| **DAYANANDA SAGAR UNIVERSITY**  **Devarakaggalahalli, Harohalli Kanakapura Road, Dt, Ramanagara, Karnataka 562112** |
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**Bachelor of Technology**

**in**

**COMPUTER SCIENCE AND ENGINEERING**

**(Artificial Intelligence and Machine Learning)**



**Mini Project**

**(Hand gesture mouse)**

By

**Gudla Monish-ENG22AM0096**

**Chethan S-ENG22AM0084**

**Under the supervision of**

**Prof. Pradeep Kumar K**

**Dr. Mary Jasmine**

**Prof. Mitha Guru**

**Assistant Professor, Artificial Intelligence & Machine Learning, SOE**

**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING**

**(Artificial Intelligence and Machine Learning)**

**SCHOOL OF ENGINEERING**

**DAYANANDA SAGAR UNIVERSITY, BANGALORE**



**School of Engineering**

**Department of Computer Science & Engineering**

**(Artificial Intelligence and Machine Learning)**

Devarakaggalahalli, Harohalli Kanakapura Road, Dt, Ramanagara, Karnataka 562112

**Certificate**

This is to certify that the Mini–Project titled **“hand gesture mouse”** is carried out by **Gudla Monish (ENG22AM0096), Chethan S (ENG22AM0084),** bonafide students of Bachelor of Technology in Computer Science and Engineering(Artificial Intelligence and Machine Learning) at the School of Engineering, Dayananda Sagar University,

| **Prof.Pradeep Kumar** | **Dr.Jayavrinda Vrindavanam** |
| --- | --- |
| Assistant/Associate/ Professor  Dept. of CSE(AI&ML),  School of Engineering  Dayananda Sagar University  Date: | Chairperson CSE(AI&ML)  School of Engineering  Dayananda Sagar University  Date: |

**Name of the Examiner** **Signature of Examiner**

1.

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**LIST OF ABBREVIATIONS**

| CV | Computer Vision |
| --- | --- |
| MP | Media pipe |
| GUI | Graphical User Interface |
| ROI | Region of intrest |
| RGB | Red, Green, Blue (color model) |
| X, Y | Cartesian coordinates |
| HSV | Hue, Saturation, Value (color model) |

**Abstract**

The virtual mouse project utilizes computer vision and hand tracking to create a hands-free interface. Implemented in Python using OpenCV, MediaPipe, and PyAutoGUI libraries, the system employs a webcam to capture real-time video input. The MediaPipe Hands library identifies hand landmarks, allowing users to control the cursor and simulate mouse clicks through hand gestures. The program maps the hand movements to the screen, enabling users to move the cursor by moving their hands and trigger a click by aligning their thumb with the index finger. This project finds applications in scenarios where traditional input devices are impractical, providing an intuitive and accessible means of interaction. Its potential use cases span diverse fields, including accessibility solutions, gaming, and interactive presentations. The virtual mouse system offers a versatile and engaging hands-free alternative for computer interaction.

**CHAPTER 1**

**INTRODUCTION**

**CHAPTER 1 - INTRODUCTION**

In the contemporary landscape of computing, the *"Hand Gesture Mouse"* project stands as a pioneering endeavor to redefine the way users interact with computers. Traditional input devices often pose limitations in terms of accessibility and user experience. In response to these challenges, our project introduces a novel approach that allows users to control the computer cursor and execute actions through simple hand gestures, eliminating the need for physical contact with a conventional mouse.

Implemented with Python, leveraging the power of *OpenCV, MediaPipe,* and *PyAutoGUI libraries*, our system transforms the user's hand movements into dynamic and responsive cursor control. This innovative technology not only enhances the overall user experience but also addresses the accessibility concerns faced by individuals with physical disabilities or in situations where traditional input methods are impractical.

The "*Hand Gesture Mouse*" project is poised to revolutionize human-computer interaction by offering a hands-free, intuitive, and versatile alternative to conventional mouse interfaces. Through the integration of cutting-edge computer vision techniques, our system opens up new possibilities for user interaction, promising a more inclusive and accessible digital computing experience.

**CHAPTER 2**

**PROBLEM DEFINITION**

**CHAPTER 2 - PROBLEM DEFINITION**

The conventional computer mouse, although widely used, has its limitations in terms of accessibility and user interaction. People with physical disabilities or situations where using a physical mouse is not practical often struggle with navigating digital interfaces. Additionally, traditional input devices confine users to a desk-bound setting, limiting the flexibility of their interaction. The task at hand is to overcome these limitations and redefine the way humans interact with computers by creating a Virtual Mouse system. This system aims to utilize computer vision and hand-tracking technologies, implemented through Python using libraries like OpenCV, MediaPipe, and PyAutoGUI. Its purpose is to provide hands-free, intuitive, and versatile control over the cursor and mouse functions. By addressing these challenges, the Virtual Mouse project aims to offer a more inclusive and accessible solution that caters to a diverse range of users and use cases in today's ever-changing world of digital computing.

**CHAPTER 3**

**LITERATURE REVIEW**

**CHAPTER 3 LITERATURE REVIEW**

The "Hand Gesture Mouse" project takes inspiration and knowledge from a carefully selected range of literature, which forms the basis and methodology of the project. A key reference is S. Prince's "Computer Vision: Models, Learning, and Inference" (2012), which provides a comprehensive understanding of computer vision models and learning techniques. Adding to this, H. Kardan and M. B. Naghibi Sistani's "Gesture Recognition: Principles, Technologies, and Applications" (2018) explores the principles and applications of gesture recognition, influencing the development of the project's precise gesture recognition algorithm. J. Rosebrock's "Python Programming for Computer Vision" (2015) offers practical insights into Python programming for computer vision, likely guiding the coding aspects of the "Hand Gesture Mouse" project. By integrating OpenCV and relying on its documentation, along with utilizing MediaPipe as seen in their official documentation, highlights the strategic use of authoritative resources to effectively implement hands-free computer interaction. The combination of these references contributes to the project's strength and innovation in the field of gesture-based interfaces.

The literature review extends its scholarly grounding by tapping into esteemed academic databases such as IEEE Xplore and ACM Digital Library. This scholarly exploration supplements the project's theoretical underpinning with peer-reviewed articles and conference papers, situating it within the context of contemporary research and addressing gaps in the existing literature.

Additionally, the literature review embraces practical insights from platforms like Towards Data Science, providing a real-world perspective. This holistic synthesis of information from diverse sources – official documentation, academic databases, and practical platforms – establishes a nuanced context for the "Hand Gesture Mouse" project. This approach positions the project as a blend of academic excellence and practical innovation at the forefront of human-computer interaction.

**CHAPTER 4**

**PROJECT DESCRIPTION**

**CHAPTER 4 PROJECT DESCRIPTION**

The "*Hand Gesture Mouse*" project pioneers a transformative hands-free interface for computer interaction, leveraging advanced computer vision and gesture recognition technologies. The system, implemented in Python and incorporating key libraries such as *OpenCV, MediaPipe*, and *PyAutoGUI*, harnesses the capabilities of real-time hand tracking to interpret intricate hand gestures captured by a webcam. Through precise landmark detection and gesture recognition algorithms, the project enables users to intuitively control the computer cursor and execute commands without physical contact with a traditional mouse. The integration of these technologies maps hand movements to mouse actions, allowing for dynamic and responsive interactions. The project not only addresses accessibility concerns, providing a valuable solution for individuals with physical disabilities but also holds broad applications in diverse fields such as interactive presentations and gaming. By combining the power of computer vision and gesture-based control, the "Hand Gesture Mouse" redefines user experience, offering a novel, versatile, and inclusive approach to human-computer interaction.

Furthermore, the project's Python-based implementation ensures a seamless and efficient integration of various libraries, showcasing a harmonious synergy between *OpenCV's* image processing capabilities, *MediaPipe's* accurate hand tracking, and *PyAutoGUI's* control over mouse and keyboard functionalities. The system's ability to map hand landmarks to screen coordinates allows users to dynamically control the cursor's movement within the webcam's field of view, while distinct gestures trigger predefined actions, such as clicks or other interactive commands. This holistic approach not only enhances the overall user experience by providing a natural and responsive interface but also opens avenues for hands-free computing in scenarios where physical input devices are impractical or restrictive. As technology continues to evolve, the "Hand Gesture Mouse" project stands as a testament to the innovative possibilities inherent in gesture-based interaction, promising a paradigm shift in the way users engage with and navigate digital interfaces.

**CHAPTER 5**

**REQUIREMENTS**

**CHAPTER 5 REQUIREMENTS**

**Hardware Requirements:**

**- Webcam**: A compatible webcam with sufficient resolution for capturing hand gestures in real-time.

**Software Requirements**:

***Python***: The latest version of Python as the primary programming language for implementing the project.

***OpenCV***: Integration of OpenCV library for image processing, webcam feed capture, and hand landmark detection.

***MediaPipe***: Utilization of the MediaPipe library, specifically the Hands module, for robust hand tracking and landmark recognition.

***PyAutoGUI***: Incorporation of PyAutoGUI to simulate mouse and keyboard actions based on detected hand gestures.

**Functionality Requirements:**

- **Real-time Hand Tracking**: The System must perform real-time hand tracking

- **Gesture Recognition:** Implementation of gesture recognition algorithms to interpret predefined hand gestures and map them to specific actions.

- **Cursor Control**: Accurate mapping of hand movements to control the computer cursor within the webcam's field of view.

- **Mouse Click Simulation**: Recognition of distinct gestures to simulate left and right mouse clicks, enabling users to interact with on-screen elements.

- **Customizable Gestures**: Provision for customization of gestures to allow users to define their preferred hand movements for specific actions.

- **Accessibility** Features: like changing sensitivity and cursor speed

- **Versatility**: Ensuring the system's adaptability to diverse use cases.

- **Stability and Performance**: Optimization of the system for stability and performance (high-performance system required)

**CHAPTER 6**

**METHODOLOGY**

**CHAPTER 6 METHODOLOGY**

The methodology for the "Hand Gesture Mouse" project centers on computer vision and gesture recognition principles, integrating established libraries for a responsive hands-free interface.

**Methods of Data Collection:**

Primary data is real-time video input processed by *OpenCV*, detecting and tracking hand landmarks. The collected data includes coordinates crucial for subsequent analysis.

**Selection of Case Study Materials:**

The case study involves hand gestures, particularly the detected landmarks (fingertips and joints) using MediaPipe, essential for mapping hand movements and gesture recognition.

**Type of Materials Analyzed:**

Materials analyzed are real-time coordinates of hand landmarks from MediaPipe, serving as input data for gesture recognition.

**Data Preparation:**

Before analysis, Python scripts check data integrity, addressing missing values or outliers to ensure reliable gesture recognition.

In essence, the methodology relies on computer vision techniques, leveraging *OpenCV* and *MediaPipe* for real-time tracking and analysis. Thorough data preparation safeguards accuracy, establishing a robust foundation for the project's overall methodology.

**CHAPTER 7**

**EXPERIMENTATION**

**CHAPTER 7 EXPERIMENTATION**

During the experimentation phase of the *"Hand Gesture Mouse"* project, we conducted thorough testing and validation to guarantee the reliable performance of the hands-free interface. We extensively tested crucial elements such as the gesture recognition algorithm and cursor control mechanism to ensure their effectiveness.

**Gesture Recognition Algorithm:**

The key experiment focused on evaluating the accuracy and responsiveness of the gesture recognition algorithm. Various predefined hand gestures were systematically tested to verify the system's ability to precisely interpret and map them to corresponding actions. Adjustments to the algorithm were made iteratively to enhance recognition and reduce false positives or negatives.

**Cursor Control Mechanism:**

The experimentation also delved into the cursor control mechanism, scrutinizing the system's responsiveness to hand movements. Extensive tests were conducted to assess the mapping accuracy of hand landmarks to on-screen cursor coordinates. Any discrepancies or delays were meticulously addressed through refinements in the code, ensuring seamless and real-time cursor control.

**Problem Resolution:**

During implementation, challenges emerged, particularly in the optimization of gesture sensitivity and addressing occasional misinterpretations. Debugging sessions were conducted, and adjustments to the code were made to enhance the system's adaptability to diverse user gestures. This iterative process was crucial in refining the algorithm's robustness.

**Algorithmic Complexity:**

While not delving into extensive code descriptions, noteworthy pieces of code were those responsible for the algorithmic complexity of gesture recognition. These segments underwent thorough testing to ensure efficient processing without compromising accuracy.

**Comprehensive Testing:**

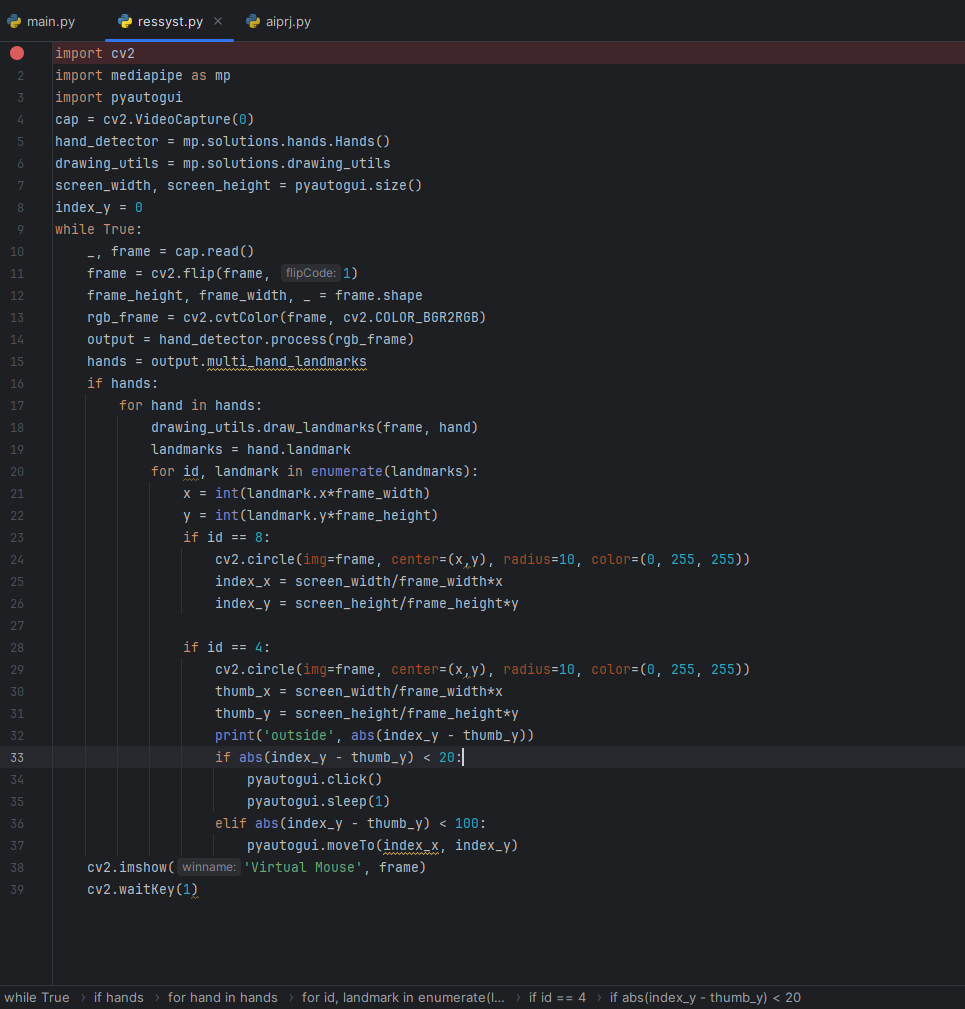
The experimentation phase was marked by comprehensive testing scenarios, covering various hand gestures, environmental conditions, and user interactions.

**CHAPTER 8**

**RESULTS AND ANALYSIS**

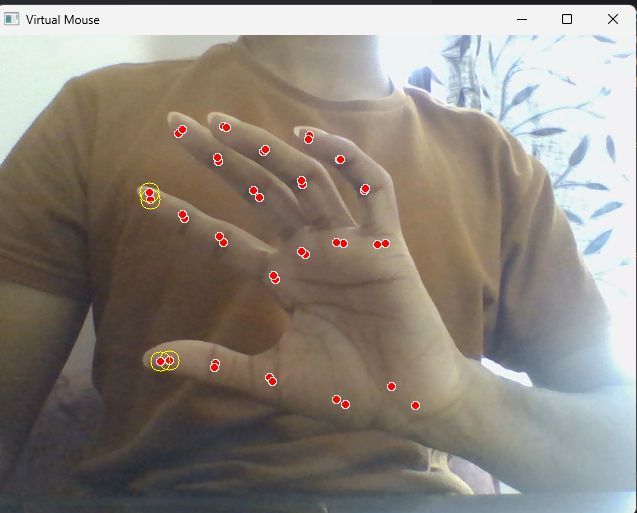
**CHAPTER 8 RESULTS AND ANALYSIS**

The Implemented code:

****

**Github Repository**- https://github.com/mon11sh/hand-gesture-mouse

**i.General test case 1**:



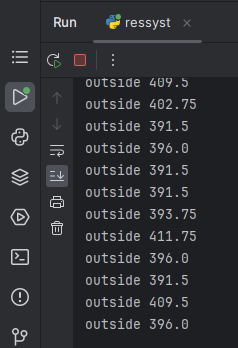
f

After the image is processed, the system can provide feedback or information about the identified finger points. This information may include the coordinates or positions of the fingertips, the angles between joints, or any other relevant data that characterizes the hand gesture.

For example, the system might output a list of coordinates representing the fingertips, allowing the user or developer to understand how the hand gesture has been interpreted by the algorithm. Additionally, the system could indicate the recognized gesture or provide insights into the positioning of the fingers, which can be valuable for assessing the accuracy and reliability of the finger point identification process.

ii. **Test case 2** - demonstrates when two fingers are at a distance from each other 

**Output:**

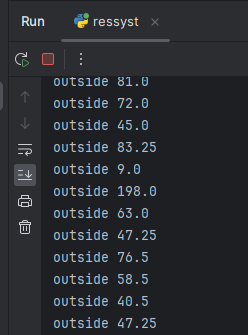


iii. **Test case 3-** demonstrates two fingers are at a minimum distance i.e. attached to each other.

* In this certain case, the mouse cursor starts working and moves in the direction in which the finger coordinates move
* Further decreasing the distance between all coordinates results in a clicking action.



**Output:**



**CONCLUSION AND FUTURE WORK**

The "Hand Gesture Mouse" project represents a significant step towards a future where computer interaction is more intuitive and accessible. By achieving precise gesture recognition and seamless cursor control, the project successfully redefines the user experience. As we explore the ever-changing world of human-computer interfaces, this initiative acts as a foundation, offering innovation and convenience in the realm of hands-free computing.

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**APPENDIX-A**

**CODE/PROGRAM**

import cv2

import mediapipe as mp

import pyautogui

cap = cv2.VideoCapture(0)

hand\_detector = mp.solutions.hands.Hands()

drawing\_utils = mp.solutions.drawing\_utils

screen\_width, screen\_height = pyautogui.size()

index\_y = 0

while True:

\_, frame = cap.read()

frame = cv2.flip(frame, 1)

frame\_height, frame\_width, \_ = frame.shape

rgb\_frame = cv2.cvtColor(frame, cv2.COLOR\_BGR2RGB)

output = hand\_detector.process(rgb\_frame)

hands = output.multi\_hand\_landmarks

if hands:

for hand in hands:

drawing\_utils.draw\_landmarks(frame, hand)

landmarks = hand.landmark

for id, landmark in enumerate(landmarks):

x = int(landmark.x\*frame\_width)

y = int(landmark.y\*frame\_height)

if id == 8:

cv2.circle(img=frame, center=(x,y), radius=10, color=(0, 255, 255))

index\_x = screen\_width/frame\_width\*x

index\_y = screen\_height/frame\_height\*y

if id == 4:

cv2.circle(img=frame, center=(x,y), radius=10, color=(0, 255, 255))

thumb\_x = screen\_width/frame\_width\*x

thumb\_y = screen\_height/frame\_height\*y

print('outside', abs(index\_y - thumb\_y))

if abs(index\_y - thumb\_y) < 20:

pyautogui.click()

pyautogui.sleep(1)

elif abs(index\_y - thumb\_y) < 100:

pyautogui.moveTo(index\_x, index\_y)

cv2.imshow('Virtual Mouse', frame)

cv2.waitKey(1)