on excessive interference (iii) for subjects After face detection, cursor is slow due to control lower Clock frequency of microcontroller. Therefore, present the focus on this work depends on using the design High speed micro-controller with various lighting settings.

1.3 SIGNIFICANCE AND COMPARISON

As accordingly to the previously invention mouse motion through eye blink was possible but the circumstances that occurred were the small blink or shorts blink were neglected. Even hardware was used for detecting eye blinks but it used to cause a eye damage. Our system uses only webcam for detecting face and eye movements and microphone for voice recognition to give better output.

Our system is real time which captures a movement of mouse cursor through face detection and facial features. It overcomes the existing system by avoiding the use of external hardware that caused serious eye damages. It uses a template matching method for eye extraction instead of using hardware, even as in previous system the short blinks of eyes were avoided or neglected. In this system the hard blink is only used for selecting particular file or folder .With eye detection its first aim is to captured face for the movement of mouse cursor. Then it reacts as the mouse does.

2. PROJECT DESCRIPTION AND GOALS

The following setup is necessary for operating our "hands-free mouse control". A user sits in front of the computer monitor. Webcam is connected to the machine, it may be either inbuilt or externally. As we know the role of webcam is to capture images whether in a form of single shot or multiple shot. Multiple shot is nothing but the images in the form of video stream. But we need to extract some features rather than total image. Features like eyes, eyebrows, between the eyes and nose tip. Using those features, we can perform mouse movement and some basic operations like left click, right click, and double click in the machine.

METHODOLOGY

- Face Detection

Face recognition is a computer technology that decides the positions and sizes in digital images of human faces. It senses facial features and ignores everything else, including houses, trees and people. A simple system for the face tracking will be developed.

- Eye Region Detection

The eyes' position in the face image is determined on the basis of certain geometrical dependencies. To perform eye-motion detection, the image of the extracted eye area is further

pre-processed. The eye region location is extracted and further eye tracking is done using matching templates. Eye area extraction is done only at system's initial stage.

Template-Matching is a common method for detecting objects. A standard eye pattern is generated manually in the template matching process, and the correlation values with the standard patterns are computed for the eyes given an input image. The presence of an eye is determined according to the values of the correlation. This strategy has the advantage of being easy to enforce.

- Eye Movement Classification

The various eye movements are classified using the support vector machine classifier. The eye-move are open-eye, close-eye, eyeball towards left and eyeball towards right. SVM may be used for the classification of the data obtained. SVM is a group of related supervised methods of learning, used for classification and regression. In SVM the training file for multiple classes is used.

- Motion Detection

The pixels are subtracted from the same pixels of the previous frame in a certain area, and motion is observed. Where the absolute value of the subtraction is greater than a certain threshold, the motion at a pixel is detected.

- Detection of Blink

The blink detection process can only run when the eye is not moving. The face is used to shift the cursor on the screen instead of the mouse, and then the blink is executed to click on eyes.

RISK INVOLVED

- Inaccurate detection/extraction leading to unfavourable human-computer interaction
- Template-Matching strategy can be ineffective for eye detection because it cannot cope effectively with variations in size, pose and form.
- The output of cursor control is sensitive depending on lighting condition

EVALUATION CRITEREA

- Accuracy of the actions performed by using facial features
- Degree of usability considering People with disabilities(especially people suffering from Tetraplegia, also known as quadriplegia)
- User's comfort about using eye blink and face expressions in order to control the mouse pointer

MAINTENANCE

- Appropriate alterations to be made in the code depending on the accuracy of function performed in accordance with respective facial gesture to minimize any possibility of a wrong output

UNIQUE FEATURES

- Text / application selecting options
- Fine and wide range of movements using two different methods
- Locking of mouse when not in use so as to avoid the inconvenience.

3. TECHNICAL SPECIFICATIONS

Software Used Description

- **scikit-learn**

Scikit-learn is a Machine learning library developed with the help of SciPy. It is widely used by Machine learning practitioners. David Cournapeau started the project in 2007 for GSoC competition and since then many developers have been working on the code which is open sourced.

Important features of scikit-learn:

- It is a plain and productive tool used for data processing software and data mining. Some of the algorithms it includes are: regression, classification, clustering algorithms like k-means, random forests, gradient boosting, support vector machines, etc.
- Open to all and reusable in different situations.
- It was built with the foundation of matplotlib, NumPy and SciPy.
- Commercially available open source-BSD license.

Installation Dependencies:

1. Python (>= v3.5)

2. NumPy (>= v1.11.0)

3. SciPy (>= v0.17.0)

4. joblib (>= v0.11)

The last version to support Python 2.7 and Python 3.4 was Scikit-learn 0.20. The later versions of Scikit-learn i.e. Scikit-learn 0.21 and later require Python 3.5 or newer. Scikit-learn also provides plotting facilities (i.e., functions start with "plot_" and classes end with

"Display") which need Matplotlib (>= v1.5.1) for running. Some examples may also need scikit-image >= v0.12.3, and some may need pandas >= v0.18.0.

User installation

If your system already has the required versions numpy and scipy which is completely working, the simplest method to install scikit-learn will be by using

```
pip install -U scikit-learn
or conda: conda install scikit-learn
```

- **PyCharm**

PyCharm is an integrated development environment (IDE) employed in programming and developing daily use softwares, developed for the Python language explicitly. PyCharm is developed by the very popular Czech company- JetBrains. It provides an interface for code analysis, a graphical debugger for debugging the code, integration with version control systems (VCSes), and supports web development using Django. And it also supports Data Science using Anaconda.

PyCharm is a cross-platform software, which makes it compatible with versions of Windows, Linux and MacOS. The software's Community Version comes out under the Apache License. It also provides extra features to Professional Edition-published under a proprietary license that can be used for technical purposes.

Installing Python

- Python can be downloaded from its official website http://www.python.org/downloads/, where you choose a version as per your needs. We choose Python v3.6.3 for our convenience.
- Python is installed by running the exe file after the completion of the download.

- Now, you can see a Window where Python is being installed.
- It will display a message saying : The Setup was Successful. Now press the close button.

Installing Pycharm

- PyCharm can be downloaded from its official website https://www.jetbrains.com/pycharm/download/.Visit the website and click DOWNLOAD"under the Community Section.
- PyCharm can be installed by running the exe file, once the download is complete.You can click the "Next" button on the Setup Wizard.
- The Path of installation can be changed on the following screen. Click the "Next" button.
- You can build a desktop shortcut on the next screen if you wish, and press "Next".
- Choose the folder in the Start tab. Make sure JetBrains is selected and press "Install".
- Wait until the setup is complete.
- When the installation is complete, you will be able to see a screen that shows the message that says PyCharm is installed. Click on "Run PyCharm Community Edition" before clicking on the "Finish" button.

- **Numpy:**

NumPy is Python's most commonly used scientific computing program. Among other items, it includes the following:

- a powerful N-dimensional array object
- sophisticated (broadcasting) functions
- tools for integrating C/C++ and Fortran code

- Fourier transform calculator, functions for linear algebra, and random number facilities

We may use NumPy as a powerful multi-dimensional container of general purpose data in addition to its obvious scientific uses. We can also describe arbitrary data types. This allows NumPy to integrate with a wide variety of databases seamlessly and effortlessly.

NumPy is licensed under the BSD license. This enables reuse of the package with few restrictions.

- **Pandas:**

Pandas is a Python programming language software library written for use in. The package's principal aim is to control and analyse data. It provides only data structures and other operations to manipulate numerical tables and statistics.

This program is fully free and was published under the BSD license with three clauses. The library name derives from the term "panel data," a term for data sets which uses observations for identical individuals from multiple time periods.

Features:

- DataFrame object with Integrated Indexing for manipulating data
- It provides resources between in-memory data structures and various file formats for both reading and writing data.
- Data synchronization, and streamlined data management.
- Pivoting and reshaping of huge data sets.
- Label slicing, clever indexing and subsetting of large data sets.
- Insertion and deletion of column Data Structure.

- This also comes with a community by engine that enables operations on data sets with split-apply-combine.
- Data set merging and joining

HCI Principles Incorporated

Shneiderman's 8 Golden Rule

- **Strive For Consistency**

This principle states that user need to be able to do same thing the same way that they have been doing in the previous versions of the software

As in our case the by facial and eye movements user will be able to perform all the operations that he was performing with a physical mouse like scrolling, highlighting and selecting.

- **Cater to the wide range and types of user**

In this principle we should strive for universal design and to cater to wide range of human user of different characterstics (age,culture,disability and educational level) with single design

As in our project we just need facial movement so it is easy to use by all group age people and specially useful for handicapped people. The portal is platform independent thus can be used on any operating system

- **Offer Informative feedback**

Interfaces need to not just be communicative but also need to inform the user in terms of learning and feedback which tells them that they are proceeding in the right direction.

Whenever you perform a certain face movement you will get a pop up saying like reading input from which you can get to know that your facial expression is being read by the system

- **Design Dailogue to yeild closure**

In an interaction dialogue needs to have a closure which is recognized by the user as end of an action

In our project offer a informative feedback technique which is included in such way that user can find it interactive eg. if mouse is in scrolling mode you can easily get a feedback that you are in that particular mode of functionality.

- **Prevent error and provide simple error handling**

User Interfaces need to minimize the error. Even if user makes an error the system need a design to neglect it and also offer a way out for recovery.

For this principle, if a person enters a wrong facial expression then he or she will get and pop up that it is an invalid facial gesture and present the list of close facial gesture of that of the facial gesture performed by the user.

- **Permit reversal of actions**

Interactions need to build in such a way that retracing backward reverse actions if need to be so as it gives relief from anxiety to user of losing the progress

For this principle, by opening your mouth wide open you can lock the screen and restart you facial gestures so as to not get a difficulty of any sort.

- **Support internal locus of control**

Allow the user to feel in control of the system and of the situation.

For this principle, we designed a grid against our face so that user get to know which part of the face is recognized by the system and feels he is in control of the system.

- **Reduce short term memory load**

It should be taken care not to load STM of user by expecting user to remember the several sequence of actions

For this principle, we designed the controls like it can be linked with real life like right eye wink for right click, eye closing for closing operation and mouth open for starting operation.

Norman's 7 Principles

- **Use both knowledge in the world and knowledge in the head**

For first time or infrequent users, knowledge required for a task should be available either explicitly in the world or derived from constraints in the environment.

For this principle, the movement of the head and the cursor are in symmetry. In this the user uses his/her knowledge prior in the head that in order to move the cursor to the left he/she needs to move his head leftwards.

- **Simplify the structure of Task**

Eliminate or restructure complexities, minimizing the planning and problem solving a task requires.

For this principle, the movement of the head to move the cursor is very simple. For example if the user want to move the cursor to the right side so he needs to move the head right side and respectively for all other directions so there is no chance of confusion.

- **Make things visible: bridge the gulfs of Execution and Evaluation**

It's important to make the correct things visible so the users for the correct interpretations and mental models through the system image

For this principle, when the user moves his head in different directions in order to move the mouse cursor the direction in which the mouse is moving is mentioned so that everything is clear

- **Get the mapping the right**

Mapping the link between what user wants to do and what is percieved as possible by the user based the user's own logic.

For this principle, Line will be used to track which side movement is used by the user. Suppose if user is moving right then a line will be made from center to left so that user will know that he is mapping the task in right way.

- **Exploit the power of constraints, both natural and artificial**

Reduce the number of possible alternative actions at each step to a few or ideally just one

For this principle, in our project there is only one option (facial expression) given for every movement of cursor so every action requires only one step.

- **Design for errors**

User Interfaces need to minimize the error. Even if user makes an error the system need a design to neglect it and also offer a way out for recovery.

For this principle, if a person enters a wrong facial expression then he or she will get and pop up that it is an invalid facial gesture and present the list of close facial gesture of that of the facial gesture performed by the user.

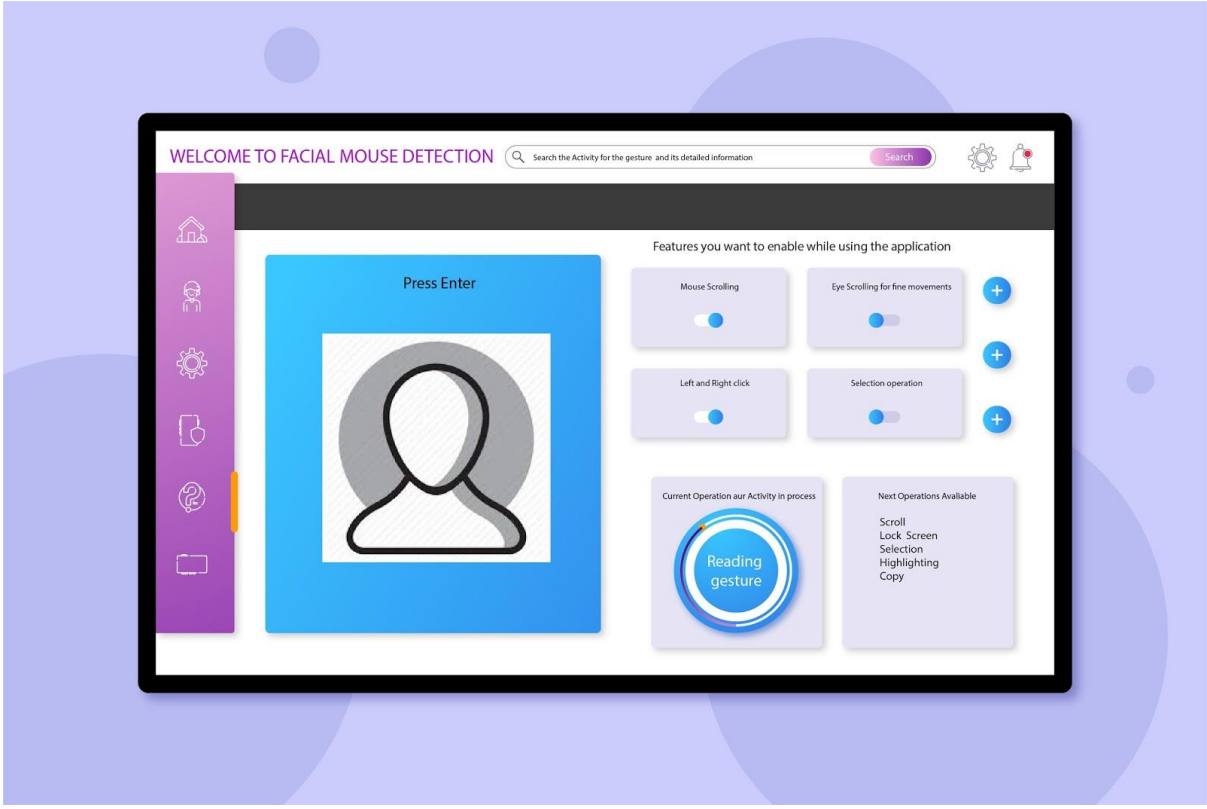
- **When all else fails, standardize**

Standardize the problem and processes, so arbitrary mappings only have to be learned once

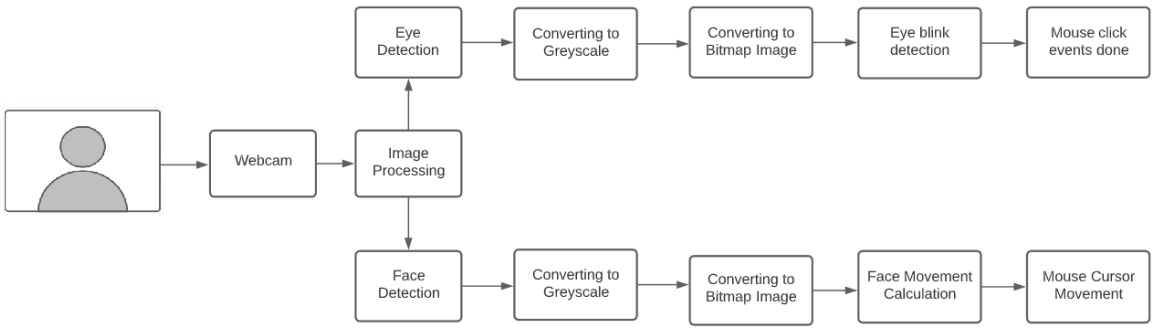
This principle is not implemented in our project as there is no significant portal is involved to incorporate this principle.

4. DESIGN APPROACH AND DETAILS

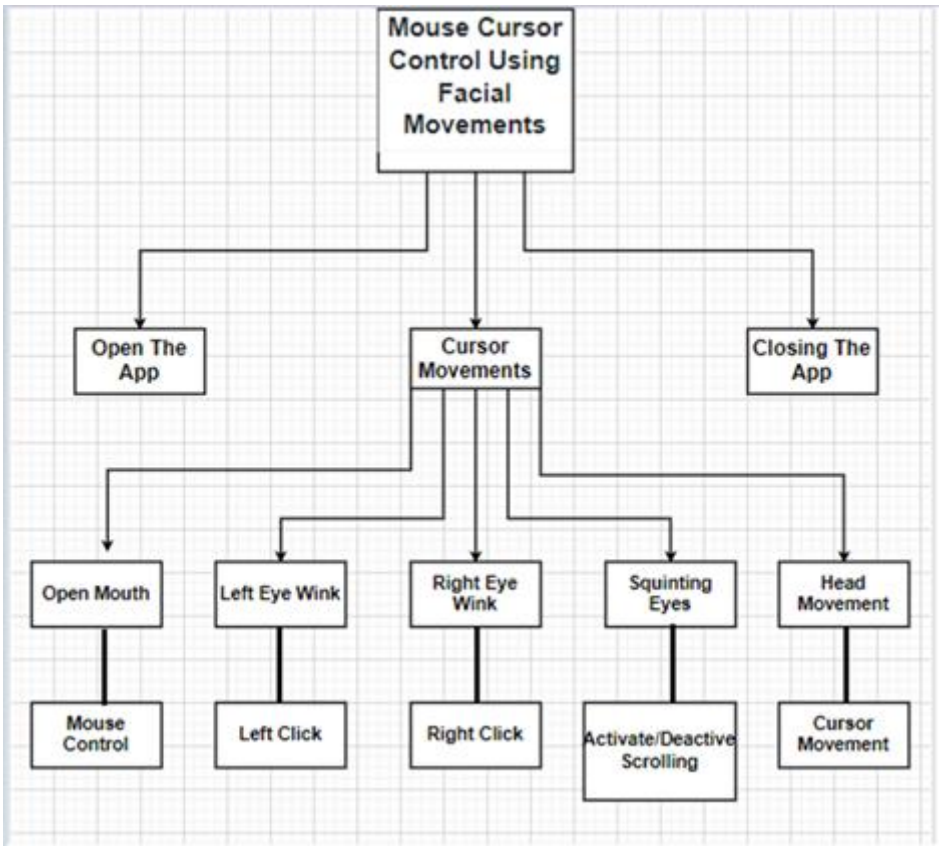
USER INTERFACE



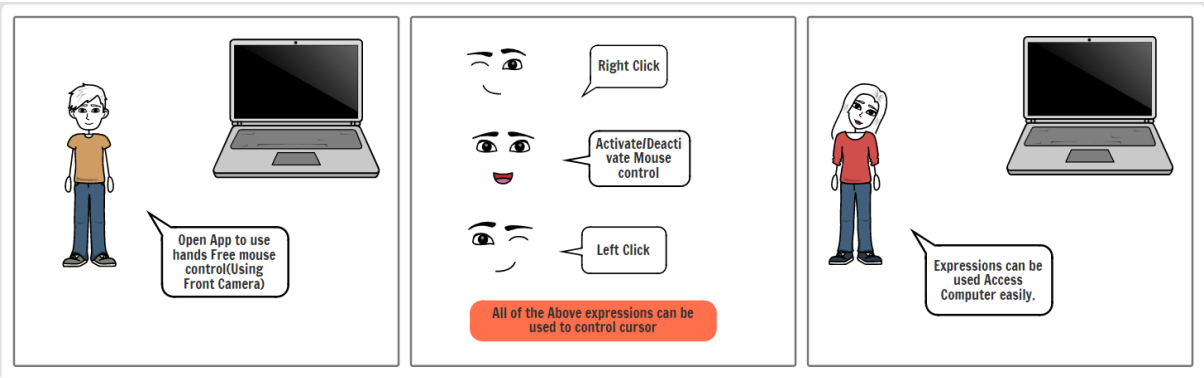
ARCHITECTURE DIAGRAM

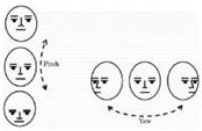


WORK BREAKDOWN STRUCTURE

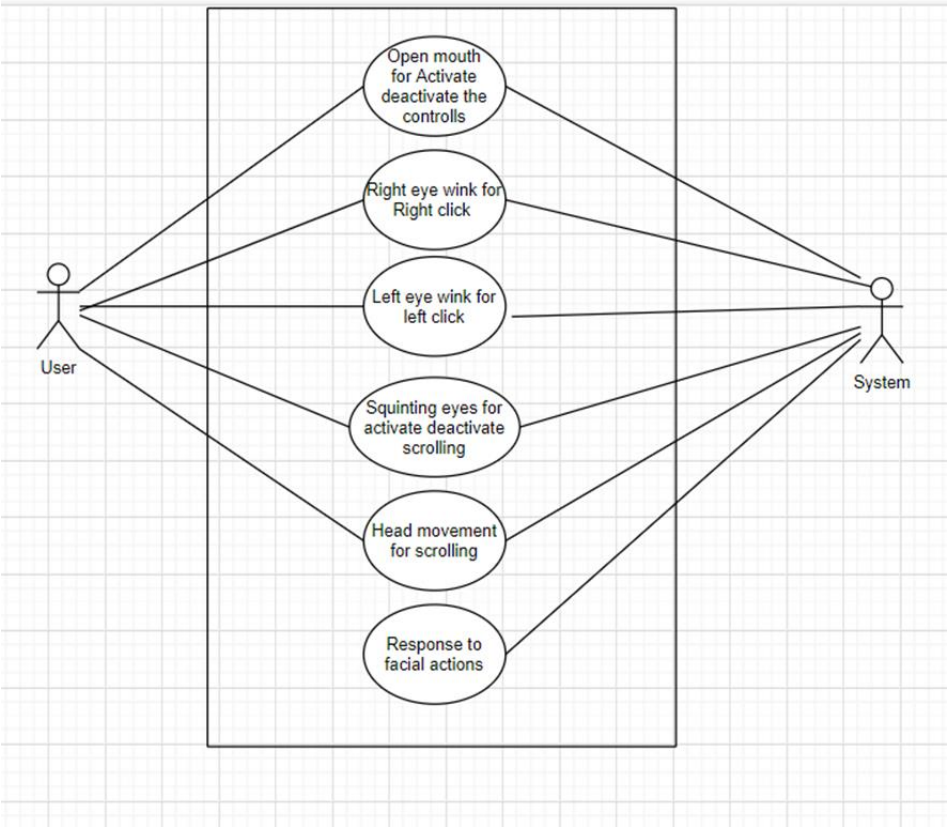


STORY BOARDING



Action	Function
 Opening Mouth	Activate / Deactivate Mouse Control
 Right Eye Wink	Right Click
 Left Eye Wink	Left Click
 Squinting Eyes	Activate / Deactivate Scrolling
 Head Movements (Pitch and Yaw)	Scrolling / Cursor Movement

USE CASE



LEARNABILITY

Learnability is a quality of products and interfaces that allows users to quickly become familiar with them and able to make good use of all their features and capabilities. A very learnable interface or product is sometimes said to be intuitive because the user can immediately grasp how to interact with the system. First-time learnability refers to the degree of ease with which a user can learn a newly-encountered system without referring to documentation, such as manuals, user guides.

For this principle, we designed the controls like it can be linked with real life like right eye wink for right click, eye closing for closing operation and mouth open for starting operation.

FLEXIBILITY

The multiplicity of ways the user and system exchange information.

The user can run this software on any environment and platform eg. Windows and linux.

It can be on basic terminal as python file as well as specialized IDE like Anaconda.

ROBUSTNESS

The level of support provided to the user in determining successful achievement and assessment of goal-directed behavior. The ease with which new users can begin effective interaction and achieve maximal performance

For this principle, if a person enters a wrong facial expression then he or she will get and pop up that it is an invalid facial gesture and present the list of close facial gesture of that of the facial gesture performed by the user. In our project offer a informative feedback technique which is included in such way that user can find it interactive eg. if mouse is in scrolling mode you can easily get a feedback that you are in that particular mode of functionality.

5. PROJECT DEMOSTRATION

https://drive.google.com/drive/folders/17Gj2WgD0GTQH0EeruuancPmNEiijSsuQ?usp=sharing

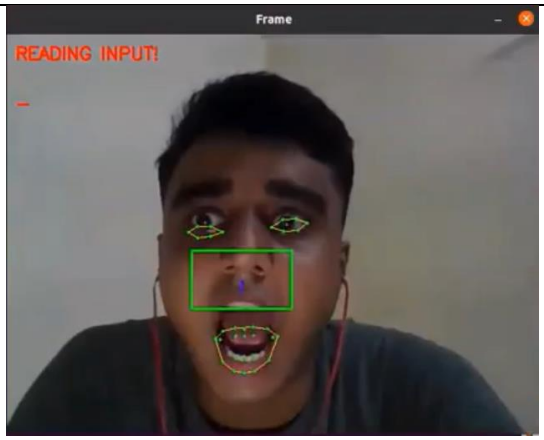
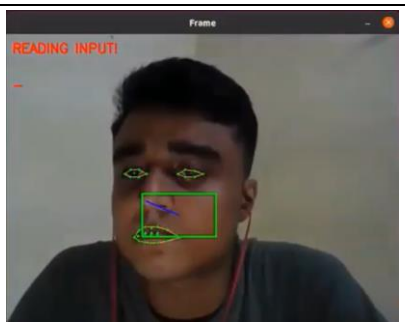
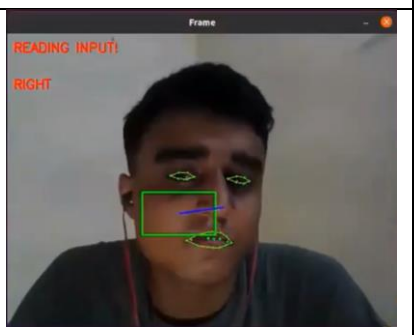
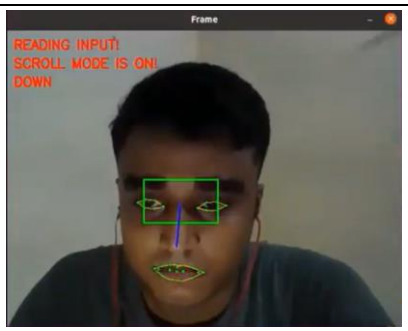
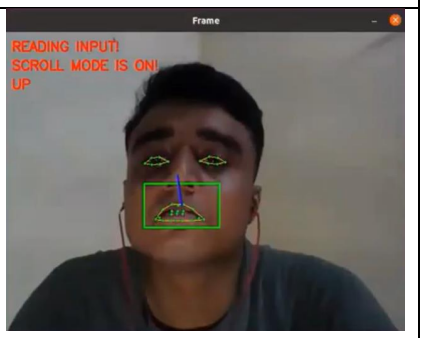
6. RESULTS AND DISCUSSION (TESTING)

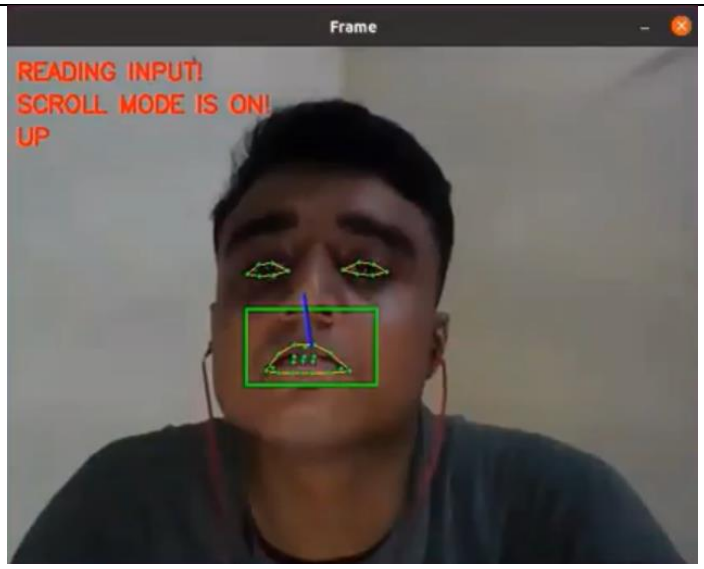
Test ID	Scenario	Input	Expected outcome	Original outcome
T_1	Activate/Deactivate control using gestures	User opens mouth	Control should be activated	Control Activated

T_2	Activate/Deactivate control using gestures	User does not open mouth	Control should not be activated	Nothing happens Control not activated
T_3	Activate/Deactivate scrolling	User squints eyes	Scrolling should be activated	Scrolling activated
T_4	Activate/Deactivate scrolling	User does not squint eyes	Scrolling should not be activated	Nothing happens Scrolling not activated
T_5	Move cursor left/right	User points eyes towards left/right of the screen	Cursor should move left/right	Cursor moves towards left/right
T_6	Move cursor left/right	User does not point eyes towards left/right of the screen	Cursor should not move left/right	Nothing happens Cursor doesn't move towards left/right
T_7	Move cursor up/down	User points eyes towards up/down of the screen	Cursor should move up/down	Cursor moves towards up/down

T_8	Move cursor up/down	User does not point eyes towards up/down of the screen	Cursor should not move up/down	Nothing happens Cursor doesn't move towards up/down
T_9	Left Mouse click	User blinks left eye	Left mouse click should be triggered	Left mouse click gets triggered
T_10	Left Mouse click	User does not blink left eye	Left mouse click should not be triggered	Nothing happens. Left mouse click does not get triggered
T_11	Right Mouse click	User blinks right eye	Right mouse click should be triggered	Right mouse click gets triggered
T_12	Right Mouse click	User does not blink right eye	Right mouse click should not be triggered	Nothing happens. Right mouse click does not get triggered

RESULTS

Serial No	Explanation	Corresponding Results
1	**Reading Input:-** This particular functionality help us to start and stop facial detected mouse activity	
2	**Corresponding Left and Right movements:-** This particular activity help us to move cursor in left to right direction	 
3	**Corresponding Up down movement:-** For moving up and down	 

4	**Enabling Scrolling Activity:-** This enables scrolling through activity	

7. CONTRIBUTIONS

1. Text / application selecting options – KANISHKA SOLANKI
2. Fine and wide range of movements using two different methods – ISHITVA
3. Locking of mouse when not in use so as to avoid the inconvenience – AKASH

8. FURTHER RESEARCH

- Addition feature of Speech recognition could be added in the future which will enable users to type text / passwords wherever required and also control system through voice command.
- More precision and accuracy can be acquired for facial expression-guided operations by introducing AI at a later stage, although not entirely necessary.

9. REFERENCES

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