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COMPUTER CONTROL WITH HAND GESTURES USING COMPUTER VISION

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Abstract—The availability of advanced image processing and computer vision libraries such as OpenCV has opened up new avenues in the use of image processing for solving real world problems. In this paper, a colour based approach is applied to support the use of hand gestures for controlling a computer. A proof of concept is provided for a cost effective and an easy to implement approach to interact with computers by making use of a single webcam. Functions such as zooming, panning, scrolling and cursor navigation can be performed.
Keywords— Hand Gestures, Control, HCI, OpenCV,

I. INTRODUCTION

Since the advent of Computers, there has always been a major focus on making the interaction between man and machine as easy and efficient as possible. This pursuit has come a long way with a variety of input and output devices been developed over the last 30 years. Input devices like mouse, keyboard, joystick, touch screen interface, etc exist and are being used by users around the globe. There are also certain systems which make use of motion detection to achieve computer control, which is implemented through different methods, requiring different kinds of hardware. One such method makes use of ultrasonic sensors, which has limitations in controls and flexibility. More new hardware technologies were introduced such as myo armband, which supports real-time gesture recognition. Though this system is sophisticated it needs the use of a lot of hardware and the cost of application is quite high. It is seen that there are a lot of existing mechanisms for users to interact with computers. Yet they don't allow us to exploit the complete possibilities in terms of ease of access and there is a lot of scope for improvement.

Human - Computer Interaction, HCI is a field of study which focuses on the design of computer technology, particularly, the interaction between humans (the users) and computers. Hand Gestures have always been a core part of communication in our daily life. Due to the ease of control it provides, we are trying to encompass it for functions such as zooming, panning, scrolling and cursor navigation. A major advantage of using hand gestures is the minimization of use of traditional hardware while providing greater sense of comfort, control and accuracy. The implementation we suggest makes use of a single webcam to capture and track hand movement.

II. LITERATURE SURVEY

A. Hand Gesture Recognition using Ultrasonic sensor and ATMEGA128 Microcontroller

The objective of this paper is to develop a system to detect hand gesture movements. They use an ultrasonic sensor where the ultrasonic waves are transmitted by a sensor module and are reflected by a moving hand. The received wave's frequency is shifted by Doppler Effect. These frequency shifts help in detection of hand gestures. The current research has four gestures move front, move back, move left and move right. They make use of an ultrasonic module which has on board transmitter and receiver. This module is connected to the ATMEGA128 microcontroller. The analog signal received is converted into digital values by ADC (analog to digital converter) of the microcontroller.

B. Hand Gesture Recognition In Real Time Using IR Sensor

Here they use a wearable glove based system fitted with Infrared Radiation sensors to help bridge the gap in Communication. The gloves are used to help recognize the hand gestures of disabled people and convert them into meaningful messages in real time. A Continuous data stream is obtained as output from Infrared sensor. It translates the finger and hand movements into words. Gloves equipped with IR sensor recognize hand movements and then transmit this data to the intended device. This system is cost efficient and portable.

C. Hand Gesture Recognition Using Machine Learning and the Myo Armband

This paper talks about Electromyography (EMG), which is a measure of the electrical activity in the skeletal muscles of the human body. Depending on the type of sensors used, there are two types of EMG: surface and intramuscular. We use a commercial sensor called Myo armband. It comes with a developer SDK and the Myo Market to download apps. In the prototype, they've used the mouse-control app to control the mouse. The Myo menu will appear on the screen, and the user can select the Myo Mouse function and confirm by spreading the fingers. Users can manipulate the 3D objects with the standard mouse control. Python and the OpenGL were used to develop the software prototype.

D. Hand gesture Movement Tracking System for Human Computer Interaction

This paper presents a more effective and user friendly method of human computer interaction intelligently with the usage of hand gestures. In this work, the hand gesture detection and recognition is implemented in order to replace the mouse function. The project uses a camera, MATLAB Image Processing Toolbox. The detection of hand image is accomplished by extraction of skin colors from image and determines the hand center point. Hand gestures offer a convenient way to interact with the device.

E. Convolutional Neural Networks and Long Short-Term Memory for skeleton-based human activity and hand gesture recognition

In this paper, the combination of a Convolutional Neural Network (CNN) and a Long Short Term Memory (LSTM) recurrent network for handling the time series of 3D coordinates of skeleton key points is used. In proposed system, the input data at every time interval is presented to the CNN+LSTM network. The CNN is mainly responsible for the capture of relevant features from the 3D data input at each time step, while the LSTM takes into account the time evolution of 3D data series. Finally, the CNN+LSTM model generates a classification output for the presented data sequence.

III. DESIGN

A. Image Capture

For the Image Capturing process, OpenCV library is used. OpenCV (Open Source Computer Vision Library) is an open source library of programming functions mainly aimed at real-time computer vision. We obtain ROI or Region of Interest by performing framing and cropping on the camera input. The color model is changed from BGR to HSV. Different filters like Gaussian Blur and Noise Reduction Filters are then applied.

B. Background Separation

Background subtraction is used for generating a foreground mask, namely a binary image containing the pixels belonging to moving objects in the scene by making use of a static camera. The foreground mask calculation is based on the subtraction of the current frame and a background model, containing the static part of the scene or everything that can be considered as background given the characteristics of the observed scene.

C. Contours and Threshold

Contour is a curve joining all the continuous points (along the boundary), which are of the same colour or intensity. The contours is useful for shape analysis, object detection and recognition.

Thresholding is an algorithm where if a pixel value is greater than a threshold value, it is assigned one value (say white), else it is assigned another value (say black).

D. Convex Hull

The Convex Hull is the smallest convex polygon constructed containing all the points of the set. It is widely used in image processing for object tracking and shape analysis.

E. Interfacing Mouse Functions

PyAutoGUI is a Python module built for programmatically controlling the keyboard and mouse. The purpose of PyAutoGUI is to provide a cross-platform module for GUI automation for humans. The API is designed to be as simple as possible with senseful defaults. It has very easy to use functions like **position** to get cursor position, **moveTo** to move the cursor etc.

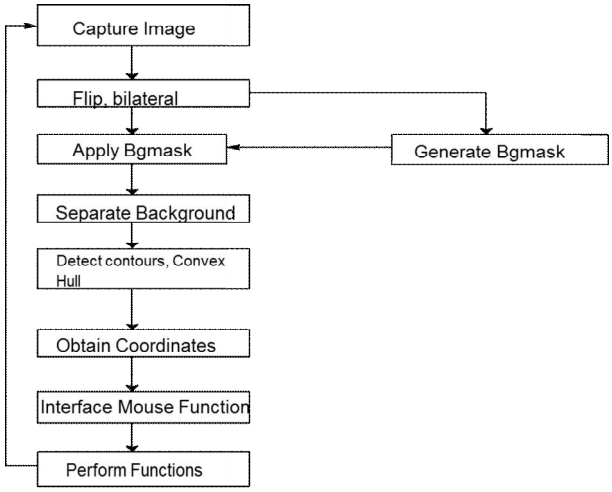

Fig. 1. System Flow diagram

IV. METHODOLOGY

After carrying out the basic tasks for pre-processing the camera input. Certain specific Algorithms are used to implement the gesture based operations like Cursor Navigation, Zooming, Panning and Scrolling.

A. Cursor Navigation

We use the inRange algorithm in OpenCV for masking in association with the contour detection to separate and isolate a particular colour from the frame. The HSV color range values for intended colour have to be specified while setting up the system. This is used to obtain the coordinates which are then translated to the screen coordinates, to be used to move the cursor across the screen. While another colour is tracked to be used to trigger the clicking function.

B. Zooming Operation

We make use of the convex hull area or the area covered by the hand to trigger the zooming operation. When the palm is open, it covers a large frame space, while lesser frame space is consumed when the palm is closed. Threshold values are set to accommodate the smooth zooming and zooming out motion.

C. Panning

To implement the panning operation, we trace part of the steps followed for cursor navigation. We track a particular colour and use them to obtain the screen coordinate values. Then we track the X coordinate values while the Y coordinate values are near constant to get a general trend value. This trend value allows the system to comprehend whether the user wants to move left or right and the same is carried out.

D. Scrolling

To implement the scrolling operations, we use an approach similar to that used for panning. The difference here is that we track the Y coordinate values while X coordinate is near constant. This trend value here allows the system to comprehend whether the user wants to scroll towards the top or bottom, and the same is carried out.

V. RESULTS

On running the application, first a background model is generated in order to separate the foreground from the background, then the colour intended is tracked and used for moving the cursor around. Zooming operations are performed by opening and closing of the fist. The Panning and Scrolling operations are carried out by moving the thumb with the coloured mark in the direction of the intended movement. The operations are performed quite accurately and smoothly. Though it is important to note that the room lighting conditions or the ambient light might drastically affect the system effectiveness. The system working depicted in the given system screenshots.

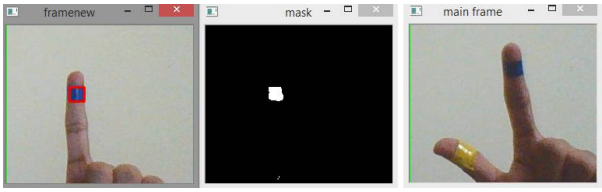

Fig. 2. Cursor Navigation

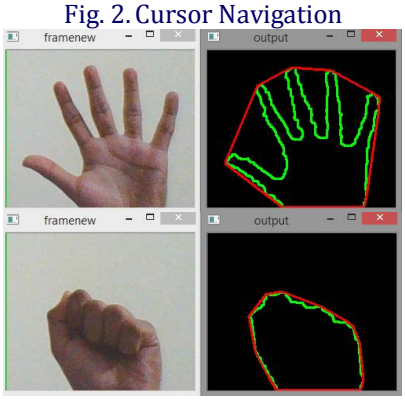

Fig. 3. Open and Closed palm for Zooming Operation

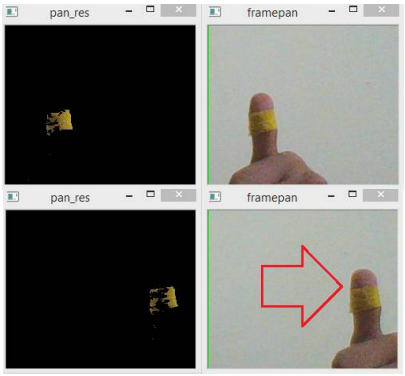

Fig. 4. Finger movement for panning towards right

VI. CONCLUSION

Human Computer Interaction has always been an interesting and intriguing field of research. Traditionally, hardware such as mouse and keyboard are used for interaction which are quite effective. But still don't allow the user to be in total sync with the system.With the growth of technology and demand of virtualization, several alternatives are being considered. The use of hand gestures is a more convenient form of interaction between computer and user. The designed model is capable of recognizing hand gestures. The model can track the hand movement and can be used to replace the mouse for carrying out functions such as zooming, panning, scrolling and cursor navigation. Thus, this system can be used as a interfacing tool in real time with wide set of applications in the field of education, computer graphics, gaming, prosthetics, robot navigation, augmented reality, surgery and biomedical instrumentation.

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