

Eye Gesture Mouse Implementation with Python OpenCV

Submitted in partial fulfillment of the required for the award of
Bachelor of Computer Science in specialization with Artificial Intelligence

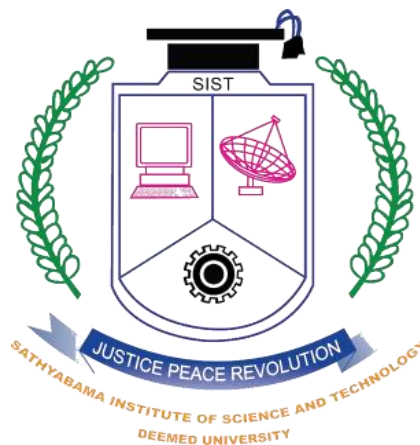
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY(DEEMED TO
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **T.K.Barath (41735003)** who carried out the project entitled “**Eye Gesture Mouse Implementation with Python Open CV**” under our supervision from JANUARY 2023 to MAY 2023.

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T.K.BARATH

ABSTRACT

This study presents the design and implementation of an AI-powered virtual mouse system utilizing OpenCV and Python. The aim is to create an intuitive and efficient interface that enables users to control their computers using eye tracking gestures captured through a webcam. The proposed system employs computer vision techniques to track and interpret eye movements, recognizing specific gestures as commands for cursor manipulation and clicking actions. By leveraging OpenCV's libraries for real-time image processing and machine learning algorithms, the virtual eye tracking mouse demonstrates promising accuracy and responsiveness in translating eye gestures into precise on-screen actions.

The project's methodology, including the image processing pipeline, gesture recognition model, and user interface, is detailed along with performance evaluations and potential applications. The virtual mouse system presents an innovative approach towards human-computer interaction, offering a hands free and intuitive means of controlling devices, particularly beneficial for scenarios requiring enhanced accessibility or gesture-based interfaces.

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CHAPTER 1

INTRODUCTION

The Eye Gesture Mouse, implemented using Python and OpenCV, represents a pioneering advancement in human computer interaction. Its core functionality revolves around enabling users to control their computer's cursor and interact with on-screen elements solely through the movement of their eyes. This approach offers a transformative solution, particularly for individuals facing physical impairments or those seeking a more intuitive means of navigating digital interfaces.

At the heart of the Eye Gesture Mouse lies the capability to track and interpret eye movements in real-time. Through the integration of a standard webcam and sophisticated computer vision techniques provided by OpenCV, the system continuously analyzes the live video feed to identify and monitor the position and movement of the user's eyes. This eye tracking functionality serves as the foundation for understanding user intent and translating it into actionable commands.

Building upon the foundation of eye tracking, the system employs gesture recognition algorithms to interpret specific patterns and movements exhibited by the user's eyes. These gestures may encompass a variety of actions, such as blinks, prolonged gazes in particular directions, or customized gestures defined by the user. By mapping these gestures to predefined mouse cursor movements and actions, the system enables users to interact with their computer's interface in a seamless and intuitive manner.

Python serves as the primary programming language for implementing the Eye Gesture Mouse, offering a versatile and accessible development environment. Leveraging the extensive capabilities of the OpenCV library, developers can harness a rich set of computer vision algorithms to facilitate eye tracking, image processing, and gesture recognition tasks. This combination of Python and OpenCV empowers developers to create a robust and responsive system capable of accurately interpreting user intentions in real-time.

The Eye Gesture Mouse implementation comprises various modular components, each serving a distinct role in the overall system architecture. These components encompass modules for eye tracking, gesture recognition, mouse control, user interface, configuration management, and feedback mechanisms. Together, these modules form a cohesive and integrated system designed to provide users with a seamless and intuitive experience.

Through its emphasis on accessibility and user-friendliness, the Eye Gesture Mouse aims to democratize computer interaction, empowering individuals of all abilities to engage with digital technology effectively. By offering an alternative input method that transcends traditional input devices, this technology not only enhances the accessibility of computing environments but also fosters inclusivity and innovation in human-computer interaction.

CHAPTER 2

LITERATURE SURVEY

Conducting a literature survey for implementing an Eye Gesture Mouse using Python and OpenCV involves reviewing existing research papers, articles, and tutorials related to eye tracking, gesture recognition, and computer vision techniques. Here's a structured approach you can take:

- 1. Search Scholarly Databases:** Look for academic papers and articles on platforms like Google Scholar, IEEE Xplore, ACM Digital Library, and PubMed using keywords such as "eye tracking", "eye gesture recognition", "computer vision", "Python", "OpenCV", and "human-computer interaction". Pay attention to recent publications as well as seminal works in the field.
- 2. Review Research Papers:** Read through research papers that discuss eye tracking and gesture recognition techniques using OpenCV and Python. Look for papers that provide detailed methodologies, experimental setups, and results. Take note of any innovative approaches or algorithms used for eye tracking and gesture recognition.
- 3. Explore OpenCV Documentation and Tutorials:** Visit the official OpenCV documentation and explore tutorials related to face detection, eye detection, and gesture recognition. OpenCV provides comprehensive documentation along with code examples that can help you understand how to implement various computer vision tasks.
- 4. Check GitHub Repositories:** Search GitHub repositories for projects related to eye tracking and gesture recognition implemented using Python and OpenCV. GitHub hosts a wealth of open-source projects where developers share their code and implementations. Look for repositories with well-documented code and examples.

5. Read Blog Posts and Articles: Look for blog posts, articles, and tutorials written by developers and researchers in the field of computer vision and human-computer interaction. These resources often provide practical insights, tips, and step-by-step guides for implementing eye gesture recognition systems.

6. Attend Conferences and Workshops: Keep an eye out for conferences, workshops, and webinars focused on computer vision, machine learning, and human-computer interaction. These events often feature presentations and demonstrations of cutting-edge research and technologies in eye tracking and gesture recognition.

7. Join Online Communities: Join online forums, discussion groups, and communities related to computer vision, Python programming, and OpenCV. Engage with other members, ask questions, and share your ideas and experiences. Platforms like Stack Overflow, Reddit, and Discord can be valuable resources for seeking advice and feedback.

8. Experiment and Implement: Once you've gathered sufficient knowledge and insights from your literature survey, start experimenting with implementing an Eye Gesture Mouse using Python and OpenCV. Start with simple prototypes and gradually refine your implementation based on your findings and observations.

By following these steps and conducting a thorough literature survey, you'll be better equipped to understand the existing techniques and approaches for implementing an Eye Gesture Mouse using Python and OpenCV, and you'll be able to leverage this knowledge to develop your own solution.

CHAPTER 3

METHODOLOGY

3.1 HARDWARE SPECIFICATION

- Webcam
- Processor (CPU)
- Graphics processing unit
- Memory
- Storage

3.2 SOFTWARE SPECIFICATION

- Programming Language - Python
- Libraries and Framework - openCV

3.3 EXISTING SYSTEM

While there may not be widely known off-the-shelf commercial Eye Gesture Mouse systems implemented specifically with Python and OpenCV, there are several research projects and open-source implementations that demonstrate similar functionalities using various technologies. These systems typically utilize computer vision techniques for eye tracking and gesture recognition. Here are a few examples:

1. **PyGaze:** PyGaze is an open-source toolbox for eye tracking in Python. While it's not specifically focused on implementing an Eye Gesture Mouse, it provides tools for eye tracking experiments and includes functions for gaze estimation, fixation detection, and saccade detection, which are relevant for such systems.
2. **EyeWriter:** The EyeWriter project is an open-source initiative that enables individuals with ALS (Amyotrophic Lateral Sclerosis) to draw and communicate using only their eyes. While it's not implemented in Python with OpenCV, it showcases the concept of using eye movements for mouse control and drawing applications.
3. **EyeControl:** EyeControl is an open-source project that uses computer vision and machine learning to create an assistive communication device for people with severe motor disabilities. While it primarily focuses on communication, it involves eye tracking and could be adapted for mouse control.

4. **OpenFace:** OpenFace is an open-source facial behavior analysis toolkit that provides facial landmark detection, head pose estimation, and eye gaze tracking functionalities. While it's not specifically designed for implementing an Eye Gesture Mouse, its eye gaze tracking feature could be integrated into such a system.

5. **EyeMouse:** EyeMouse is a research project that aims to develop a low-cost eye-tracking system using a webcam and computer vision techniques. While it may not be implemented in Python with OpenCV, it demonstrates the feasibility of using basic hardware for eye tracking.

These examples illustrate the potential of using computer vision techniques for eye tracking and gesture recognition in various applications, including assistive technology and human-computer interaction. While there may not be a direct off-the-shelf solution for an Eye Gesture Mouse implemented with Python and OpenCV, you can draw inspiration from these projects and adapt their techniques to create your own implementation

• 3.4 DISADVANTAGES

While implementing an Eye Gesture Mouse system using Python and OpenCV offers many advantages, there are also some potential disadvantages to consider:

1. **Processing Power:** Eye tracking and gesture recognition can be computationally intensive tasks, especially when performed in real-time. Python, while flexible and easy to use, may not always offer the best performance compared to lower-level languages like C++.

2. **Latency:** Real-time processing in Python may introduce latency, leading to a delay between the user's eye movements and cursor actions. This latency can impact the responsiveness and usability of the Eye Gesture Mouse system.

3. **Accuracy:** The accuracy of eye tracking and gesture recognition algorithms can vary depending on factors such as lighting conditions, user variability, and the quality of the webcam. Achieving high accuracy may require sophisticated algorithms and calibration procedures.

4. Hardware Dependency: The performance of the Eye Gesture Mouse system is heavily dependent on the hardware used, particularly the webcam. Low-quality webcams or those with poor low-light performance may result in inaccurate tracking and gesture recognition.

5. Limited Features: While Python and OpenCV offer a wide range of features for image processing and computer vision, they may not provide all the advanced functionalities required for complex eye tracking and gesture recognition tasks. Integrating additional libraries or developing custom algorithms may be necessary to overcome these limitations.

6. Portability : Python-based applications can be less portable compared to compiled languages like C++, as they typically require the Python interpreter and dependencies to be installed on the target system. This can complicate deployment, especially on systems where Python is not readily available.

7. Maintenance: Python-based projects may require more frequent updates and maintenance compared to compiled applications, as Python is dynamically typed and may be more prone to errors or compatibility issues over time.

8. Learning Curve: Developing an Eye Gesture Mouse system using Python and OpenCV requires proficiency in both programming and computer vision concepts. Individuals with limited experience in these areas may face a steep learning curve.

Despite these potential disadvantages, many successful Eye Gesture Mouse systems have been implemented using Python and OpenCV, leveraging their flexibility and ease of development. By carefully considering these challenges and employing best practices in algorithm design and system optimization, it's possible to create a reliable and effective Eye Gesture Mouse system.

3.5 PROPOSED SYSTEM

This study presents the design and implementation of an AI-powered virtual mouse system utilizing OpenCV and Python. The aim is to create an intuitive and efficient interface that enables users to control their computers using eye tracking gestures captured through a webcam. The proposed system employs computer vision techniques to track and interpret eye movements,

recognizing specific gestures as commands for cursor manipulation and clicking actions. By leveraging OpenCV's libraries for real-time image processing and machine learning algorithms, the virtual eye tracking mouse demonstrates promising accuracy and responsiveness in translating eye gestures into precise on-screen actions.

The project's methodology, including the image processing pipeline, gesture recognition model, and user interface, is detailed along with performance evaluations and potential applications. The virtual mouse system presents an innovative approach towards human-computer interaction, offering a hands free and intuitive means of controlling devices, particularly beneficial for scenarios requiring enhanced accessibility or gesture-based interfaces.

3.6 ADVANTAGES

Implementing an Eye Gesture Mouse system using Python and OpenCV offers several advantages:

1. **Ease of Development:** Python is a high-level programming language known for its simplicity and readability. Combined with the OpenCV library, developers can quickly prototype and implement eye tracking and gesture recognition functionalities without delving into complex low-level programming.
2. **Rich Ecosystem:** Python has a vast ecosystem of libraries and frameworks, making it easy to integrate additional functionalities such as machine learning for improved gesture recognition, or graphical user interface (GUI) development for user interaction.

3. Cross-Platform Compatibility: Python and OpenCV are cross-platform, meaning the Eye Gesture Mouse system can be developed and deployed on various operating systems, including Windows, macOS, and Linux, without significant modifications.

4. Community Support: Python and OpenCV have large and active communities of developers and researchers. This means ample resources, tutorials, and forums are available to help address challenges and optimize the implementation of the Eye Gesture Mouse system.

5. Flexibility: Python's dynamic nature and OpenCV's versatility allow developers to customize and adapt the Eye Gesture Mouse system to suit specific requirements and user preferences. This includes adjusting algorithms, fine-tuning parameters, and integrating additional features as needed.

6. Rapid Prototyping: Python's interpreted nature enables quick iteration and experimentation during the development process. Developers can rapidly prototype different algorithms and ideas, allowing for efficient refinement and optimization of the Eye Gesture Mouse system.

7. Integration with Existing Systems: Python seamlessly integrates with other technologies and systems, making it straightforward to incorporate the Eye Gesture Mouse functionality into existing applications or workflows. This facilitates the adoption of eye tracking and gesture-based interaction in various domains, including gaming, accessibility, and human-computer interaction.

8. Cost-Effectiveness: Python and OpenCV are open-source and freely available, reducing development costs associated with licensing fees and proprietary software. This makes it an attractive option for individuals and organizations seeking to develop affordable Eye Gesture Mouse solutions.

Overall, leveraging Python and OpenCV for Eye Gesture Mouse implementation provides a powerful combination of simplicity, flexibility, and community support, enabling developers to create innovative and accessible human-computer interaction experiences.

CHAPTER 4

SYSTEM DESIGN

4.1 ARCHITECTURE DIAGRAM

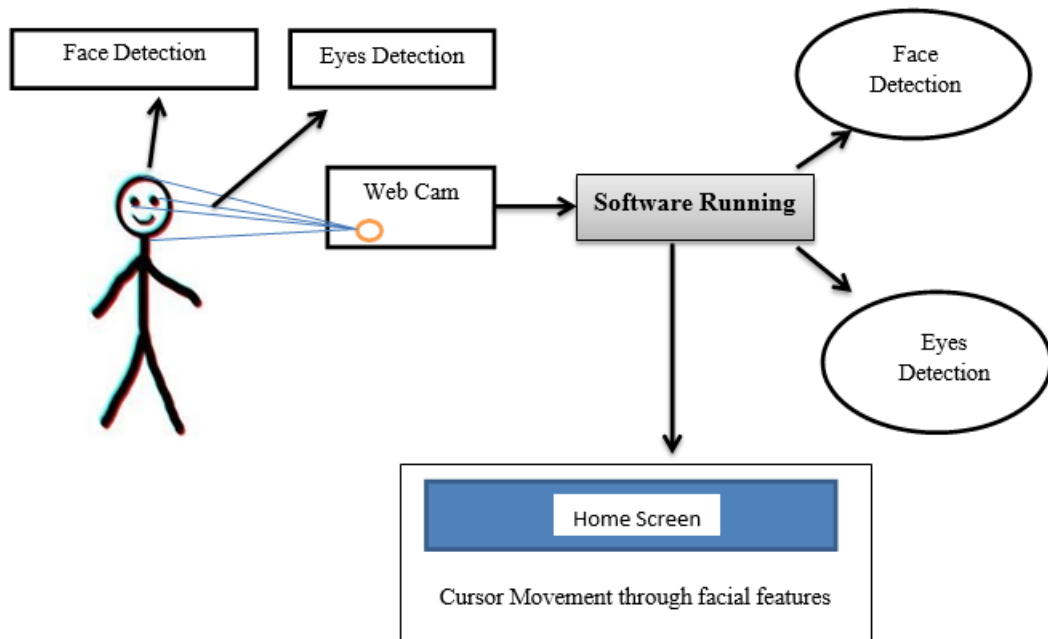


Fig 4.1 architecture diagram

4.2 SEQUENCE DIAGRAM

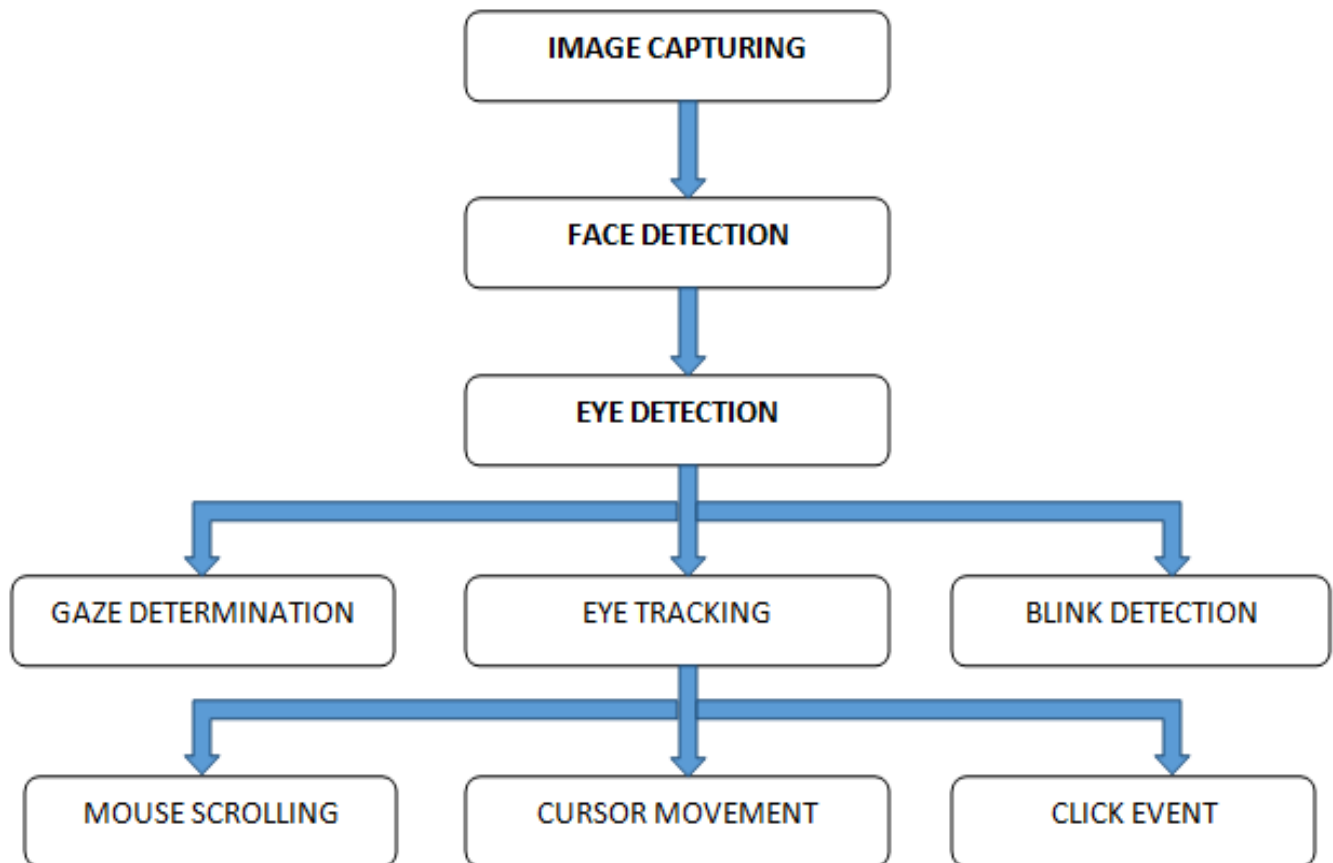


Fig 4.2 sequence diagram

4.3 CLASS DIAGRAM

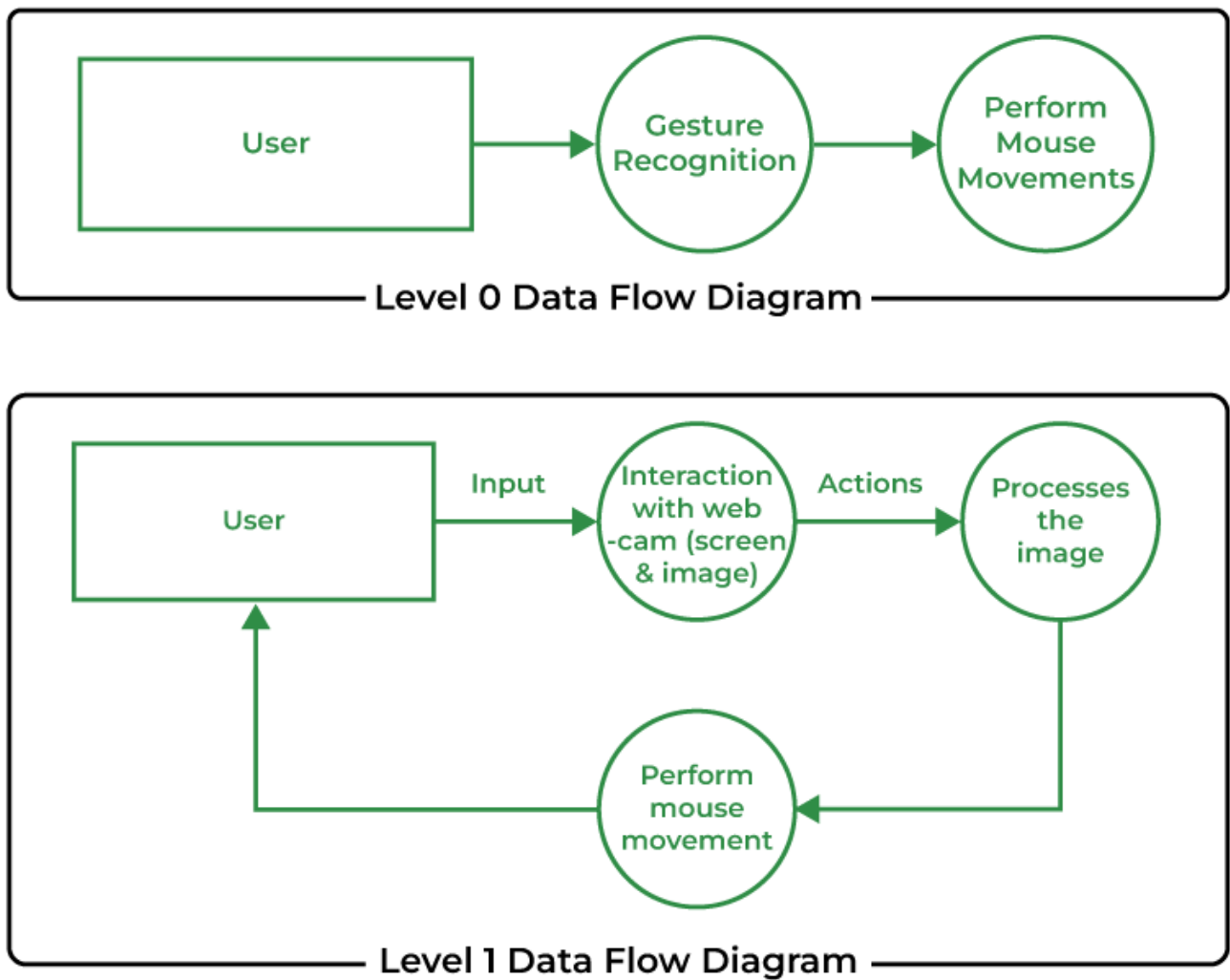


Fig 4.3 Class diagram

4.4 DATA FLOW DIAGRAM

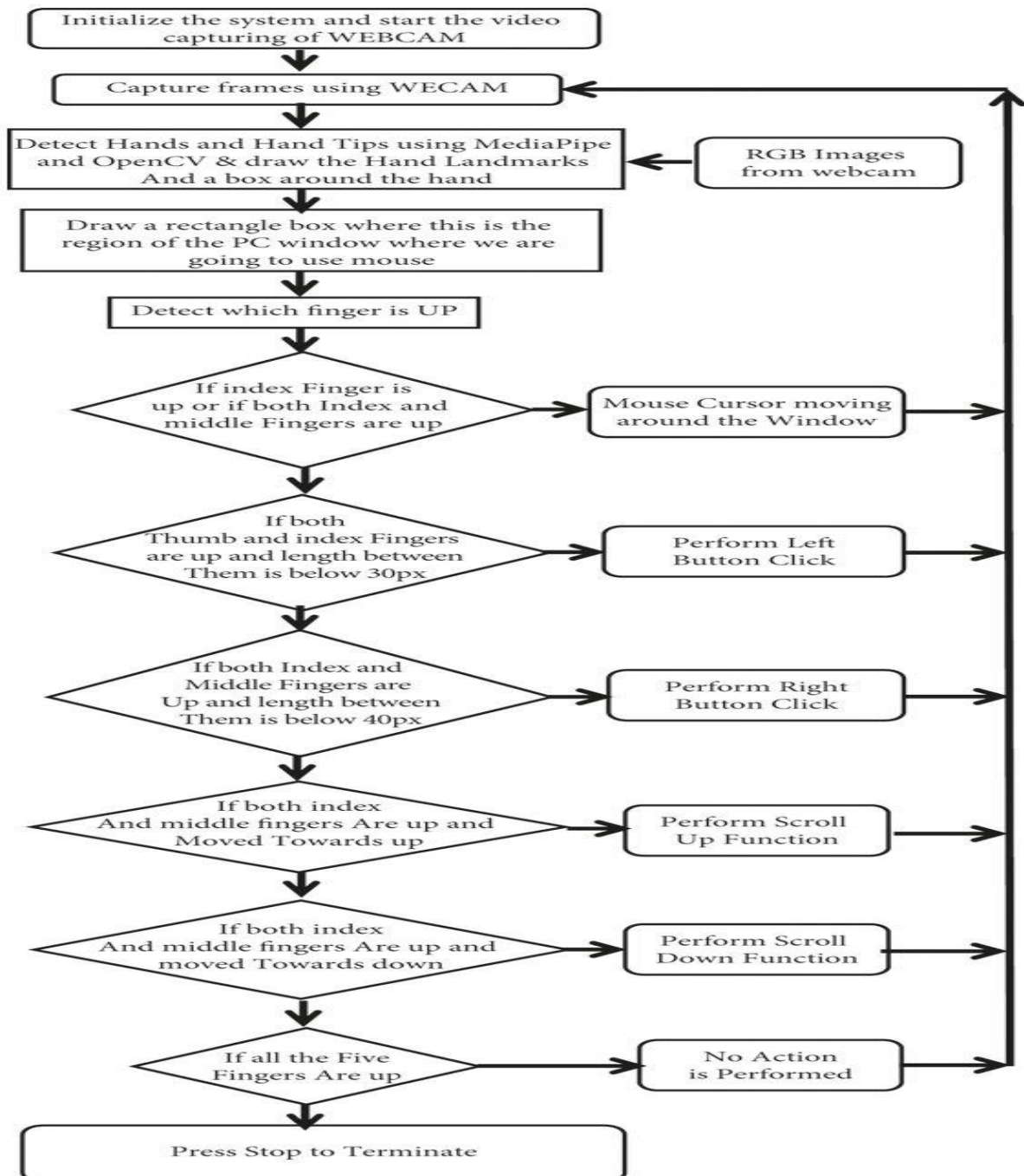


Fig 4.4 Data flow diagram

4.5 USECASE DIAGRAM

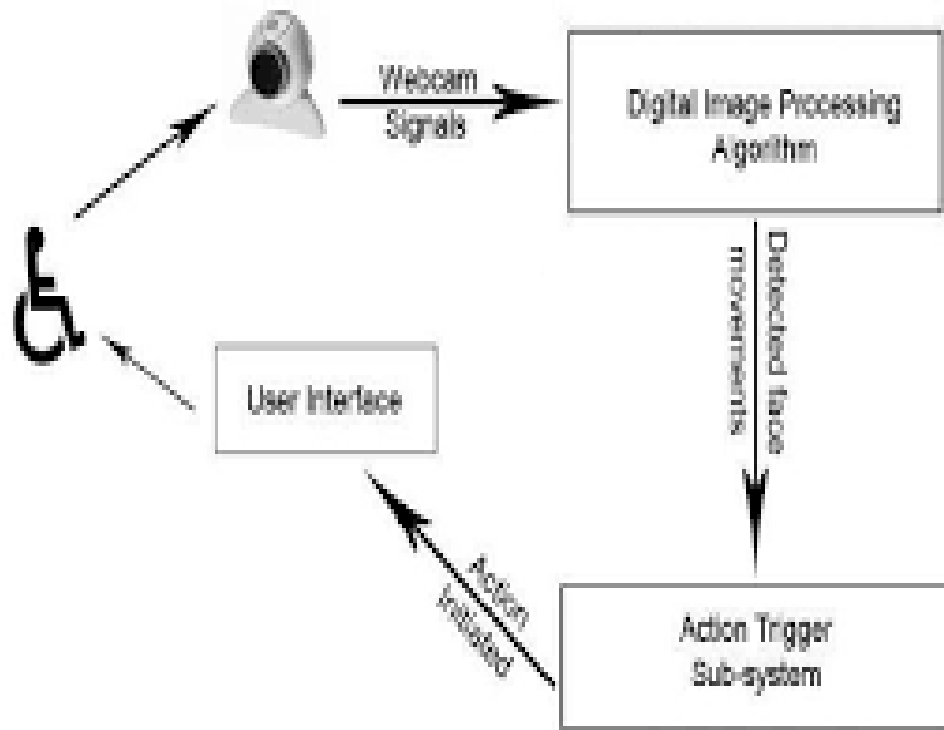


Fig 4.5 Usecase diagram

4.6 COLLABRATION DIAGRAM

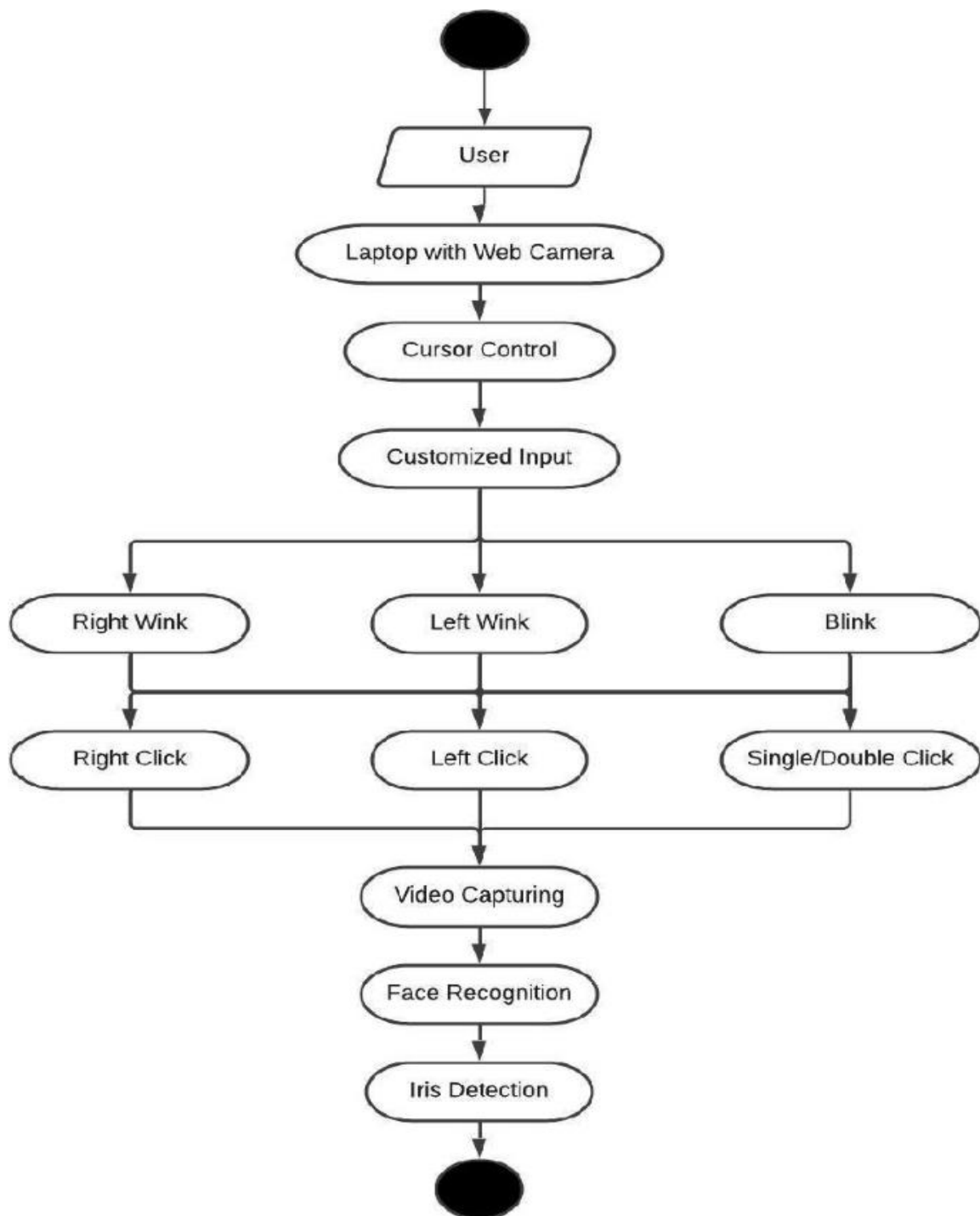


Fig 4.6 collabration diagram

CHAPTER-5

SOFTWARE DESCRIPTION

5.1 DESCRIPTION

The Eye Gesture Mouse is a Python-based application utilizing the power of OpenCV to provide hands-free control of the computer cursor through eye movements. This innovative software offers a versatile solution for users with physical disabilities, providing an alternative input method that relies solely on eye gestures for navigation and interaction.

5.2 KEY FEATURES

1. **Real-time Eye Tracking:** Utilizing computer vision techniques, the software tracks the movement of the user's eyes in real-time using a standard webcam.
2. **Gesture Recognition:** It interprets predefined eye gestures such as blinks, gaze direction changes, and sustained stares to trigger mouse cursor movements and actions.
3. **Intuitive Cursor Control:** Users can effortlessly move the mouse cursor across the screen by simply shifting their gaze or performing specific eye gestures.
4. **Click Actions:** The software translates blinking patterns or extended gazes into mouse clicks, allowing users to interact with on-screen elements and applications seamlessly.
5. **Customizable Settings:** Users have the flexibility to adjust sensitivity settings, define custom gestures, and configure actions to suit their individual preferences and needs.
6. **Accessibility Focus:** Designed with accessibility in mind, the Eye Gesture Mouse aims to empower users with limited mobility or motor impairments by providing an intuitive and convenient input method.
7. **User-Friendly Interface:** The application features a user-friendly interface that offers visual feedback, calibration options, and easy-to-use configuration settings.
8. **Cross-Platform Compatibility:** Compatible with major operating systems such as Windows, macOS, and Linux, the software ensures accessibility and usability across different platforms.

5.3 IMPLEMENTATIONS

The Eye Gesture Mouse is implemented in Python, leveraging the capabilities of the OpenCV library for real-time image processing and eye tracking. Additionally, it may utilize other Python libraries for GUI development and mouse control functionalities. The implementation follows a modular and extensible architecture, enabling seamless integration of new features and enhancements.

5.4 USAGE

Users can launch the Eye Gesture Mouse application on their computer and perform a quick calibration process to fine-tune sensitivity settings and optimize eye tracking accuracy. Once calibrated, users can control the mouse cursor effortlessly by adjusting their gaze or performing predefined eye gestures. The software provides visual feedback to aid users in understanding their interactions and making necessary adjustments.

In summary, the Eye Gesture Mouse offers a sophisticated yet accessible solution for hands-free computer interaction, providing users with diverse needs the ability to navigate and interact with digital interfaces using only their eye movements.

CHAPTER 6

MODULES DESCRIPTION

Modules Description for Eye Gesture Mouse Implementation with Python OpenCV:

6.1 EYE TRACKING MODULE

- This module is responsible for detecting and tracking the user's eyes in real-time using the OpenCV library.
- Techniques such as Haar cascades or deep learning-based models (e.g., Dlib) may be utilized for eye detection.
- Once detected, the module continuously tracks the position and movement of the eyes within the webcam feed.

6.2. GESTURE RECOGNITION MODULE

- This module interprets the movements and patterns of the tracked eyes to recognize predefined gestures.
- Gestures may include blinks, prolonged gazes in specific directions, or other custom-defined eye movements.
- Algorithms such as rule-based systems, machine learning classifiers, or deep learning networks can be employed for gesture recognition.

6.3. MOUSE CONTROL MODULE

- Responsible for translating the recognized gestures into corresponding mouse cursor movements and actions.
- It interacts with the operating system's mouse control APIs to move the cursor, simulate clicks, and perform other mouse actions.
- This module ensures smooth and responsive cursor control based on the user's eye movements.

6.4. USER INTERFACE (UI) MODULE

- Provides a graphical user interface (GUI) for users to interact with the Eye Gesture Mouse application.
- Displays visual feedback such as the webcam feed with overlaid eye tracking markers or regions of interest.
- Includes calibration options, sensitivity settings, and gesture configuration interfaces for user customization.

6.5. CONFGIRUATION MODULE

- Manages the settings and configurations of the Eye Gesture Mouse application.
- Allows users to adjust sensitivity levels, define custom gestures, and configure other parameters according to their preferences.
- Provides mechanisms for saving and loading configuration profiles for different users or scenarios.

6.6. FEEDBACK MODULE

- Provides visual or auditory feedback to the user to assist in understanding their interactions with the Eye Gesture Mouse.
- Feedback may include cursor movement trails, click confirmation sounds, or on-screen notifications for successful gestures.

6.7. CROSS-PLATFORM COMPLATIBILITY MODULE

- Ensures compatibility with different operating systems (Windows, macOS, Linux) by abstracting platform-specific functionalities.
- Handles differences in mouse control APIs, webcam access, and other system-level interactions to maintain consistency across platforms.

6.8. UTILITIES MODULE

- Contains utility functions and helper classes used throughout the application.
- Includes functions for image processing, data visualization, and other common tasks required for eye tracking and gesture recognition.

These modules collectively form the backbone of the Eye Gesture Mouse application, enabling seamless integration of eye tracking technology with cursor control functionalities using Python and OpenCV.

CHAPTER 7

SYSTEM SECURITY

System Security Considerations for Eye Gesture Mouse Implementation with Python OpenCV:

7.1. DATA PRIVACY AND PROTECTION

- Ensure that any personal data collected, such as webcam feeds or user configurations, is handled securely and in compliance with relevant privacy regulations (e.g., GDPR).
- Implement data encryption mechanisms to protect sensitive information stored or transmitted by the application.

7.2. ACCESS CONTROL

- Limit access to the Eye Gesture Mouse application to authorized users only.
- Implement user authentication mechanisms to prevent unauthorized access to the system and its functionalities.

7.3. SECURE COMMUNICATION

- If the application communicates with external servers or devices, use secure communication protocols such as HTTPS to encrypt data transmission and prevent eavesdropping or tampering.

7.4.INPUT VALIDATION

- Implement robust input validation mechanisms to prevent injection attacks or unexpected behaviors due to malformed input.
- Validate user input from gestures or configuration settings to ensure they conform to expected formats and ranges.

7.5. CODE REVIEW AND TESTING

- Conduct regular code reviews to identify and mitigate security vulnerabilities in the application codebase.
- Perform thorough testing, including unit tests, integration tests, and security testing (e.g., penetration testing),
to Identify and address potential security flaws.

7.6. SECURE CONFIGURATION

- Ensure that default configurations are secure and do not expose unnecessary risks.
- Provide guidance and documentation on secure configuration best practices for users to follow.

7.7. ERROR HANDLING AND LOGGING

- Implement robust error handling mechanisms to gracefully handle unexpected errors and prevent information leakage.
- Log security-relevant events and actions to facilitate monitoring, auditing, and incident response activities.

7.8. UPDATE AND PATCH MANAGEMENT

- Regularly update and patch dependencies, libraries, and frameworks used by the Eye Gesture Mouse application to address security vulnerabilities.
- Provide mechanisms for users to easily update the application to the latest secure version.

7.9. SECURE DEPLOYMENT

- Securely deploy the Eye Gesture Mouse application on trusted and properly configured environments.
- Implement secure deployment practices, such as using firewalls, intrusion detection/prevention systems, and network segmentation to protect the application from external threats.

7.10. USER AWARENESS AND TRAINING

- Educate users about potential security risks associated with using the Eye Gesture Mouse application.
- Provide guidance on best practices for maintaining security, such as avoiding sharing sensitive information or using the application on unsecured networks.

By addressing these system security considerations, you can enhance the overall security posture of the Eye Gesture Mouse implementation and mitigate potential risks associated with its usage.

CHAPTER 8

APPENDICES

8.1 SAMPLE CODE

```
# For monitoring web camera and performing image manipulations
import cv2
# For performing array operations
import numpy as np
# For creating and removing directories
import os
import shutil
# For recognizing and performing actions on mouse presses
from pynput.mouse import Listener

from pynput.mouse import Listener
def on_click(x, y, button, pressed):
    """
    Args:
        x: the x-coordinate of the mouse
        y: the y-coordinate of the mouse
        button: 1 or 0, depending on right-click or left-click
        pressed: 1 or 0, whether the mouse was pressed or released
    """
    if pressed:
        print (x, y)
with Listener(on_click = on_click) as listener:
    listener.join()
import cv2
# Load the cascade classifier detection object
cascade = cv2.CascadeClassifier("haarcascade_eye.xml")
# Turn on the web camera
video_capture = cv2.VideoCapture(0)
# Read data from the web camera (get the frame)
_, frame = video_capture.read()
# Convert the image to grayscale
gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
# Predict the bounding box of the eyes
boxes = cascade.detectMultiScale(gray, 1.3, 10)
# Filter out images taken from a bad angle with errors
# We want to make sure both eyes were detected, and nothing else
if len(boxes) == 2:
    eyes = []
    for box in boxes:
        # Get the rectangle parameters for the detected eye
        x, y, w, h = box
        # Crop the bounding box from the frame
        eye = frame[y:y + h, x:x + w]
        # Resize the crop to 32x32
        eye = cv2.resize(eye, (32, 32))
```

```

# Normalize
eye = (eye - eye.min()) / (eye.max() - eye.min())
# Further crop to just around the eyeball
eye = eye[10:-10, 5:-5]
# Scale between [0, 255] and convert to int datatype
eye = (eye * 255).astype(np.uint8)
# Add the current eye to the list of 2 eyes
eyes.append(eye)
# Concatenate the two eye images into one
eyes = np.hstack(eyes)
def normalize(x):
    minn, maxx = x.min(), x.max()
    return (x - minn) / (maxx - minn)

def scan(image_size=(32, 32)):
    _, frame = video_capture.read()
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    boxes = cascade.detectMultiScale(gray, 1.3, 10)
    if len(boxes) == 2:
        eyes = []
        for box in boxes:
            x, y, w, h = box
            eye = frame[y:y + h, x:x + w]
            eye = cv2.resize(eye, image_size)
            eye = normalize(eye)
            eye = eye[10:-10, 5:-5]
            eyes.append(eye)
        return (np.hstack(eyes) * 255).astype(np.uint8)
    else:
        return None

def on_click(x, y, button, pressed):
    # If the action was a mouse PRESS (not a RELEASE)
    if pressed:
        # Crop the eyes
        eyes = scan()
        # If the function returned None, something went wrong
        if not eyes is None:
            # Save the image
            filename = root + "{} {} {}.jpeg".format(x, y, button)
            cv2.imwrite(filename, eyes)

import numpy as np
import os
import cv2
import pyautogui
from tensorflow.keras.models import *
from tensorflow.keras.layers import *
from tensorflow.keras.optimizers import *

cascade = cv2.CascadeClassifier("haarcascade_eye.xml")
video_capture = cv2.VideoCapture(0)

def normalize(x):
    minn, maxx = x.min(), x.max()

```

```

return (x - minn) / (maxx - minn)

def scan(image_size=(32, 32)):
    _, frame = video_capture.read()
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    boxes = cascade.detectMultiScale(gray, 1.3, 10)
    if len(boxes) == 2:
        eyes = []
        for box in boxes:
            x, y, w, h = box
            eye = frame[y:y + h, x:x + w]
            eye = cv2.resize(eye, image_size)
            eye = normalize(eye)
            eye = eye[10:-10, 5:-5]
            eyes.append(eye)
        return (np.hstack(eyes) * 255).astype(np.uint8)
    else:
        return None

filepaths = os.listdir(root)
X, Y = [], []
for filepath in filepaths:
    x, y, _ = filepath.split(' ')
    x = float(x) / width
    y = float(y) / height
    X.append(cv2.imread(root + filepath))
    Y.append([x, y])
X = np.array(X) / 255.0
Y = np.array(Y)
print (X.shape, Y.shape)

model = Sequential()
model.add(Conv2D(32, 3, 2, activation = 'relu', input_shape = (12, 44, 3)))
model.add(Conv2D(64, 2, 2, activation = 'relu'))
model.add(Flatten())
model.add(Dense(32, activation = 'relu'))
model.add(Dense(2, activation = 'sigmoid'))
model.compile(optimizer = "adam", loss = "mean_squared_error")
model.summary()

```

Layer (type)	Output Shape	Param #
=====		
conv2d (Conv2D)	(None, 5, 21, 32)	896
conv2d_1 (Conv2D)	(None, 2, 10, 64)	8256
flatten (Flatten)	(None, 1280)	0
dense (Dense)	(None, 32)	40992
dense_1 (Dense)	(None, 2)	66
=====		
Total params: 50,210		
Trainable params: 50,210		
Non-trainable params: 0		

```

epochs = 200
for epoch in range(epochs):
    model.fit(X, Y, batch_size = 32)

while True:
    eyes = scan()
    if not eyes is None:
        eyes = np.expand_dims(eyes / 255.0, axis = 0)
        x, y = model.predict(eyes)[0]
        pyautogui.moveTo(x * width, y * height)

```

CHAPTER 9

CONCLUSION AND FUTURE WORK

CONCLUSION:

The implementation of the Eye Gesture Mouse using Python and OpenCV represents a significant advancement in human-computer interaction, offering a transformative solution for individuals with physical disabilities and those seeking a more intuitive means of interacting with digital interfaces. By harnessing the power of eye tracking and gesture recognition technologies, the system enables users to control their computer cursor and perform actions solely through the movement of their eyes. The integration of Python and OpenCV provides a flexible and accessible platform for developing such a system, allowing for the creation of a robust and responsive user experience.

FUTURE WORK:

Enhanced Gesture Recognition: Further refinement of gesture recognition algorithms to support a wider range of gestures and improve accuracy.

Advanced Interaction Techniques: Exploration of advanced interaction techniques beyond basic cursor control, such as text input or manipulation of 3D environments.

Adaptive Learning: Implementation of adaptive learning algorithms to personalize the system based on individual user preferences and behavior patterns.

Cross-Platform Support: Development of versions of the Eye Gesture Mouse application for mobile devices and other platforms to extend accessibility.

Integration with Assistive Technologies: Integration with assistive technologies and devices to enhance the overall accessibility and usability of the system.

User Experience Optimization: Continuous optimization of the user interface and feedback mechanisms to ensure a seamless and intuitive user experience.

Collaborative Research: Collaboration with researchers and healthcare professionals to explore the application of the Eye Gesture Mouse in healthcare and rehabilitation contexts.

Community Engagement: Engagement with the community of users and developers to gather feedback, prioritize features, and drive further innovation in the field of eye-based interaction.

In conclusion, while the Eye Gesture Mouse implementation represents a significant milestone in accessible computing, there are ample opportunities for future research and development to further enhance its

capabilities and impact. By continuing to innovate and collaborate, we can ensure that eye-based interaction technologies continue to advance and empower individuals of all abilities to engage with digital technology effectively and inclusively.

CHAPTER 10

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