Controlling Media Player with Hand Gestures

Parshav Maloo, Dr. Deepa K
Velore Institute Of technology

***Abstract*—At this time and age, working with a computer in some capacity is a common task. In most situations, the keyboard and mouse are the primary input devices. However, there are several problems associated with excessive usage of the same interaction medium, such as health problems brought on by continuous use of input devices, etc. Humans express their feelings through gestures because it feels like the most natural method to communicate. Compared to external devices like keyboards and mouse, the motions feel more natural. Thus, the project's stated goal is to use hand gestures to operate standard media player controls. In this paper, a hand gesture recognition system which is able to control computer media players is offered. Hand gestures are one of the key elements to interact with the smart system. We used the hand gesture recognition mechanism of a computer media player, for instance, volume down/up, next music, etc.**

Keywords—Hand gesture, interaction, media player, contour, convexity hulls, convexity defects

I. INTRODUCTION

Gesture recognition is taking note of how various human body components, such as the head, arms, face, and fingers, move when interacting with the surroundings. The design of effective and trustworthy human-computer interaction programs depends heavily on gesture recognition. Common gesture recognition-based computer applications include those for interacting with schoolchildren, monitoring the behaviour of elderly or disabled individuals, translating sign language, and sluggish driving detection. Since a few decades ago, gesture recognition has been a significant topic of research. Different types of sensors, such as vision sensors and wearable sensors, have been used to create gesture recognition systems. Regular cameras and the Kinect are two examples of widely used vision-based sensors. Hand gestures offer an inspiring field of research because they can facilitate communication and provide a natural means of interaction that can be used across a variety of applications.

At the present time, hand gesture recognition systems could be employed as a more commonplace and practical method of human computer interaction. Hand gestures are a form of body language that can be expressed through the position of the fingers, the centre of the palm, and the shape the hand forms. There are two types of hand gestures: static and dynamic. The static gesture, as its name suggests, relates to the stable shape of the hand, whereas the dynamic gesture is made up of a sequence of hand motions like waving. A new method of interacting with the virtual environment is offered by an automatic hand gesture recognition system. In the proposed method, the hand gesture and facial position are first extracted from the primary image using a skin and cascade detector combination, and are then sent to the recognition stage. In the recognition stage, first, the threshold condition is inspected then the extracted face and gesture will be recognised. We count the convexity defects using the cosine formula in next stage, and then we bind these numbers of convexity defects for various functionalities to control the media player/YouTube.

II. RELATED WORK

1. Hand Gesture Recognition Based on Computer Vision [1]
Author: Munir Oudah, Ali Al-Naji and Javaan Chahl (2020)

This paper describes the various Instrumental devices-based hand gesture recognition techniques, their requirements and performances. This paper focuses on a review of the literature on hand gesture techniques and introduces their merits and limitations under different circumstances. This paper is a thorough general overview of hand gesture methods with a brief discussion of some possible applications such as the similarity and difference points, technique of hand segmentation used, classification algorithms and drawbacks, number and types of gestures, dataset used, detection range (distance) and type of camera used

2. Machine Learning Based Hand Gesture Recognition via EMG Data [2]
Author: Senturk, Z. K., & Bakay, M. S. (2021)

For years, researchers have researched electromyography (EMG) pattern recognition for gesture recognition to operate prostheses and rehabilitation systems. Information on the electrical activity of muscles is available via EMG data. In this paper, author aims to understand hand gestures using six different machine learning methods on hand gesture data from the UCI2019 EMG dataset obtained from myo Thalmic armband. Several performance metrics, including accuracy, precision, sensitivity, specificity, classification error, kappa, root mean squared error (RMSE), and correlation, were used to compare and recognize and classify seven hand gestures successfully in comparison with the literature.

3. Robust hand gesture recognition using multiple shape-oriented visual cues [3]
Author: Samy Bakheet and Ayoub Al-Hamadi (2021)

This paper proposes a real-time method for hand gesture recognition based on an optimized shape representation build from multiple shape cues. The framework includes a dedicated module for hand position estimation using depth map data, in which the hand silhouette is first retrieved from the incredibly precise and detailed depth map recorded by a time-of-flight (ToF) depth sensor. Also, when evaluated on a publicly available dataset incorporating a relatively large and diverse collection of egocentric hand gestures, the approach yields encouraging results that agree very favourably with those reported in the literature, while maintaining real-time operation.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

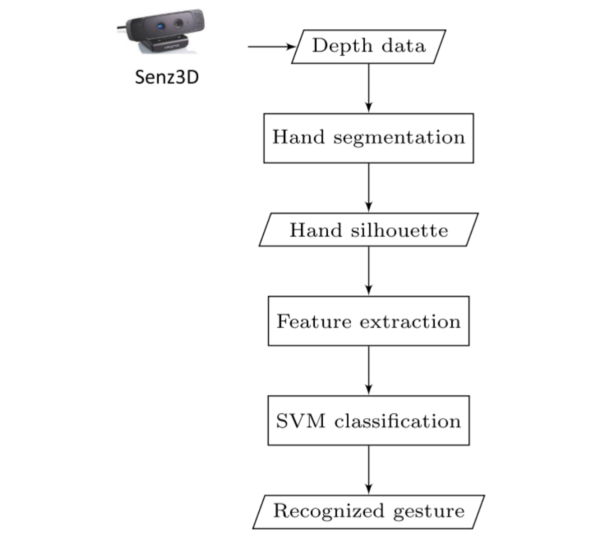


Fig. 1 The general workflow of the proposed framework

4. Gesture Controlled Media Player using TinyYoloV3 [4]
Author: Abhilash Dayanandan, Akshay Chakkungal, Anooj Kommeri, Deepak Koppuliparam bil, Dr. Prashant Nitnaware (2020)

YOLO is a fast and accurate algorithm. This algorithm can be used for gesture recognition and for training model by bringing balance between speed and accuracy. The goal of the proposed project is to develop a gesture-controlled media player that will enable us to use our hands to manage the computer-played movie. In this paper, instead relying just on image processing and machine learning, the YOLO object identification model can recognize a variety of hand gesture combinations more accurately thanks to deep learning and neural networks. There is a tradeoff between speed and accuracy which can be controlled. If higher accuracy is required, speed decreases and vice versa.

5. Static Hand Gesture Recognition Based on Convolutional Neural Networks [5]
Author: Raimundo F.Pinto, Carlos D. B. Borges, Antônio M. A. Almeida,and Iális C. Paula (2019)

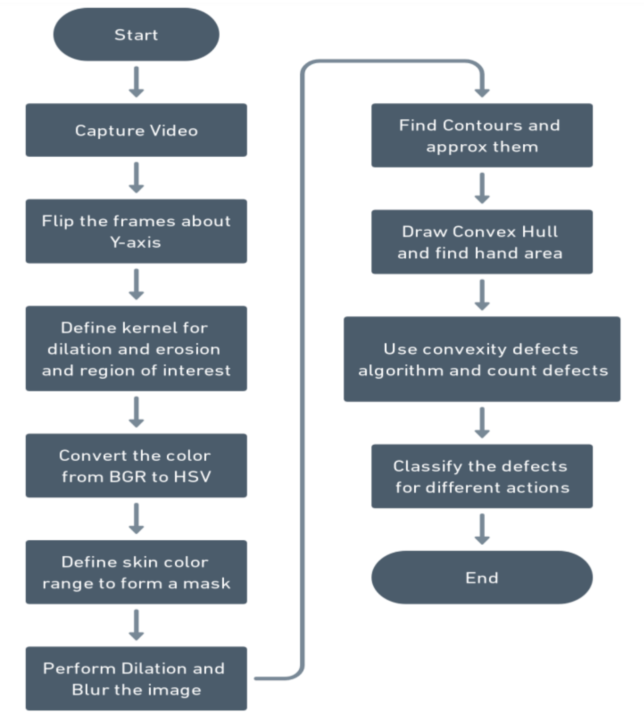
In this paper, a convolutional neural network-based technique for gesture recognition is proposed. In order to improve feature extraction, the approach applies morphological filters, contour generation, polygonal approximation, and segmentation during preprocessing. The images are used to train a CNN and assess the performance of the technique with cross validation. Finally, the validation results are analysed. The proposed method results were superior to other methods that use the same method of classification of gestures, the success rate of 96.83% shows the robustness of the presented methodology.

6. A wearable biosensing system with in-sensor adaptive machine learning for hand gesture recognition [6]
Author: Ali Moin, Andy Zhou, Abbas Rahimi, Alisha Menon, Simone Benatti, George Alexandrov, & Rabaey, J. M. (2021)

This paper describes the use of wearable devices that monitor muscle activity based on surface electromyography could be of use in the development of hand gesture recognition using ML. The system is implemented using a hyperdimensional computer technique with neural inspiration that is locally implemented for real-time gesture classification, model training, and updating under a variety of scenarios like changing arm postures and sensor replacement. When trained with a single trial for each gesture, the system can categorise 13 hand gestures for two participants with an accuracy of 97.12%. A drawback identified could be that the local processing cannot offer training and updating of the machine-learning model during use, resulting in suboptimal performance under practical conditions.

III. PROPOSED ARCHITECTURE

In the proposed architecture, the real-time hand gesture input from the user through the integrated webcam is used by the hand gesture recognition system on controlling media player, and it works when the user's inputted gesture matches one that can control the media player. The model offers the fundamental controls for the media player, including play, pause, volume adjustment. To develop the application, we employ a variety of Python tools and modules, including PyAutoGUI, OpenCV and subprocess. The architecture diagram of a proposed model is,



We have used PyAutoGUI to control the keys, map gestures to keys. i.e., to automatically press the keys according to conditions. The image frames are obtained from the video feed and converted from bgr image to hsv image using library function called, cvtcolor bgr2hsv. Crop image is used to divide the result window into gettrackbarpos gets the hsv values from trackbar. resize is used to make the screen small to show multiple tabs.

The mask is used ‘inRange ’where only the values within the range are displayed after applying the mask. The image

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

with the mask is filtered using the bitwise image. It's better to have foreground as white and background as black in order to identify contours. hence, we use "not" operator to invert the background and foreground of the image.

Contours

Contours are defined as the line joining all the points along the boundary of an image that are having the same intensity. Contours come handy in shape analysis, finding the size of the object of interest, and object detection.

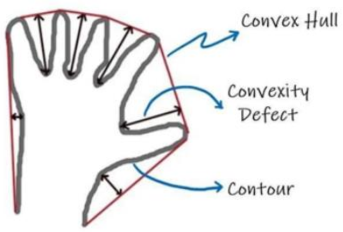
The contour of the hand in the region of interest is the set of points which correspond to the extremities of the human hand, which in turn define the hand's boundaries. The contour is then analyzed for the gesture and also approximated into a polygon. Canny edge detection method is opted to calculate the contour.

Hand Contour with OpenCV

Contours are found out using the 'findContours 'function. Using this we find out the convexity defect and convexity hull. The contour of the hand is a series of points which are the boundary pixels of the hand area. saved as a list. Find the contour with the largest area; if there is no contour, use try. The maximum contour arc length is determined, and the approxpolydp is then utilized to roughly determine the polygon (in this case, our hand) with the desired precision (which is epsilon). Now the red color line, which represents the contour, is used to create the convex hull. Draw the contour line around the hand in green and the convex hull in green on the figure.

Convexity Defects

Convexity defects are found out from the convexity hull, it is the farthest points from the convex points, i.e. if the finger tips are convex points, then the trough between fingers are the convexity defects. and these defects are counted. The angle between the fingers is found out using the cosine rule, so we understand the difference between index, middle, ring, little and thumb fingers.



Finding defects using Cosine Theorem

After detecting the convexity defects, we will get to know the number of fingers shown by the user then we can bind the count of convexity defect with the key to control the media.

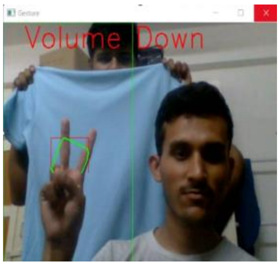
- Volume Up - 0 defect
- Volume Down - 1 defect
- Volume Mute - 2 defects
- Play/Pause – 3 defects
- Stop – 4 defects

IMPLEMENTATION RESULTS

The model is restricted to a plain background so that the model can detect the color of the skin based on the HSV values. After detecting the convexity defects, we will get to know the number of fingers shown by the user then we can bind the count of convexity defect with the key to control the media.

Video Capture:

A real time video is captured using OpenCV library and camera. The process involves selecting a rectangular portion of the captured image which is then filtered by a mask to extract the gray scaled binary image of the hand. For accurate tracking the user's hand the hue and saturation range should be selected appropriately according to the user. Tracking can be done by creating a filter of the hue and saturation range and applying it to the input image through bitwise-and operation.

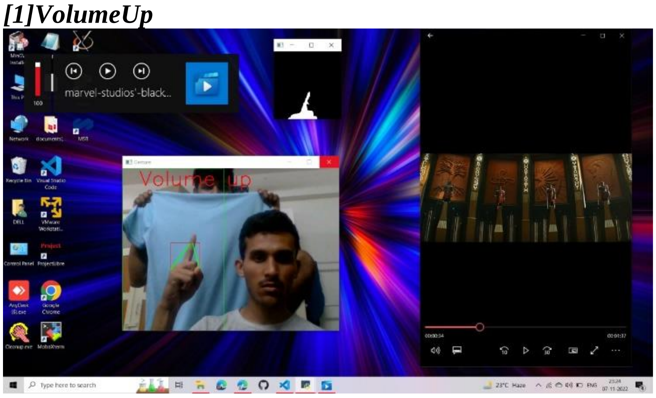


Captured Image

Masked Image

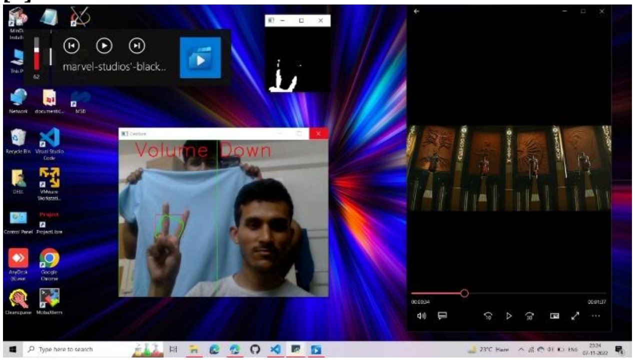
Resultant Outputs:

[1]VolumeUp



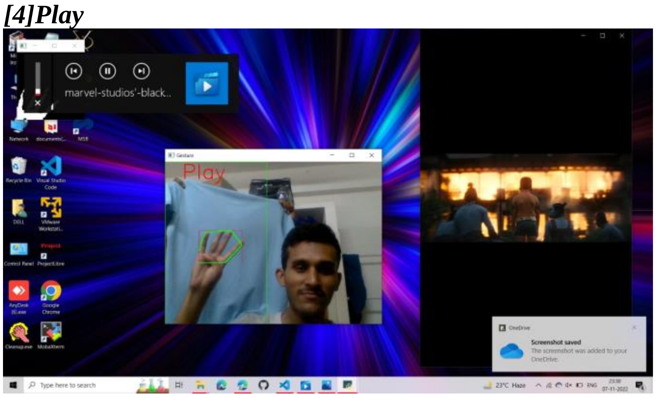
International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 11, November-2022

[2]VolumeDown

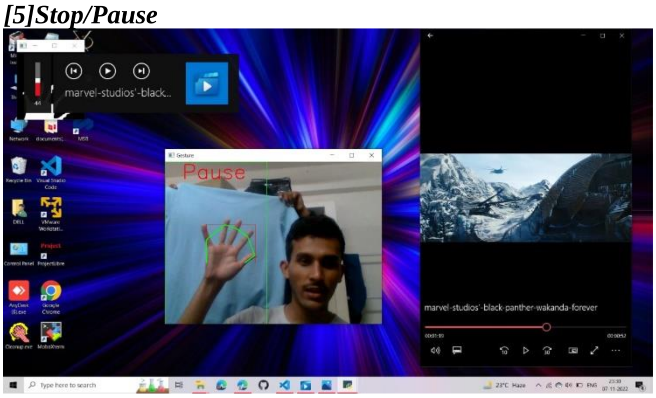


[3]VolumeMute

[4]Play



[5]Stop/Pause



The above-mentioned examples demonstrate how the created system functions well against a plain background. However, this also serves as a drawback. In order for the model to determine the color of the skin using the predetermined HSV values, a plain background is necessary. Similar-colored backgrounds might cause false detections, rendering the technique worthless. In the future, hand detection can be enhanced by using a stronger and more reliable technique. Such a system would depend on the other characteristics of a human hand in addition to the skin tone.

The finger detection mechanism is also affected if the hand is not properly detected. The contours and convexity defects are expected based on the shape of a human hand. If the hand detection is imperfect, it creates a domino effect, making the following steps unusable. A good hand detection mechanism ensures that the finger counting mechanism works correctly.

Following are some key observations and results of our project:

- The lower and upper bound of colour for the hand is critical in detecting the hand.
- Extracting contours was easier in the binary image which was obtained by binary thresholding.
- Sometimes the application fails to detect the hand gesture due to poor image quality.
- The implementation works well with plain backgrounds.

CONCLUSION

In this project, we performed hand and gesture recognition in python using OpenCV. Using the recognized gestures, we controlled various UI elements in the screen, hence making it easier for users to interact with the system. Hand recognition is based on the lower and upper bound of color, resulting in a binary threshold image. Contours and convexity defects are calculated, based on which the number of fingers is found out, which becomes the gesture. This is then used to control UI elements. This implementation works well with a suitable background. In the future, we can improve upon many aspects of the project. Some of them are:

- ➢ Adaptive thresholding to properly segment hand and background
- ➢ Removing the dependency on background colour to identify the hand
- ➢ Adding more UI control with the recognized gestures specific to a particular application
- ➢ Improving the gesture recognition, possibly by using machine and deep learning

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