



VOLUME CONTROLLED BY HAND GESTURE RECOGNITION.

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Abstract—

In this paper we discuss the significance of gesture control in technological advancements for people with visual impairment. It highlights the use of computer vision and the main objective of the project, which is to control computer settings using hand gestures. The project focuses specifically on need of people with certain disability and here volume control using hand gestures and incorporates the use of OpenCV. The module utilizes a computer's webcam to capture images or videos, processes them to extract necessary information, and performs volume adjustments based on the input gestures. The program allows users to increase or decrease the volume without the need for physical touch or input devices like the mouse or keyboard. The module performs gesture recognition using OpenCV and Python, identifying specific human gestures to carry out the desired changes in device settings. By intercepting the video input and analyzing the gestures within a defined range, the module effectively changes the computer's volume.

Index Terms—gesture control, technological advancements, computer vision, hand gestures, volume control, OpenCV, webcam, image processing, gesture recognition, input devices, touchless interaction, Python, video input, volume adjustment.

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I. INTRODUCTION

In the present scenario increasingly more people are using gesture recognition technology since it is a simple and natural form of communication. In this paper, we provide a system for device volume control that recognizes gestures. The technology uses a camera and an algorithm to recognize and interpret hand motions to change the loudness. The suggested approach locates the hand in the given video frame using skin color segmentation and blob analysis. A machine learning model that has been trained on a dataset of hand gestures is then used to recognize the hand gestures. The system modifies the volume after identifying a gesture.

This paper presents a system for gesture-based volume control using a camera and an algorithm to interpret hand motions. The approach involves locating the hand in video frames using skin color segmentation and blob analysis, and then using a trained machine learning model to recognize specific hand gestures. The system accurately modifies the volume based on the identified gestures. Experiments conducted on a dataset validate the performance of the proposed approach. The paper highlights the importance of gesture recognition in facilitating human-computer interaction and describes the implementation of the system using Python libraries such as OpenCV, Mediapipe, Pycaw, and NumPy.

The simplified approach offers hands-free control, particularly benefiting users with disabilities who may have difficulty using traditional input devices. The low-cost and low maintenance solution as we are not the Using open-source libraries like OpenCV, Mediapipe, Pycaw, and NumPy makes the program a low-cost solution that can be easily implemented by anyone with programming experience so this research will help anyone and along with this the programmer can customize the program according to the outcome they require to recognize different hand gestures and perform different actions based on those gestures, where each hand gesture performs a different function. The program improves efficiency and convenience by enabling volume adjustment without interrupting workflow.

Additionally, the use of open-source libraries makes the system a cost-effective and customizable solution. Overall, the hand gesture recognition and volume control program provide an efficient and convenient method for adjusting computer volume.

II. FORMULATION OF PROBLEM

This project primarily focuses on the difficult component of this system which is the background

movies or images recorded or taken as input such as the hand movements of user. The light effects of the area can alter the video quality. We can also see segmentation being used in this method. Being able to use technology is now one of the necessities of anyone living in the current world. As all the basic functionalities can be accessed through technology and working on computer systems and operating systems, all individuals are not able to access it.

The problem arises when not all the humans are able to access the technology, computer systems, operating systems due to the complexities of the functionalities of these systems. If we investigate the problem, particularly we will notice that senior citizens, people with vision problems, kids, people with disabilities, or general people with less dexterity in computer applications are not able to perform even the simple functions of an operating device. Studies also show that people with disabilities are less likely to use technology than people who do not have disabilities. This happens due to the non-inclusivity of measures into normal day to day technology which prevents especially abled citizens from using the technology that a normal person uses not only for leisure but also to access fundamental right benefits that are necessary, so this makes it a serious issue to provide a solution for. We want to create a solution for such members of society so that they can also use working with various programming languages. It supports different operating systems and is widely used in projects involving face, hand, arm, and object detection, as well as motion detection.

The Mediapipe library, developed by Google, provides user-friendly machine learning solutions for computer vision tasks. It can be used for both facial and gesture recognition. The integration of Mediapipe into Python code is straightforward, making it convenient for developers to prototype and develop hand gesture recognition applications. It offers accuracy, speed, flexibility, and ease of use. Pycaw, short for Python Core Audio Windows Library, is compatible with both Python2 and Python3. It is essential for accessing the device's speakers and controlling the master volume. The project utilizes the camera as the input device, processing the input video to control the device's volume based on the space between the tips of the index finger and thumb.

technology and computer systems by just using their hand gestures and here we have picked the features of volume control with hand gestures. Any person sitting from any position can control the volume of the device by just using their hands.

III. TOOLS AND TECHNOLOGY USED

In this project, we utilized various techniques and modules, with the code developed in Python using OpenCV and NumPy.

The project focuses on gesture-controlled volume and requires Fig.1 Hand landmarks the following libraries: OpenCV, Mediapipe, math, ctypes, We have used this new approach by using Mediapipe, several Pycaw, and numpy. The main camera provides video input, factors make the Mediapipe library for hand gesture recognition which is recognized using Mediapipe. The hand module useful, including The Mediapipe hand tracking technology offers detects gestures, and Pycaw is used to access the speaker and precise and reliable identification and tracking of the landmarks control the volume within a specified range. NumPy is a of the human hand, which can improve the recognition of hand fundamental package in Python, offering multidimensional gestures. For the applications that require quick and accurate containers, N-dimensional arrays, broadcasting functions, and hand gesture identification, the Mediapipe hand tracking system tools for efficient computation, including linear algebra, is optimized for real-time performance.

Fourier transform, and random number generation. OpenCV is Hand gesture detection is just one of many uses for the variety of a powerful Python library for computer vision tasks, enabling pre-built computer vision and machine learning models offered image analysis, processing, detection, recognition, and by the Mediapipe library.

The major principle behind the code of this program is we will record the input video from the camera and the program will detect our hands in the input video and will mark up the points, as suggested by the Mediapipe library and shown in Fig. 1. Mediapipe hand landmarks is the standard system with which can identify the hands' landmarks in an image using the Mediapipe Hand Landmarker job. This task can be used to localize the hands' important spots and create visual effects on top of the hands.

We have implemented the concept of histogram, a type of graph which represents the movement of the pixels power in the video data input. We convert image into the rgb using histogram to process the image in our programmed system. As we know that, the power of a pixel is in the range [0,255]

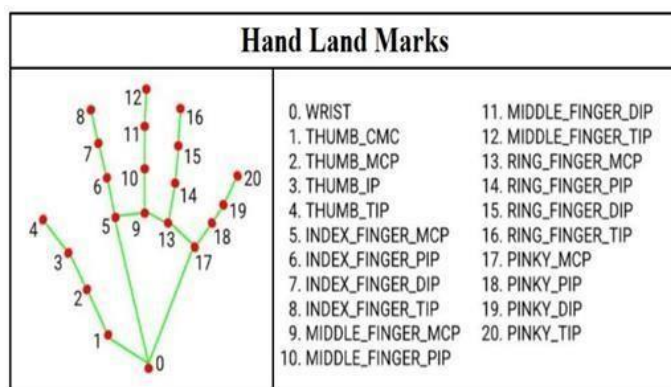


Fig. 1 Hand Landmarks

IV. LITRATURE SURVEY

This paper presents a system for gesture-based volume control using a camera and an algorithm to interpret hand motions. The approach involves locating the hand in video. As we have researched the topic of hand gesture recognition systems, it has been determined that using the Mediapipe framework with Python is the most suitable language for this purpose, and we are utilizing its libraries to enhance accuracy for users. Hand gesture recognition plays a crucial role in human-computer interactions, allowing systems to capture gestures and execute commands without physical touch. Mediapipe is a machine learning framework that offers hand gesture recognition technology.

In our study, we employ the Mediapipe framework to develop a user guide application,[2] which provides step-by-step instructions for system usage, reducing user annoyance and enabling users to resolve technical issues. To make the user guide application more interactive, the implementation of hand gesture recognition using Mediapipe is recommended.

Hand gesture recognition has gained popularity due to its use in various devices, including gaming consoles and smartphones, and has applications in healthcare and accessibility. OpenCV and Python 2.7[3] are suggested for creating a hand gesture detection simulation.

The Mediapipe framework supports ML pipelines for data processing across different platforms, such

as desktop/server, Android, iOS, Raspberry Pi, and Jetson Nano. Our technical approach involves using loops to obtain hand landmark coordinates and IDs. By utilizing the Mediapipe framework, we demonstrate how it can accurately detect complex hand gestures, achieving an average accuracy of 99% in most sign language samples.[4]

The model is robust and efficient, requiring less computational power and suitable for smart devices. It can be customized for regional sign language datasets and offers faster real-time detection than current state-of-the-art approaches. The study also suggests expanding the application by incorporating word detection for sign language from videos using Media pipe's advanced classification algorithms.[5]

In our project, we utilize hand gestures as an alternative means of communication, replacing traditional devices like keyboards. Gesture recognition allows computers to better understand human body language, creating a more powerful connection between humans and technology Here we are using hand gestures to communicate with the discussion we normally use LED Indicators, Switches, Touch Screens and display of LCD as a part. Another way to communicate with machines Hand Gestures. Instead of using a keyboard, we use other devices in a web page and many 4 more or to control the volume of the computer system. Here we have used hand gestures to make this project.[6]

The goal is to develop an interface that dynamically captures and interprets human hand gestures for controlling applications, such as volume control.

Computers can better grasp human body language thanks to gesture recognition, which promotes the development of a more powerful connection between humans and technology, rather than relying solely on standard text user interfaces or graphical user interfaces (GUIs). In this gesture recognition project, a computer camera interprets the movements of the human body, and this information is then utilized as input by the computer to handle applications. The objective is to create an interface that dynamically captures human hand gestures and controls loudness. [7]

The use of Mediapipe allows predictions over sets of frames, rather than single frames, resulting in improved accuracy for input video streams. The reason behind using the libraries is also discussed before, as for recognizing American Sign Language they used MediaPipe. Hand gesture recognition is a complex task and needs lots of data and complex methodology.

They use Mediapipe with Long Short-Term Memory model to predict American Sign Language. They use Mediapipe, NumPy, Pandas, and OpenCV to create their own dataset for their project. The main reason to use Mediapipe is that they want to make predictions over the set of frames rather than on a single frame. To achieve good accuracy over an input video stream, it can be easily achieved with the help of Mediapipe and taking input with the help of OpenCV, which is a Python library. [8]

Furthermore, this concept can be extended to keyboards, as discussed in a journal where an IoT project utilized sensors and other technologies to enable data exchange through hand gestures. This concept can also be extended to keyboards, as discussed in this journal, where an IoT project was created. In this project, objects were embedded with sensors and other technologies to facilitate the exchange of data. [9]

V. METHODOLOGY AND RESULTS

The methodology described outlines the system flow for a Python program that uses hand gestures or the range between fingers to control and adjust the volume range of a connected computer system or operating device. The program begins by opening a camera dialog box to capture images of the user's gestures using a camera or other sensor. It utilizes the Mediapipe library to detect and recognize the user's hands and their landmarks. Image processing techniques are then applied to extract relevant information such as hand position and movement.

The program analyses the pre-processed data using Python libraries to recognize specific hand gestures or finger ranges made by the user. For example, it can identify the gap between the index finger and thumb to indicate an increase or decrease in volume range. By accessing the coordinates of specific hand landmarks, such as the tip of the thumb and index finger, the program calculates the distance between them. The program provides visual feedback to the user by displaying a volume bar that reflects the current volume range or the effect of their gestures or finger ranges.

We will see a bar showing the increase and decrease in volume as soon as we increase or decrease the gap between our finger and thumb increases or decreases. The program continues to capture input and adjust the volume range based on the user's gestures or finger ranges until the user stops or until the program is terminated.

In the methodology of this very salient and similar procedure we are using Mediapipe, landmarks on the hand are marked by dots representing

significant points. The collected data is then analysed by the program and Python libraries to identify specific hand gestures or finger ranges made by the user. For instance, the program can recognize the gap between the index finger and thumb to indicate an increase in the computer volume range, while a decreasing gap between the thumb and index finger would be interpreted as a signal to decrease the volume range. This approach allows for intuitive and gesture-based control over various computer functionalities, enhancing the user experience and providing a more interactive means of interaction with technology. We detect the hand point, then we identify the points of significance and then we measure the distance between the points and interpret it.

The program continues to capture input and adjust the volume range accordingly until the user stops or the program is terminated. It's important to note that the specific implementation of the program and the hardware/software involved may influence the system flow. Additionally, the program may require additional modules or libraries to implement specific image processing or gesture recognition algorithms.

Function hand [4] that returns the {x, y,z} of the tip of the thumb.

Function hand [8] that returns {x, y,z} of the tip of index finger. Then we get the x1 and y1 of the first point and second point's x2 and y2 and use.

distance=int(sqrt(((x2-x1)*(x2-x1))\ +((y2-y1)*(y2-y1))))

To interface with the volume of the Windows operating system, the program utilizes the Pycaw module, which employs logarithmic regression. The linear win volume module is used and includes four functions to derive an equation that accurately represents the volume range from 0 to 100. The program calculates a logarithmic regression equation of the form $y = A \ln(x) + B$, where C is used to reduce the error margin and is defined as $100 - \text{intersect} / \text{max volume in decibels (dB)}$. D is defined as $\text{max} - y = A \ln(x) + Cx + B$, where x is

100. These calculations help ensure precise volume control based on the user's gestures or finger ranges. The described result highlights the outputs obtained when using the program with image or video input captured by the camera. Image processing involves detecting landmarks and preprocessing them to control the volume. The program applies image processing techniques to extract and figure out the relevant information by examining the input data, such as the position of the hand and movement of the user's hand or fingers. Fig. 2 Result at 0 perc. Fig. 3 Result at 39 perc. Fig. 4 Result at 99 perc. This Fig. 2 The result shows a video playing in the background with no volume, and the screen bar indicates a volume of 0%. This occurs when the distance between the thumb tip (point 4) and the fingertip (point 8) is 0. Fig. 3 The result displays a video playing in the background with medium volume, and the screen bar shows a volume of 33%. This occurs when there is a significant distance between the thumb tip (point 4) and the fingertip (point 8). Fig. 4 The result presents a video playing in the background with maximum volume, and the screen bar indicates a volume of 99%. This occurs when the distance between the thumb tip (point 4) and the fingertip (point 8) is at its maximum. These results demonstrate how a disabled personnel or a person with less dexterity in tech will be able to just use their hand and perform gestures to increase or decrease the volume of computer.

The described result highlights the outputs obtained when using the program with image or video input captured by the camera. Image processing involves detecting landmarks and preprocessing them to control the volume. The program applies image processing techniques to extract and figure out the relevant information by examining the input data, such as the position of the hand and movement of the user's hand or fingers.



Fig. 2 Result at 0 perc.

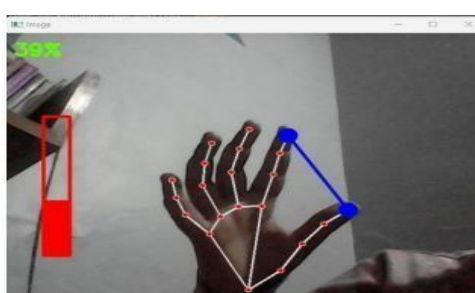


Fig. 3 Result at 39 perc.

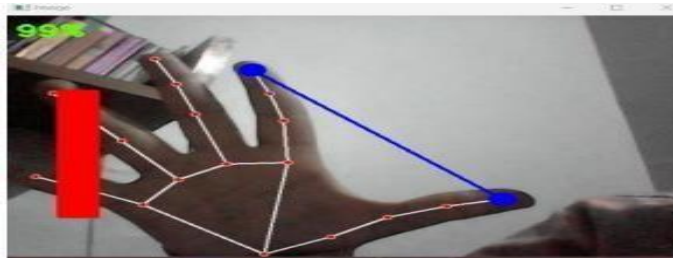


Fig. 4 Result at 99perc.

CONCLUSION

This project focuses on human movement recognition using hand gestures to control the volume settings of a computer system. It is a simplified version of more advanced projects aimed at utilizing human movement recognition and pattern detection in various real-life applications. The main goal of such programs is to enhance communication between humans and machines, promoting automation of daily activities and minimizing human errors. This project has significant benefits for senior citizens, individuals with disabilities, and those with limited technological knowledge, as it simplifies the process of controlling computer settings and reduces the fear associated with using technical devices. The use of hand gesture-driven computer systems is particularly beneficial for people with disabilities or special needs who may struggle with traditional input devices like a mouse or keyboard.

The summary suggests various potential applications for hand gesture volume control, including home entertainment systems, public address systems, and assistive technologies for individuals with impairments. Future research could explore the accuracy and usability of these systems in more depth. Hand gesture volume control has practical uses in adjusting the volume of music or movies in home entertainment systems, enabling speakers in classrooms or conference rooms to control their speech volume without disruptions, and serving as assistive technology for individuals with disabilities who may face challenges with conventional controls. In gaming, it can enhance the immersive experience by allowing players to adjust audio levels without interrupting gameplay. Additionally, in the fields of virtual and augmented reality, hand gesture-controlled volume can contribute to the manipulation of audio levels within simulated environments, enhancing immersion and realism.

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