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Virtual mouse control using Machine learning

Prof.S.V.Mahale(Assistant Professor)[*1], Aniket Shinde[*2], Prafull Sonawane [*3] , Linesh Gahival [*4]

Shatabdi Institute of engineering and research Nashik , Maharashtra

Abstract *:* In the contemporary era, computer vision has achieved remarkable advancements, enabling computers to identify their owners through sophisticated image processing programs. This technological progress has permeated various aspects of daily life, manifesting in applications like Face Recognition, Color Detection, and Automatic Cars. The current project leverages computer vision to innovate an Optical mouse and keyboard system driven by hand gestures. In this project, the computer's camera captures images of different hand gestures performed by an individual, translating these gestures into movements of the mouse cursor. The gestures can also trigger right and left clicks, simulating the functions of a traditional mouse. Similarly, keyboard functions are integrated, with distinct gestures such as one-finger movements for alphabet selection and four-finger swipes for left and right commands. This setup acts as a virtual mouse and keyboard, eliminating the need for wires or external devices. The sole hardware requirement for this project is a webcam, and the coding is executed using Python on the Anaconda platform. The methodology involves the generation of convex hull defects, and through defect calculations, an algorithm is developed. By mapping these defects to mouse and keyboard functions, the computer interprets the user's gestures accurately. By associating specific gestures with mouse and keyboard actions, the system comprehends the user's intentions and responds accordingly. This innovative approach not only demonstrates the power of computer vision but also showcases its practical application in creating an intuitive and wire-free interface for interacting with computers. The utilization of hand gestures as input commands enhances user experience and expands the possibilities of human-computer interaction. The project exemplifies the versatility and convenience that modern computer vision technologies bring to our daily lives.

IndexTerms **- Virtual Keyboard, EEG, Electroencephalogram, Brain Computer Interface (BCI), RGB, Touch-Less Keyboard.**

I. INTRODUCTION

The computer webcam captures a video of the person seated in front of the computer, where a small green box is generated in the center of the screen. Within this green box, the objects presented are processed by the code, and if there is a match, a red-colored border is activated. This indicates that the computer has successfully identified the object, allowing the user to manipulate the mouse cursor by moving the recognized object. This not only enhances computer security but also creates a virtual computing experience. In this setup, instead of utilizing various physical objects, hand gestures are employed for different functions. One gesture is designated for moving the cursor, while distinct gestures are assigned for right-click and left-click actions. Similarly, straightforward hand gestures can virtually replicate keyboard functions that would typically be performed using a physical keyboard. When an unrecognized gesture is detected, only the green box is displayed, but when a known gesture is recognized, a red border appears. This innovative approach not only contributes to computer security but also introduces an interactive and virtual computing experience. The utilization of hand gestures as input commands provides a user-friendly interface, enabling users to control the mouse cursor and perform keyboard functions seamlessly. The red border serves as a visual cue, signifying successful recognition of the gesture, while the green box indicates an unidentified or unmatched gesture. Overall, this implementation offers a blend of security and user convenience, showcasing the potential for enhanced human-computer interaction.

This paper sheds light on the formidable challenges faced by individuals dealing with physical disabilities, such as paralysis, impeding their ability to carry out everyday tasks independently. Conditions like paralysis, affecting 1.9% of the population, not only present physical limitations but can also lead to profound emotional distress, anxiety, and depression. The integration of Brain-Computer Interface (BCI) technology emerges as a promising solution, offering a direct communication pathway to control input/output (I/O) devices and addressing the limitations posed by traditional devices like the mouse and keyboard. BCI technology, with its diverse applications in the biomedical field, presents opportunities for therapeutic rehabilitation, gaming, communication assessments, and environmental control systems. This research specifically proposes the development of a virtual keyboard segmented into three distinct colors (red, green, and blue) to enhance the efficacy of BCI technology for individuals with physical disabilities. Electrodes are strategically placed on the subject's scalp to capture neural activity, with the signals subsequently amplified for detailed analysis. The Support Vector Machine (SVM) serves as a classifier for data classification and pattern recognition. The overarching goal of this research is to create a user-friendly and efficient BCI application with a high spelling completion rate and accuracy. The paper meticulously outlines the methodology, encompassing subjects, environmental setup, interface design, and the data collection procedure. The experimental results are presented, offering valuable insights into the potential of BCI technology to enhance the quality of life for individuals facing physical disabilities. The paper concludes with thoughtful considerations for future research and development in this domain, emphasizing the ongoing efforts to create BCI applications that are not only effective but also user-friendly, contributing to improved accessibility and independence for individuals with physical challenges.

II. METHODOLOGY

1. Subjects
   In the experiment, six university students (3 males and 3 females) participated, aged between 20 to 26 years. All participants had normal eyesight, color vision, and were medically fit. Each participant underwent training to use the software, and the experimental process was explained before commencement.

2. Environment
   The experiment took place during daytime in normal weather conditions. The room where the experiment was conducted had standard lighting (500 lux, optimal for computer use) and maintained a room temperature of 24-25°C. A Dell LED (Model P2214h, Resolution 1920x1080, Size 22") with an Intel HD Graphics controller was utilized to present the virtual keyboard interface. The color enhancement was set to standard mode, and the distance between the subject and the screen was 60 centimeters.

3. Interface Design
   The interface consisted of two main components: the text area and the virtual keyboard. Fig. 1 displays the software interface, with approximately 25% and 75% (height-wise) covered by the text area and virtual keyboard, respectively. The virtual keyboard interface comprised four layers (Fig. 1). The first two layers were divided into three groups, differentiated by basic RGB colors (Red, Green, and Blue). The remaining two layers were subdivided into two groups, differentiated by red and green colors. The EEG-controlled virtual keyboard operates through RGB color brain values, offering a solution that eliminates eyestrain, fatigue, mental tiredness, and other similar problems associated with existing solutions.

4. Procedure
   The OpenBCI Ultracortex Mark-IV headset with eight electrodes was employed to sense neural signals. Following the international 10/20 system standards for EEG electrode positioning, eight electrodes were attached to Fp1, Fp2, F7, F8, C3, C4, O1, and O2 locations on the subject's scalp (as shown in Fig. 1). Data acquired from electrodes were received through the OpenBCI Cyton Board, featuring eight input channels, and transferred to the computer via Cyton USB Bluetooth. The use of RGB colors in EEG signals for controlling the virtual keyboard introduces an innovative approach that addresses existing challenges. This procedure provides an efficient and user-friendly solution for individuals with physical disabilities, enhancing accessibility and usability in virtual keyboard applications.

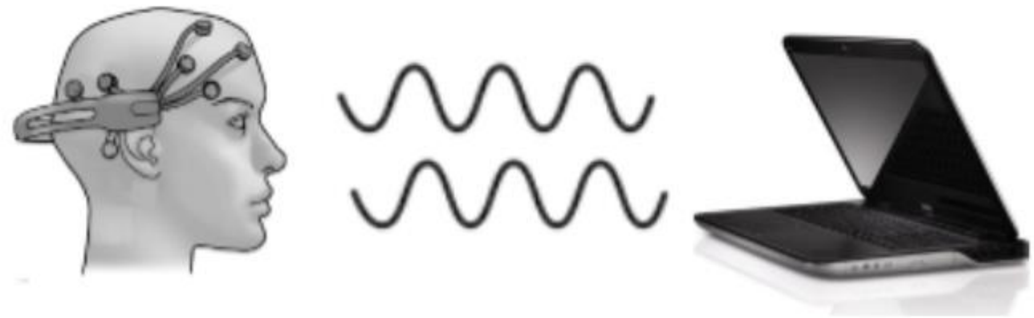

Fig. 1: Block Diagram

In Figure I, a comparative analysis of various methods for virtually controlling computer keyboards is presented, with input signal, character selection time, and drawbacks serving as the criteria for evaluation. Different approaches employ distinct signaling methods, such as eye blinks (opening and closing) or utilizing the brain's focus and attention on the targeted character when highlighted. One prevalent method involves the use of eye blinks, a process known to induce eye strain and fatigue, rendering it suboptimal for prolonged use. In contrast, our proposed system employs color stimuli, mitigating the issues associated with eye strain. In this system, the subject simply needs to focus on the respective color block without the need to wait for a specific group or block to be highlighted. This deviation from waiting for a specific block to be highlighted enhances time efficiency when compared to other approaches. Crucially, our proposed system ensures a consistent and relatively minimal character selection time, setting it apart from other methods. Common weaknesses observed in alternative approaches include eye strain, mental fatigue, time inefficiency, and reliance on physical surgeries. Remarkably, the system introduced in this paper successfully mitigates almost all the challenges encountered in other approaches. It stands out as a solution that not only improves time efficiency and reduces user fatigue but also eliminates the need for physical surgeries, contributing to a more effective and user-friendly virtual keyboard control system.

III. LITERATURE SURVEY

1) Paper 1: Research on Deep Learning-Based Hand Gesture Recognition"

Authors: Shu-Bin Zhang, Ting-Ting Ji, and Jing-Hao Sun the need for interaction between humans and machines is growing as computer vision technology advances quickly. Hand gesture recognition is frequently utilized in robot control, intelligent furniture, and other areas because hand motions can represent enhanced information. The segmentation of hand gestures is accomplished in this study by developing a skin color model and an AdaBoost classifier based on here to account for the specificities of skin color for hand motions. Additionally, hand movements are denaturized with one frame of video being cut for analysis. In this sense, the human hand is separated from the complex background, and the CamShift algorithm also makes it possible to track hand gestures in real-time. Convolutional neural network then recognizes the area of hand motions that have been detected in real-time in order to achieve the recognition of 10 common digits. Research indicates 98.3% accuracy.[1]

2) Paper 2: Personalized and Dynamic Keyboard for Eye Tracker Typing

Authors: Kadir Akdeniz and Zehra C. athlete Stroke and Amyotrophic lateral sclerosis (ALS) patients are unable to speak or convey their daily necessities. Since they can still move their heads and use their eyes, they can converse via eye trackers. This study offers fresh ideas for enhancing the speed and usability of eye tracking software. First, letter prediction is used to increase speed, and second, a novel design eliminates the need for blinking while using eye trackers, allowing for more comfortable and extended writing sessions.[2]

3) Paper 3: Visual gesture decoding algorithm for an assisted virtual keyboard"

Authors: Rafael Augusto Da Silva, an IEEE member, and Antonio Claudio Paschoarelli Veiga, an IEEE member, one of the most common computer tasks is creating text, a simple task that can be difficult for those with severe neuromotor illnesses like Amyotrophic Lateral Sclerosis, which can cause Locked-in syndrome. Since these people may only be able to communicate and engage with the outside world through eye movements, they require augmentative and alternative communication tools. This study explores eye movement-based interaction techniques and introduces a virtual keyboard that accepts text input via gaze detection.[3]

4) Paper 4: "Using Colored Finger Tips and Hand Gesture Recognition, Virtual Mouse Control,"

Authors: Galla Vamsi Krishna, Thumma Dhyanchand, and Vantukala Vishnu Teja Reddy One study in the field of human-computer interaction uses a virtual mouse with fingertip recognition and hand motion tracking based on image in a live video. This work proposes fingertip identification and hand motion detection for virtual mouse control. The two finger tracking techniques used in this study are hand gesture detection and employing colored caps.[4]

IV. RESULTS AND DISCUSSION

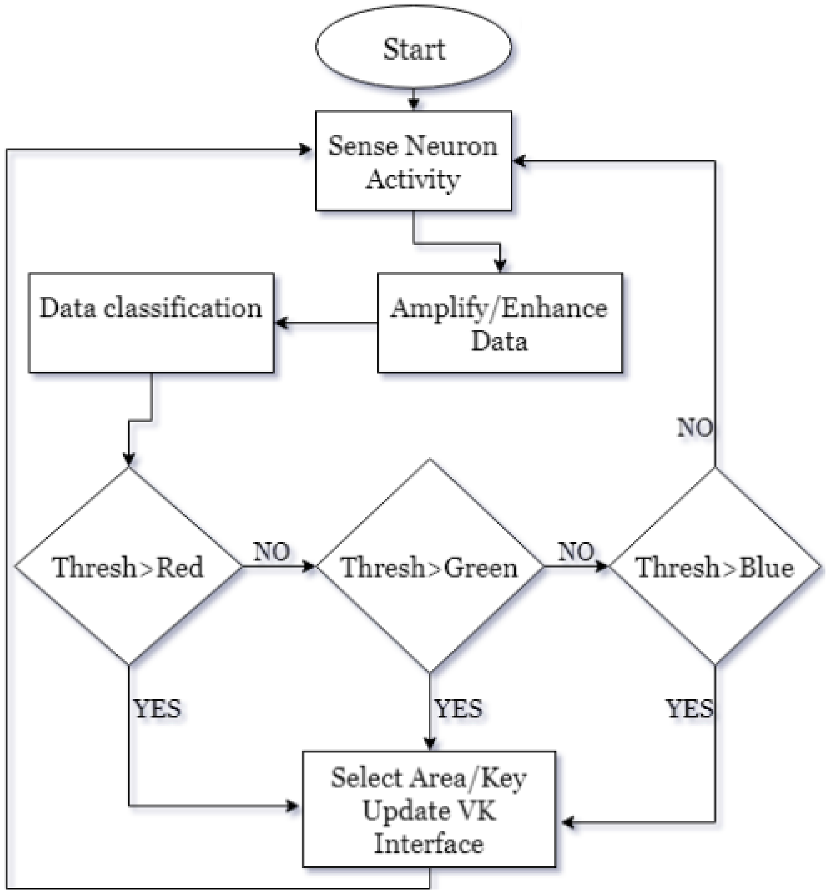

Figure 2: Flowchart

Python served as the foundational programming language for the design of the mouse system, and several essential Python modules were imported to facilitate its operation. One crucial Python extension module utilized in this system is NumPy, which provides rapid and efficient operations on collections of related data. For technical and scientific computing needs, the open-source SciPy Python library was employed, enhancing the system's capabilities. To harness real-time computer vision functionalities, the system leveraged the OpenCV library—a programming toolkit dedicated to computer vision tasks. Additionally, PyAutoGUI, a cross-platform GUI automation module written in Python, was integrated. PyAutoGUI enables the automation of computer tasks by facilitating control over the mouse and keyboard, along with basic image recognition capabilities. The device's functionality involves using the webcam to identify a person's pupil, allowing for mouse cursor movement through eye control. This innovation was demonstrated by students who successfully moved the mouse cursor on the computer's home screen using their eyes. Notably, this approach eliminates the need for manual mouse control, offering a more intuitive and hands-free interaction. To complement eye-controlled cursor movement, the system incorporated a virtual keyboard, enabling users to type using their fingertips. The integration of these technologies showcases the versatility and practicality of Python and its associated modules in developing innovative human-computer interaction systems. This approach not only provides an efficient and hands-free alternative for computer control but also highlights the adaptability of Python in diverse application domains.

Step 1: Using the computer's webcam to record live video

Step 2: Processing every image frame from the recorded video

Step 3: Image frame conversion

Step 4: Virtual Keyboard Step

Step 5: Hand landmarks are used to recognize hand gestures.

Step 6: Find the object's position over the virtual keyboard and flip the input device.

Step 7. The character Convolutional Neural Network identification techniques should be printed.

V. MODULE

The system initiates by detecting and capturing the face through a machine learning process. Subsequently, the system identifies and captures the eyes, with a specific focus on the pupils. The utilization of gesture recognition technology enhances the overall functionality of the system. The advantages of incorporating gesture recognition technology into the system are multifaceted. One notable application is the ability to commence mouse cursor movement by tracking the movements of the pupils. This innovative approach represents a significant improvement in several fields, showcasing the potential impact of gesture recognition in human-computer interaction. By integrating gesture recognition, the system transforms the way users interact with the computer, particularly in cursor control. The ability to initiate mouse movements through pupil tracking not only demonstrates technological advancements but also introduces a more intuitive and hands-free approach to computer control. In conclusion, the described system, leveraging facial detection, eye tracking, and gesture recognition, signifies a noteworthy advancement with practical applications in various domains. The integration of these technologies highlights the continuous evolution of human-computer interaction, paving the way for more seamless and innovative user experiences.

Module 1 GUI:

We have designed our GUI in TKinter. Tkinter is a Python binding to the Tk GUI toolkit. It is the standard Python interface to the Tk GUI toolkit, and is Python's de facto standard GUI.

Module 2: Registration/Login System:

User need to Register before using the application. User's data will get store into the database and while user login to the system database will be get fetch. If user is registered then only, they can login to the system.

Module 3:Database Module:

Database is used to store data of user. We have used DB SQLite database.

Module 4: Mouse Functioning:

The system is a mouse-like eye-based interface that converts eye movements like blinking, staring, and squinting into mouse cursor actions. The software requirements for this technique include Python, OpenCV, NumPy, and a few more facial recognitions Harr Cascade algorithm, as well as a basic camera.

Module 5: keyboard Functioning:

Keyboard functioning will be managed by gesture methods. We are using forefinger and mid finger for gestures. We are locating coordinates as top, mid, and base. As a finger moves, we will manage using keyboard.

VI. CONCLUSION

This project introduces a novel system designed for hand gesture recognition, aiming to replace traditional mouse and keyboard functions. The envisioned functionalities encompass mouse cursor movement, drag-and-click actions, and keyboard operations such as typing alphabets and executing other keyboard functions. The implementation employs a skin segmentation process to effectively isolate the color/image of the hand from its background. Additionally, the "remove arm" method is utilized to address challenges associated with capturing the entire body in the camera frame. In essence, the proposed algorithm demonstrates the capability to detect and recognize hand gestures, enabling the operation of mouse and keyboard features. The envisioned real-world user interface has broad applications, ranging from 3D printing and architectural drawings to performing medical operations remotely. The project's versatility suggests that it can find widespread application in the medical field, overcoming limitations in human-computer interaction and enhancing computational capabilities in scenarios where full implementation was previously challenging. In conclusion, the proposed system not only introduces an innovative approach to hand gesture recognition but also opens up vast possibilities for its application in various domains, particularly in medical science where computational requirements may have been hindered by limitations in human-computer interaction.

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