Virtual AI Mouse by detecting Hand Landmarks

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Abstract

The AI Virtual Mouse using Hand Tracking leverages computer vision and machine learning to create an intuitive and contactless human-computer interaction system. By employing advanced hand detection algorithms and real-time tracking techniques, this project replaces traditional input devices such as the physical mouse with dynamic hand gestures. Utilizing libraries like OpenCV and MediaPipe, the system detects hand landmarks and interprets various gestures to perform standard mouse functions such as cursor movement, clicking, scrolling, and drag-and-drop. This technology enhances accessibility, particularly for users with physical limitations, and offers a more natural, hygienic, and immersive way to interact with computers. Through efficient gesture recognition and real-time processing, the virtual mouse aims to improve user experience in both personal computing and emerging fields such as virtual reality and augmented reality.

1 Introduction

The rapid advancements in artificial intelligence (AI) and computer vision have transformed how humans interact with technology. One of the most promising areas of innovation is the development of touchless, gesture-based interfaces that provide more intuitive and accessible ways to control digital devices. Traditional input methods like keyboards and mice, while functional, are limited in flexibility and can present challenges for users with physical disabilities. To address these limitations, this project focuses on creating an AI-based virtual mouse using hand tracking technology, allowing users to control computer systems with hand gestures in real-time.

The core objective of this project is to replace the conventional mouse with a virtual alternative that tracks hand movements and interprets gestures for actions such as moving the cursor, clicking, scrolling, and dragging. By utilizing hand landmarks and tracking algorithms, this system aims to improve user experience, enhance accessibility, and offer a hygienic alternative to physical input devices. The applications for such a system extend beyond personal computing, with potential use cases in virtual reality (VR), augmented reality (AR), and smart environments. This project explores the development of a real-time hand gesture recognition system, which serves as the foundation for creating a responsive and accurate virtual mouse.

2 Literature Review

The concept of gesture-based interaction has gained traction in the past decade, particularly with advancements in computer vision and AI. One of the earliest systems, Microsoft Kinect, allowed users to control applications through body gestures but was limited by hardware requirements.

Recent developments have focused on software solutions using standard cameras for gesture recognition, with hand detection and tracking being pivotal. Traditional methods relied on color segmentation and shape recognition, but these were often hindered by lighting and background noise. The shift to deep learning models, particularly convolutional neural networks (CNNs), has significantly improved hand tracking accuracy.

Google's MediaPipe framework has simplified the creation of hand tracking systems, providing efficient real-time landmark detection that models hand key points in 3D space. This has facilitated the use of gestures for controlling virtual objects and user interfaces, paving the way for applications like virtual mouse functionality.

Gesture recognition has also seen significant interest, with gestures such as pinch and swipe being extensively studied. Research by Li et al. (2020) and Zhou et al. (2019) demonstrated the effectiveness of deep neural networks and CNNs in achieving high accuracy in gesture classification for human-computer interaction.

Despite these advancements, challenges like system responsiveness and accuracy under varying lighting conditions remain. This project aims to build on existing systems by optimizing hand tracking performance to create a seamless and efficient gesture-based input method.

Technical Plan

Overview

This project aims to develop an AI-based virtual mouse utilizing hand tracking technology to enhance human-computer interaction. The methodology leverages deep learning algorithms and real-time hand tracking frameworks to recognize hand gestures and translate them into mouse movements.

Methodology

1. **Literature Review**: Analyze existing research on hand gesture recognition and tracking techniques, focusing on the use of deep learning methods and frameworks like MediaPipe.

2. **Framework Selection**: Choose the appropriate tools and frameworks, such as MediaPipe for hand tracking and TensorFlow or PyTorch for implementing machine learning models.

3. **Data Collection**: Gather datasets for training and testing hand gesture recognition models. This may include synthetic data or publicly available datasets.

4. **Model Development**: Implement deep learning models (e.g., CNN, RNN) for gesture recognition. Fine-tune hyperparameters to enhance model accuracy.

5. **Integration**: Combine the hand tracking and gesture recognition modules to translate detected gestures into mouse commands.

6. **Testing and Validation**: Test the integrated system in various environments and refine based on results that i will get.

7. **Documentation**: Document findings, methodologies, and results throughout the project lifecycle.

Monthly Task Breakdown

Month and Task Description
October
Begin literature review and framework selection.
Begin data collection and preprocessing.
Start developing deep learning models.
Submit Project Mid-term Report .
Integrate gesture recognition with hand tracking.
November
Conduct initial testing and validation.
Refine models based on testing feedback.
Begin drafting final report and documentation.
Submit Project Final Report .

References

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