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HAND GESTURE RECOGNITION USING OPENCV AND PYTHON

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Abstract: Hand gesture recognition systems have advanced rapidly in recent years, owing to their capacity to successfully collaborate with machines. In a virtual environment, gestures are seen to be the most natural way for humans and computers to communicate. We frequently use hand gestures to convey information because they are a form of nonverbal communication that allows us to express ourselves freely. To extract the hand region in our system, we employed background subtraction. Our PC's camera records a live video, from which a preview is taken with the assistance of its functionalities or activities.

Keywords: Gesture recognition, OpenCV, human-computer interaction, python, machine learning.

I. INTRODUCTION

Hand gestures are a natural and reliable means of transmission for Human-Computer Interaction (HCI). Although a keyboard, mouse, joystick, or touch screen can be used to connect to a computer, they do not provide an appropriate interface. In contrast, the current system will include either a desktop or laptop interface in which hand gestures can be performed using data gloves or a web camera to capture a hand image. Hand capture and analysis is the first step toward gesture recognition. Sensors are utilized in Data-Glove methods to train hand movements as well as to initialize finger movement. In comparison, the vision-based solution simply requires a camera and thereby identifies the actual human-computer connection without the use of any other technologies. The steady background, occasionally a person, and illumination are all obstacles for this system. The procedures and methods employed in this system, as well as the recognition approaches, are detailed here. Segmentation is the process of looking for a connecting region in a photograph with given criteria, such as color or intensity, and adjusting a pattern and algorithm.

II. METHODS AND MATERIALS

Typically, a system consists of two sections: the backend and the front end. The back end consists of three modules: a camera module, a detection module, and an interface module, as shown in Fig 1. In summary, it is as follows.

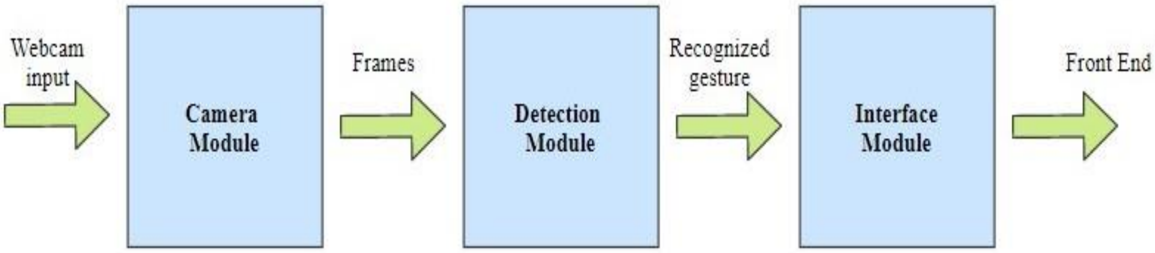

Fig 1 Back end and Architecture

Camera module

This module is designed to capture various kinds of image markers and interfaces and inputs and send these images to the detection module for processing as frames. Commonly used input capture and recognition methods are hand straps, data gloves, and cameras. We use a built-in webcam for our structure, so it is economical for viewing both static and dynamic symbols.

Detection module

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This module is responsible for image processing. The output of the camera module is provided for various image processing methods such as color conversion, denoising, and thresholding, after which the image is passed through edge extraction. If there is a defect in the image, a convex defect is found at this location to identify the gesture. If there are no defects, we classify the images using the Haar cascade for gesture recognition.

Interface module

This module is responsible for adjusting the recognized hand gestures to the associated actions. These actions are passed to the appropriate application. The front section consists of three windows. The main window contains the video input captured by the camera with the corresponding name of the identified gesture. The following window shows the contour found in the input image. The third window shows the smooth threshold processing of the image. The advantage of integrating thresholds and contour windows as an aspect of the graphical user interface is to warn the user of background irregularities that affect the input to the system and, as a result, adjust the laptop or desktop webcam. It can be avoided. This will improve execution.

Proposed Methodology

The final architecture for any system to recognize the hand gesture could be elaborated as appeared in Fig.2. We proposed a gesture recognition system that follows a very efficient methodology. Our framework contains four steps, which are as followed.

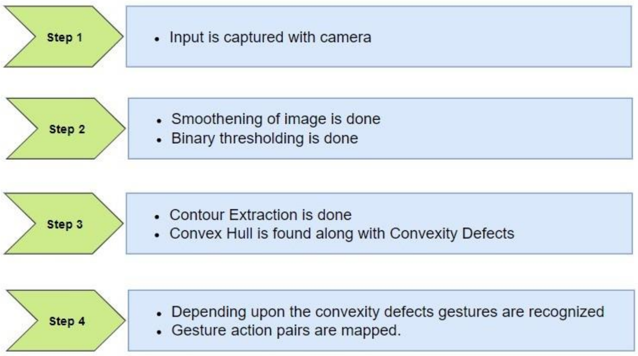

Fig. 2 Proposed method for our gesture recognition system

Image capturing

In this initial stage, we used a webcam to capture RGB images (frame by frame) with just hand gestures.

Pre-processing

Then, in this step, in order to minimize the calculation time, we captured only the important area, not the entire frame from the video stream, called the region of interest (ROI). Image processing continues the process by manipulating the color image into a grayscale image and restoring the image to its original color space when the process is complete. This is a way to convert the area of interest to a grayscale image. Note that in this step the algorithm will fail if the camera vibrates.

Hand area segmentation

This phase is important in any hand gesture recognition process and facilitates the development of how the system works by eliminating unwanted data in the video stream. Basically, there are two ways to detect a hand in an image. The first method depends on the color of the skin. It's simple, but it works well depending on the lighting conditions of the environment and the type of background. The second technique is the shape of the hand, which benefits from the convex principle when capturing the hand. Hand posture is a very important function in the hand gesture recognition process (Li & Zhang, 2012).

There are many other techniques that can help you recognize the area of the hand from the image, which can be summarized as follows:

A. Edge detection.

B. The RGB values for hands are completely different from the background of the image, so they are RGB values.

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C. Background subtraction.

This background subtraction method separates the hand from the background. The background is identified by targeting at least 30 frames of the process in a particular scene and using the provided formula to generate the last frame and all moving averages.

dst (x, y) = (1 alpha) .dst (x, y) + alpha.src (x, y)

Where src (x, y) is a source photo consisting of one or three channels and an 8-bit or 32-bit floating-point. DST (x, y) is a destination photo with a channel similar to the source image. And 32-bit or 64-bit floating-point numbers. Finally, the alpha is the weight of the source image and can be used as a threshold to determine the time to calculate the moving average for the entire frame. After analyzing the background, hold your hand in front of the camera lens and calculate the absolute difference between the background calculated using the moving average and the current frame containing your hand as the foreground object. This method is called background subtraction. The next step is image thresholding. This is done after subtracting the background and the result is only a white hand gesture. This method is very important and must be done before giving any way to the contour to achieve high accuracy.

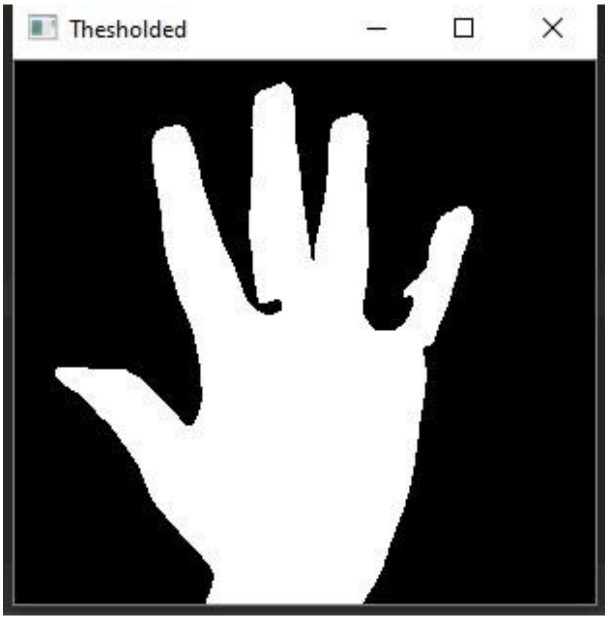

Fig. 3 Hand area segmentation process

Contour Extraction

The outline is drawn as the boundary line of the object (hand) that can be confirmed in the image. Contours have similar color values and can be important wave junctions in shape analysis and object identification processes.

Feature extraction and recognition

The convex hull group consists of spikes that cover the area of the hand. Now we need to clarify the principle of convex sets. This means that all lines between any two points on the ship are completely within it. After deciding on a gesture, certain functions are performed. The motion detection method is a dynamic process. After executing a specific command from the gesture, go back to the first step and accept another image to process, etc.

III. RESULTS AND DISCUSSION

This project recognized the number of fingers as shown in Fig.4. Our first approach to form a gesture recognition system was performed by tactics of background subtraction. Many issues and accuracy issues were faced while implementing the recognition system using background subtraction. Background subtraction cannot handle sudden and sudden changes in lighting, resulting in many inconsistencies. The gesture recognition system was robust and performed with high accuracy when used against plain backgrounds. This accuracy was maintained for a simple, consistent, monochromatic background, regardless of the background color. If the background is not clear, it turns out that the object in the background is inconsistent with the image capture method, resulting in incorrect output. Therefore, it is recommended to use this system with a clear background to provide the simplest potential results and excellent accuracy.

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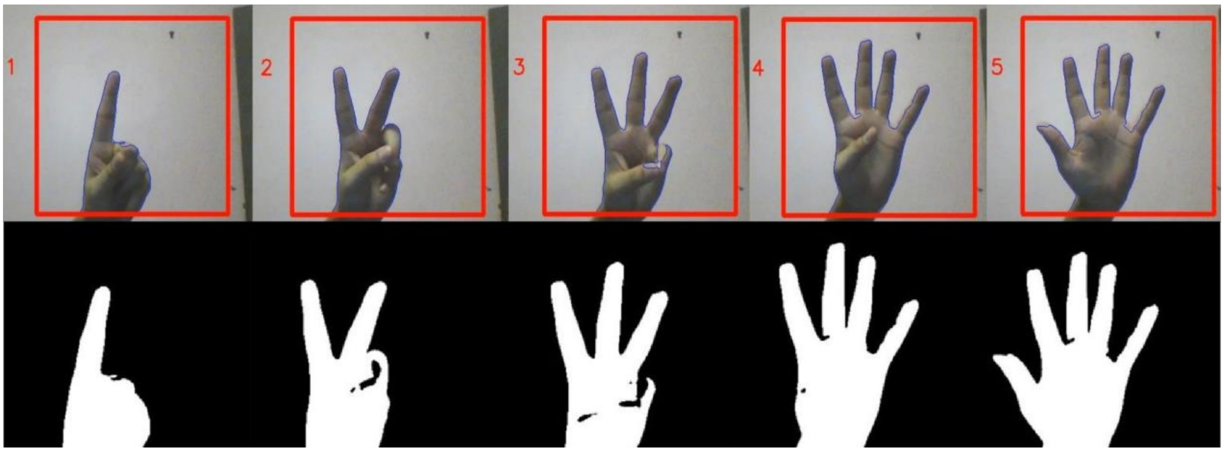

Fig.4 Five hand gestures

Table 1: Accuracy of each gesture with a plain background and non-plain background

Gesture	Accuracy with a plain background (in %)	Accuracy with non-plain background (in %)
1	95	45
2	94	48
3	96	46
4	91	40
5	92	41

IV. CONCLUSION

Due to the difficulty of removing the targeted object, such as the hand, from a framework that was producing a mess in real-time, the challenge of differentiating movement was critical in computer perception for a long hour. In reality, a person can easily identify what is in a picture while gazing at it, whereas a computer, due to its functionality of dealing with a picture as a three-dimensional matrix, will have a considerably more difficult time doing so. We'd like to increase the precision even more in the future, as well as add more gestures to perform more functions.

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