https://doi.org/ 10.33472/AFJBS.6.Si2.2024.3516-3521

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Gesture-Driven Virtual Assistant: Empowering Individuals with Impairments

MADHUMITHA K[1]

Department of Computer Science and Engineering,

Kongunadu College of Engineering and Technology, Trichy, India

madhumithakamaraj26@gmail.com

SWARNA DEVI K M[2]

Department of Computer Science and Engineering,

Kongunadu College of Engineering and Technology, Trichy, India

swarnadevikm@gmail.com

Abstract- As technology continues to evolve, the demand for intrusive Human-Computer Interaction (HCI) methods has intensified. In this context, the utilization of computer vision and Artificial Intelligence (AI) to create an AI virtual mouse system has emerged. This system aims to facilitate hands-free computer control through the analysis of hand gestures captured by a webcam. Traditional input devices, such as keyboards, are not always suitable for individuals with mobility challenges or in scenarios where hands-free interaction is preferred. Existing solutions often lack versatility or are cumbersome to implement. Addressing these limitations requires an innovative approach that integrates AI and computer vision technologies to create a seamless and responsive virtual mouse system. The proposed solution involves the development of an AI virtual mouse system that harnesses the power of computer vision, specifically utilizing the TensorFlow library for hand gesture analysis. The system employs a webcam to capture real-time video frames, processes them to detect hand gestures, and translates these gestures into meaningful computer commands. Key components include video frame processing, virtual screen matching, and Finger Detection Algorithms, culminating in an interactive and adaptive interface. Upon implementation, the AI virtual mouse system demonstrates the capability to interpret a variety of hand gestures, allowing users to control the computer seamlessly. The proposed methodology leverages the webcam's video feed to accurately detect and respond to specific finger movements. By integrating functions such as cursor movement and left-click actions based on finger gestures, the outcome is an accessible and efficient hands-free computing experience. The system showcases the potential for improved accessibility, particularly for individuals with mobility constraints, and represents a step forward in the evolution of HumanComputer Interaction paradigms.

Keywords- Artificial Intelligence, TensorFlow, Impairments and Inclusivity, Human-Computer Interaction, Virtual Mouse.

I INTRODUCTION

Nonverbal communication, characterized by gestures through body language, hand movements, and facial expressions, plays a crucial role in human interaction. From simple motions to complex sign language elements, these gestures enhance communication efficiency, especially when integrated with computers. Current technologies, including, the interpretation of these gestures, allow for hands-free interaction and the evolution of intuitive human-computer interfaces.

In response to the growing demand for intuitive interaction methods, the integration of computer vision and artificial intelligence (AI) [1] has given rise to an innovative solution—the AI Virtual Mouse System. This system capitalizes on the analysis of hand gestures captured by a webcam, paving the way for hands-free computer control. Unlike traditional input devices, such as keyboards, this novel approach addresses limitations associated with mobility challenges and offers a versatile, responsive, and accessible virtual mouse system. Drawing on the power of computer vision, the proposed solution leverages TensorFlow for in-depth hand gesture analysis. Through real-time video frame capture and processing, the system detects various hand gestures, translating them into meaningful computer commands [2]. Key components, including video frame processing, virtual screen matching, and finger detection algorithms, culminate in an interactive and adaptive interface. The AI Virtual Mouse System demonstrates the capability to interpret a diverse range of hand gestures, enabling seamless control over computer

II BODY OF THE PAPER LITERATURE SURVEY

Quam's hardware-driven system involved using a Data Glove manipulated by a human hand to experiment on gesture recognition. In [6] 22 gestures that were divided into three groups were the subject of the investigation. The first class just comprised finger flexure exercises, but the second class integrated finger flexing with hand rotation. The third category of motions needed finger, flexion, position, and extra gestures with the fingers. The presence of flex sensors in the Data Glove enabled the recognition of up to 15 distinct movements with relative ease.

Undoubtedly, the accuracy of sensors depends on the nature of movements and the specific gestures targeted for identification. While recognition of class 3 gestures seems feasible, further research is necessary to refine recognition methods and also suggest a real-time hand movement identification system that combines a face skin color representation and a movement historical picture. They presented two static gestures, the wave of the hand and the fist, together with four dynamic motions: up, down, left, and right. These motions were

showcasing the transformative potential of human-computer interpotentially substituting different hand gestures for colored ction paradigms. The key contributions of the proposed model are depicted asmarkers to achieve the same outcome.

- The proposed AI Virtual Mouse System introducesThe mouse serves various functions such as scrolling, singlea novel approach to human-computer interaction by utilizing hand clicking, double-clicking on the left side, and more [8]. Different gestures captured through a webcam without the arrangements of colored caps are utilized for different processes. e d for traditional input devices. The application's adaptability to diverse skin tones and lighting
- The system incorporates cutting-edge technologies, specifically conditions allows for adjustments. Analyzing the programmed computer vision and artificial intelligence (AI), to analyze and output during hand motions helps estimate the area ratio within interpret hand gestures in real time. the convex hull that remains unused. Detection accuracy for red,
- By leveraging the TensorFlow library for sophisticated gesture green, and blue colors remains around 90% within the typical analysis, the system achieves a high level of accuracy and brightness range of 500 to 600 lux found in offices and well-lit responsiveness, marking a significant advancement in the fusion classrooms. Addressing the challenge of variable lighting, a hand of AI and human-computer interaction. gesture recognition technology capable of detecting hand
- Unlike existing solutions that may lack versatility or require contours is employed. The importance of concealed Markov additional hardware, the AI Virtual Mouse System offers a models in real-time dynamic detection of gestures is emphasized responsive and adaptive interface. The system's adaptability by [9] study. When combined with the Baum-Welch Method for contributes to improved accessibility, catering to a diverse range instruction and both the Forward and Viterbi Schemes for

functions. By leveraging the webcam's video feed, the system accurately detects and responds to specific finger movements, facilitating functions such as cursor movement and left-click actions based on gestures [3-5]. This outcome represents a significant advancement in hands-free computing, particularly beneficial for individuals with mobility constraints, of user needs and preferences.

intended to be easy and uncomplicated. The four-directional active hand movements have been identified utilizing harr-like characteristics, and the still gestures of the hand were retrieved and then recognized inside a face-based area of interest (AI) by applying a dynamic coloration model to the human face. This strategy worked with five individuals, averaging 94.1% accuracy. [7] devised a system called "Virtual Mouse Controlling Utilizing colored Finger Strategies and Hand Gesture Analysis" that eliminates the requirement for detectors or explicit touching. This system involves tracking colorful fingertips to control a cursor, evaluation, HMMs appear to be a realistic solution for pattern recognition. While the system in this study seems user-friendly compared to newer or command-based systems, it shows reduced effectiveness in pattern detection and recognition. The experimental system includes an Arduino Uno with ultrasound sensors, and a personal computer to enable hand gesture-based manipulation of functions such as handling media and controlling the volume. Python, Arduino platform, and Ultrasound detector provide serial connectivity.

[13] introduced 'Media Pipe Hands' a comprehensive real-time hand tracking system designed across various platforms. This pipeli forecasts 2.5D landmarks without requiring specialized equipment, and it may be easily installed on common systems. By making the pipeline open-source, they aim to inspire researchers and engineers to innovate in gesture control and AR/VR applications. Authors of [14] introduced a brand-new virtual mouse technology that makes use of fingerprint sensing and RGB-D pictures. This method allows users to perform actions solely by using their fingertips in front of a webcam. The technique demonstrated exceptional accuracy in gesture estimation, showcasing its suitability for various applications.

PROPOSED SYSTEM

The TensorFlow framework is employed for hand gesture detection and hand tracking [7–10]. The algorithm incorporates machine learning principles to facilitate hand gesture recognition and hand tip tracking.

TensorFlow

TensorFlow, an open-source framework developed by Google, serves as a machine learning pipeline, enabling cross-platform development due to its reliance on time series data. This versatile framework caters to multimodal applications encompassing various audio and video formats [11]. Developers leverage TensorFlow to construct, analyze, and design systems using graphs, employed for both analytical and application-driven purposes.

For real-time hand detection and recognition, TensorFlow employs a single-shot detector model, specifically trained for palm detection due to its simpler training and better performance with small objects like palms or fists [13]. Finding 21 joint or knuckle locations within the surface of the hand is the goal of a hand landmarks approach.

This library, which is based on the language used in Python, makes it easier illustrated in Figure 3. Subsequently, the webcam captures to create real-time apps for computer vision. It is capable of analyzing frames, forwarding them to the AI virtual system for processing.

images and videos, allowing for features like objects and the identification of faces [15].

(ii) Recording videos and process

The AI virtual mouse technology uses the camera to collect every picture till the program stops. During this procedure, the recorded pictures go through color space alteration, switching ...s to RGBs. This bit of code serves as an example of ...ement:

findHands function is responsible for this conversion,

frame.

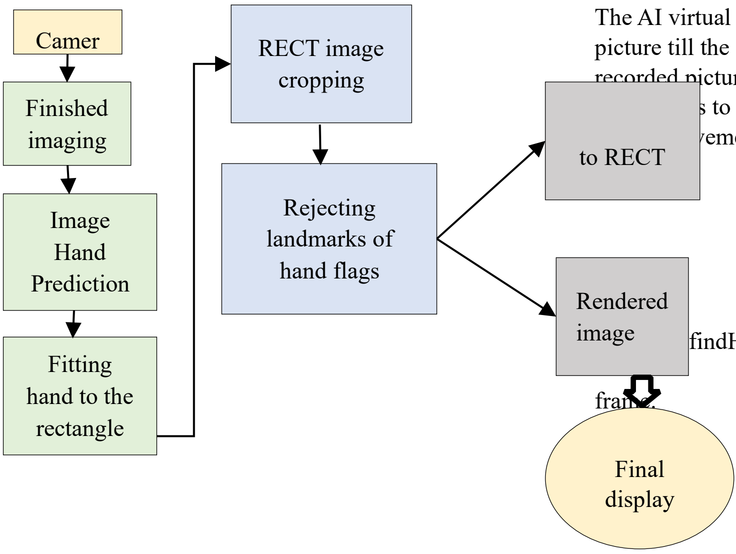
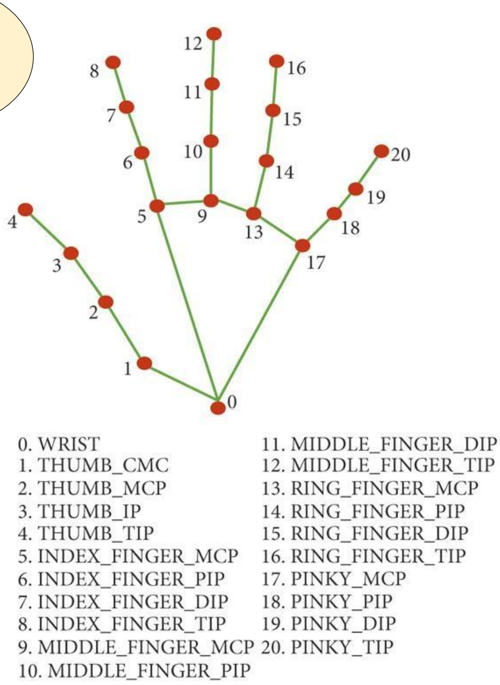


Figure 1. Hand prediction Graph algorithm



Algorithm

Step 1: Start the program.

Step 2: Open the software and run the program using the location of the file.

Step 3: Initiate the system and start to capture the video through WEBCAM

Step 4: Implement Hand Detection Algorithm for Gesture Recognition using TensorFlow.

S

Landmarks def findHands(self, img,

draw=True):

imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)

self.results = self.hands.process(imgRGB)

allowing the system to detect hands within the video frame-by-

Step 5: Analyze the hand region to recognize different gestures.

Step 6: Translate recognized gestures into corresponding cursor movements.

Step 7: Execute mouse functions corresponding to different gestures.

Step 8: Stop the program

METHODOLOGY

Procedural flow of the proposed system

The flowchart in Figure 2 which shows the real-time Artificial virtual mouse technology goes into depth about the many circumstances and operations used in the framework.

(i) The webcam Utilized in the AI Virtual Mouse system

Employing the TensorFlow Python library, a video capture object is generated, initiating video capture by the webcam, as

Figure 2. Landmarks in the hand

(iii) Rectangular area corresponding to virtual screen for Navigating within the Window

The AI virtual mouse technology employs an alternation technique to transfer fingertip values from the camera screen to the whole computer display, enabling mouse operation. Upon hand recognition and recognition of the fingers for a certain mouse operation, a rectangular frame depicting the computer windows is formed inside the camera view. They enable mouse cursor movement inside the window.

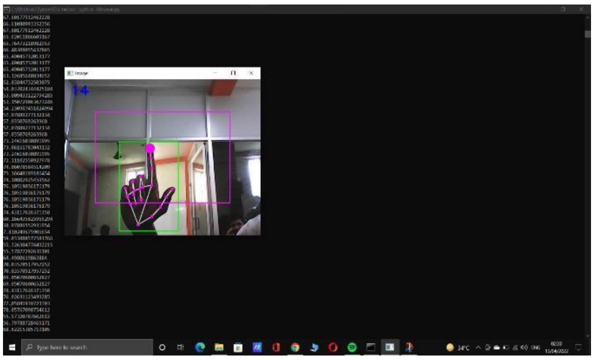
(iv) Recognizing the Raising Finger and Implementing the Specific Mouse Instruction

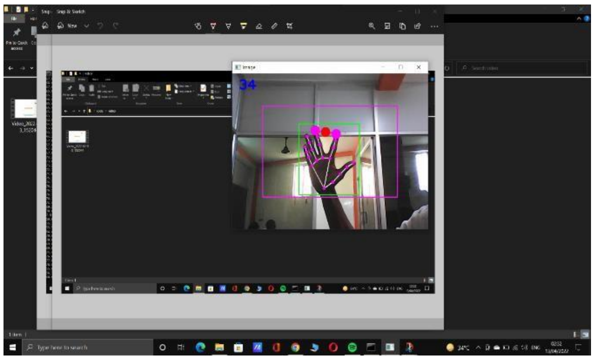
During this phase, we determine the raised finger by identifying the tip IDs corresponding to the fingers detected through TensorFlow. Utilizing the coordinates of the active fingers, specific mouse functions are executed based on the identified finger.

do this task.

RESULT

AI virtual mouse technology emphasizes computer vision for interaction between humans and computers However, the system's testing faces challenges due to limited available datasets. The system underwent testing for hand gestures and fingertip detection across various illumination conditions and distances from the webcam. This experiment encompassed 600 manually labeled gestures from 25 trials conducted by 4 individuals under diverse lighting and proximity scenarios.





(v) To Drag the Mouse Pointer Throughout the Computer Display

operation in a virtual environment for selecting, left-clicking, rightclicking, scrolling up and down, and moving the pointer.

The AutoPy Python library is used to control the mouse cursor's position inside the machine's display when whether your index finger (tip IDs = 1) or the second index finger (tip IDs = 1) and the pointer thumb (tip IDs = 2) are extended. Figure 6 illustrates this procedure.

(vi) To Trigger a Left Mouse

When the fingers of the thumb (tip IDs = 0) and your index finger (tip IDs = 1) are both raised so that the space among them is smaller than thirty pixels, the machine clicks the left mouse button. The Pynput Python library is used to do this task.

(vii)To Trigger a Right Mouse

The computer performs a right-left mouse click if the distance between your extended index finger (tip IDs = 1) and extended middle fingers (tip IDs = 2) is fewer than forty pixels. The Pynput Python library is used to

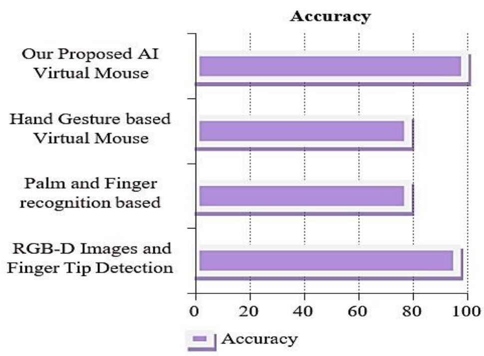


Figure 3: Graph for comparison among techniques

Affirming the proposed model's superior accuracy. Its unique feature is that it uses fingertip recognition to simulate actual mouse **CONCLUSION**

By using hand gestures to regulate the cursor's functionalities, the AI virtual mouse technology marks a big step towards revolutionizing human-computer interaction. The technology effectively recognizes hand gestures and hand tips using a webcam or integrated camera, converting these inputs into distinct mouse actions. The outcomes show excellent performance, outperforming current models in accuracy and successfully reducing many of the drawbacks of traditional systems.

The device promotes hygiene-conscious behavior by providing a touchless substitute for conventional physical mice, hence enhancing the safety of the computing environment. Despite the notable achievements, the model does exhibit some limitations, including a slight decrease in accuracy for the right-click mouse function and challenges in clicking and dragging to select text. To address these shortcomings and enhance the system's overall performance.

Thus the future work will focus on refining the finger-tip detection algorithm. This improvement aims to produce more accurate and reliable results, ensuring seamless interaction and expanding the system's usability across a variety of tasks.

REFERENCES

1. Sankar E, Nitish Bharadwaj B, Vignesh A V. (2023), ‘Virtual mouse using Hand Gestures’, a survey in IJSREM, ISSN 2582-3930.
2. Bala Harshithaa B, Leelavathi R. (2023), ‘Virtual Mouse using OpenCV’, in International Research Journal of Engineering and Technology, pages 374-378.
3. Qiuyu Zhang, Fan Chen, Xinwen Liu. (2023), ‘Hand Gesture Detection and Segmentation Based on Difference Background Image with Complex Background’, in IEEE, DOI 10.1109.
4. Agarwal, Prachi. (2022), ‘Gesture Control Virtual Mouse’, a survey in IEEE.
5. Sangeetha B, Abarna M, Jemima Esther Grace M. (2022), ‘Virtual Mouse using Hand Sign Identification’, a survey in International Research Journal of Modernization in Engineering Technology and Science, Vol.4, Issue:06, pages 5104-5106.
6. Omkar Shinde, Kiran Navale, Dipak Kunjir. (2021), ‘Gesture Recognition Based Virtual Mouse and Keyboard’, in International Research Journal of Modernization in Engineering Technology and Science, pages 1769-1770.
7. Sankar, Sankha, Sumanta Chatterjee. (2021), ‘A Vision Base Application for Virtual Mouse Interface Using Hand Gesture’, a survey in International Journal of Innovative Science and Research Technology, pages 940-945.
8. Shriram S, Nagaraj B, Jaya J, Shankar S, Ajay P. (2021), ‘Deep Learning-Based Real-Time AI Virtual Mouse System Using Computer Vision to Avoid COVID-19 Spread’, in Journal of Healthcare Engineering, pages.
9. Mandar Salvi, Shravan Kegade, Aniket Shinde, Bhanu Tekwani. (2021), ‘Cursor Manipulation with Hand Recognition Using Computer Vision’, in IT Industry, pages 1455-1456.
10. Dinh-Son Tran, Ngoc-Huynh Ho, Hyung-Jeong Yang. (2020), ‘Real-time virtual mouse system using RGB-D images and fingertip detection’, Vol.80, pages 10473-1049.
11. Vantukala VishnuTeja Reddy, Thumma Dhyanchand, Galla Vamsi Krishna. (2020), ‘Virtual Mouse Control using Colored Fingertips and Hand gesture recognition’, a survey in IEEE, pages 620-625.
12. Sandeep Thakur, Rajesh Mehra, Buddhi Prakash. (2015), ‘Visionbased Computer Mouse Control using Hand Gesture’, in ICSCTI, pages 85-89.
13. Subhash Chandra N, Venu T, Srikanth P. (2015), ‘A Real-time Static & Dynamic hand gesture recognition system’, International Journal of Engineering Inventions, pages 93-98.
14. Ashish Mehta, Sriroop B K, Ka
15. vya AGS, Ramanath Nayak, Ravikumar Javali. (2014), ‘Virtual Mouse’, a survey in Conference I4C, pages 69-72.
16. Abhik Banerjee, Abhirup Ghosh. (2014), ‘Mouse Control using Web camera based on Colour detection’, in IJCTT, Vol.9, pages 1520.