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# Hand Gesture Recognition using OpenCV and Python

**Siddhartha Panwar[1], Dr. Sunil Maggu[2]**

[1]Student, Information Technology, Maharaja Agrasen Institute of Technology, Rohini, Delhi

[2]Assistant Professor, Information Technology, Maharaja Agrasen Institute of Technology, Rohini, Delhi

**Abstract:** Computers have been aiding us to perform herculean tasks for decades. From carrying out complicated calculations to automating a lot of our daily life's processes - all has been made possible due to advancement in technology and making computers smarter. In a similar fashion, we can implement a program that mimics the way the human eye works (Computer Vision) and make it recognize the patterns that it comes across. Our goal is to make a program that is able to recognize gestures made by our hand. The program is written in Python programming language along with OpenCV libraries.

In order to use this program, the user needs to be in front of a computer webcam that will be used to recognize the gesture made by the user's hand. The program will display results of recognized hand gestures on a live video frame stream.

**Keywords** - Computer Vision, OpenCV, Python, Gestures

## INTRODUCTION

Keyboard and mouse have been the key medium for human-computer interactions since decades. However, due to the rapid development of hardware and software, new types of human-computer interaction methods have emerged over time. In particular, technologies such as speech recognition and gesture recognition have been the major innovation in this field.

A gesture is the symbolization of physical behavior or emotional expression of a person. Gestures can be classified as - body gesture and hand gesture. Hand gestures are particularly important. With their help one can express themselves in a sign language that can have universal meaning. Humans use their fingers (hand gestures) for various things- to point to something, to count, to express something without using words, etc.

Computers can be programmed to decipher these gestures and even be coded up to perform some tasks. These tasks can range from outputting the meaning of a gesture to making the hand act like a mouse pointer, hence acting as a medium for human-computer interaction.

## TECHNOLOGY USED

**OpenCV** is the huge open-source library for computer vision, machine learning, and image processing and it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis.

Image processing includes:

- Edge Detection and Image Gradients
- Dilation, Opening, Closing, And Erosion
- Perspective Transformation
- Image Pyramids
- Cropping

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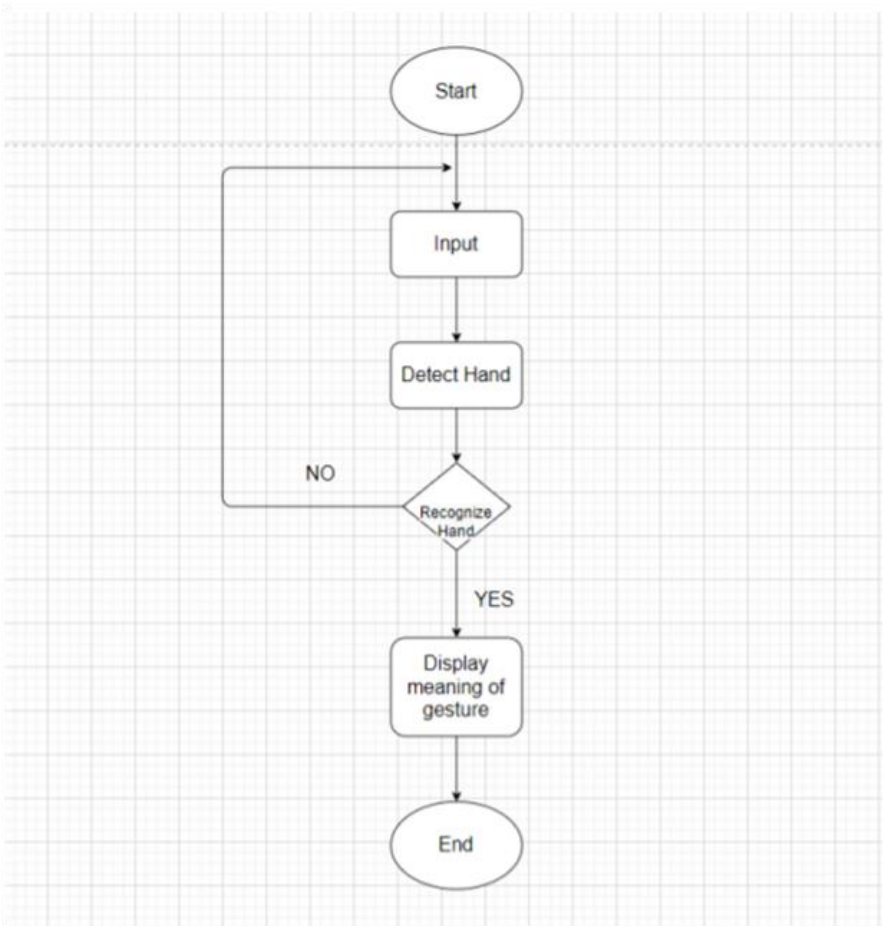
- Scaling, Interpolations, And Re-Sizing
- Thresholding, Adaptive Thresholding, And Binarization
- Sharpening
- Blurring
- Contours
- Finding Corners
- Counting Circles And Ellipses

**FLOWCHART**




**METHODOLOGY**

We are going to recognize hand gestures from a video sequence. To recognize these gestures from a live video sequence, we first need to take out the hand region alone, removing all the unwanted portions in the video sequence. After segmenting the hand region, we then count the fingers. The region of interest is the box in which we have to place our hand so that our program can perform further processing upon it. If the user does not place his hand there, the program will instruct him to.

Thus, the entire problem could be solved using 2 simple steps -

1. **Finding and segmenting the hand region from the video sequence.**

- Background Subtraction and Thresholding

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It involves converting the image to grayscale. Afterwards, the gray scale image is transformed into a binary image by OTSU Binarization. This ensures that only two objects are present in the image : the hand and the background. We also apply Gaussian Blur to smoothen out the hand surface captured and also reduce any amount of noise present.

- Contour Extraction

We find all the contours in the region of interest and select the maximum one i.e. the one formed by our hand.

**2. Count the number of fingers from the segmented hand region in the video sequence.**

- Finding the convex hull of the hand region

The convex hull takes the outline of a shape, and identifies the convex and concave (defect) points along the outline. These points provide us with a rough idea of the shape of the object.

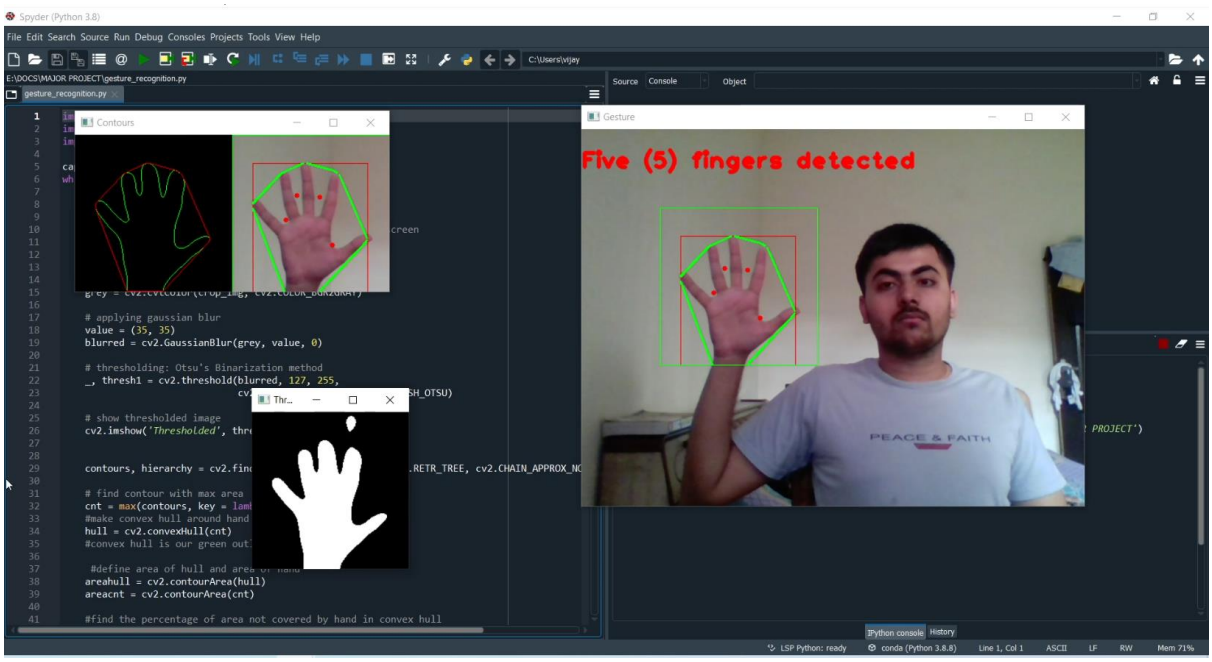
- Counting the number of defects in our contour

In the case of an open hand (showing 5 fingers), we have 5 convex points (one for each finger) and 4 defects (one between two adjacent fingers). Using this method, we can identify the number of fingers the user is showing to us by the number of convex and defect points.

- Instructing the program to output according to how many defects have been detected. Say there are 4 convex and 3 defect points, it means that the user is showing us 4 fingers.

## RESULTS

Our program realizes that the user has properly placed the hand in the box hence it does further processing on it. It processes that there are 5 convex and 4 defect points which means that the user is showing it 5 fingers and therefore it outputs the “Five (5) fingers detected”.



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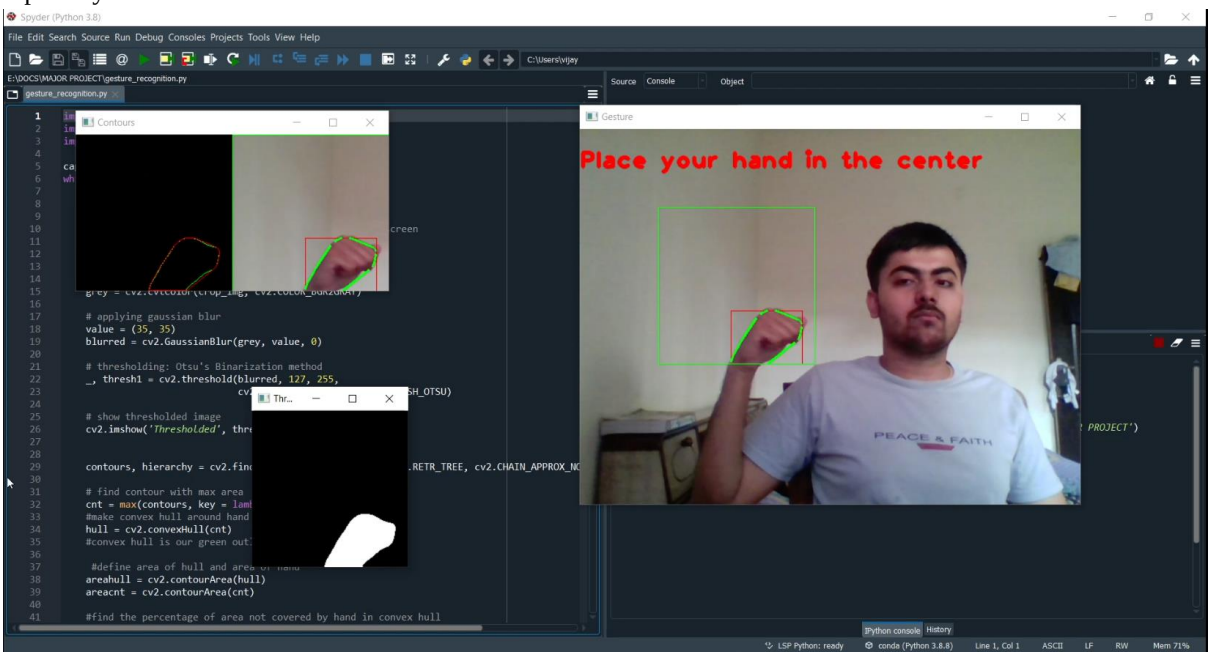
Our program can make sure whether the user is properly positioning his hand with respect to the box (region of interest) he is provided with. If not, it outputs the message “Place your hand in the center” to instruct the user to position his hand appropriately.




## CONCLUSION

Our program is able to recognize the user’s hand and decipher the gesture shown to it. Aside from this, our program is also capable of telling the user if his current hand position needs repositioning.

## FUTURE ENHANCEMENTS

One can always improve upon one’s work. The system can be further improved by integrating it with other technologies available (like Tensorflow). Addition of those can make the current system even more versatile.

Also, we can expand upon the range of gestures that our project can recognize. We can also try to make it less affected by noise that originates from light sources present in the room.

The nature of our project is very open-ended and there are multiple directions we can take this project in.

## ACKNOWLEDGMENTs

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