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Air Canvas- Motion to Digital Convertor

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ABSTRACT—

Object tracking is a crucial task within the discipline of computer vision. The development of faster computers, the availability of realtively low cost and high quality video cameras have increased the use of object tracking systems. Generally, video analysis procedure has three major steps: firstly, detecting of the object, secondly tracking its movement from frame to frame and lastly using the tracked coordinates to perform the required operation. Despite numerous recent advances in the field of deep learning in motion-to-digital conversion, the integration of these machine learning tools into applications for drawing and visual expression has been an underexplored field. The project takes advantage of this gap and focuses on developing a motion- to-digital converter that can potentially serve for writing from the air. The project air canvas makes a speciality of motion-to- digital converter. This project works on hand tracking system development which aims to track the finger which acts as pen to create or draw different shapes on screen. It will use computer vision algorithms to trace the path of the finger. It will be a powerful means of communication for the deaf and dumb.

***Index Terms*—Air Writing, Character Recognition, Object Detection, Real-Time Gesture Control System, Computer Vision.**

I. INTRODUCTION

Earlier painting was done using either a mouse or touch pad which was quite stressful and hectic task . Even though we have touch screen laptops , they are expensive . Hand tracking more specifically finger tracking technique is used as a tool of the computer acting as an external device similar to a keyboard and a mouse. Air Canvas is a hands-free digital drawing canvas which utilizes camera, and opencv to recognize and map the hand gestures. The user finger is considered as the brush or the pen used to draw or annotate pdf. The pen color can be changed by hovering pointer over built-in buttons. Computer vision techniques are used to draw different shapes. This system uses python language to built the code. Computer Vision built in methods are used to draw shapes on the canvas or the area provided. In the era of digital world, traditional art of writing is being replaced by digital art. Digital art refers to forms of expression and transmission of art form with digital form. Relying on modern science and technology is the distinctive characteristics of the digital manifestation. Digital art and traditional art are interrelated and interdependent. The traditional way includes pen and paper, chalk and board method of writing. The essential aim of digital art is of building hand gesture recognition system to write digitally. Digital art includes many ways of writing like by using keyboard, touch-screen surface, digital pen, stylus, using electronic hand gloves, etc. But in this system, we are using hand gesture recognition with the use of machine learning algorithm by using python programming, which creates natural interaction between man and machine. With the advancement in technology, the need of development of natural human – computer Interaction systems to replace traditional systems is increasing rapidly.

II. LITERATURE SURVEY

A. Robust Hand Recognition with Kinect Sensor

In [3], the project used the depth and colour information from the Kinect sensor to detect the hand shape. As for gesture recognition, even with the Kinect sensor. It still has a major drawback. It works well to track a large object, e.g., the human body. But following a tiny thing like a finger is complex.

B. LED fitted finger movements

In [4], the authors suggested a method in which an LED is mounted on the user's finger, and the web camera is used to track the finger. The character which is drawn by user on canvas is compared in the database. It returns the alphabet that matches the pattern drawn. It requires a redcoloured LED pointed light source is attached to the finger. Also, it is assumed that there is no red-coloured object other than the LED light within the web camera's focus.

C. Augmented Desk Interface

In [5], Augmented segmented desk interface approach for interaction was proposed. This system makes use of a video projector and charge-coupled device (CCD) camera so that us- ing the fingertip. In this system, each hand performs different tasks. The left hand is used to select radial menus, whereas the right hand is used for selecting objects to be manipulated. Determining the fingertip is expensive, so this system defines search windows for fingertips.

D. Computer Vision and Image Understanding

Ruiduo Yang, Sudeep Sarkar, "Coupled grouping and matching for sign and gesture recognition", Computer Vision and Image Understanding, Elsevier, 2008 In this paper, Yang et.al discussed an alternative solution for the problem of matching an image sequence to a model and this problem generally occurs in hand gesture recognition. Their proposed method does not rely on skin color models and can work with bad segmentation as well. They coupled both the segmentation process with recognition using intermediate grouping process. Their results show better performance with the 5

E. ACM siggraph Symposium on Computer Animation

In this paper, Wang et.al discussed the color based motion capturing system for both indoor and outdoor environments. In their proposed method they used web camera and a color shirt in order to track the object. Their proposed method result shows the proposed method can be used for virtual reality applications.

III. CHALLENGES IDENTIFIED

A. Fingertip detection

The existing system only works with your fingers, and there are no highlighters, paints, or relatives. Identifying and characterizing an object such as a finger from an RGB image without a depth sensor is a great challenge.

B. Lack of pen up and down motion

The system uses a single RGB camera to write from above. Since depth sensing is not possible, up and down pen movements cannot be followed. Therefore, the fingertip's entire trajectory is traced, and the resulting image would be absurd and not recognized by the model. The difference between hand written and air written 'G' is shown in Figure 1.

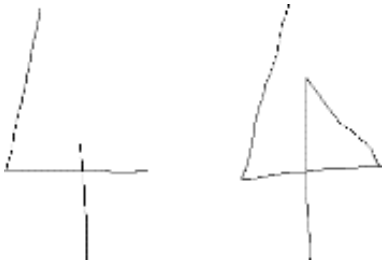

Fig. 1. Actual vs. Drawn Trajectory

C. Limitation of background color

Another constraint of our project is that we need to have a white color background because any other color which may lie in the range of the color of our cap may cause hindrance in the normal execution of our project.

PROBLEM DEFINITION

Writing in air has been one of the most fascinating and chal- lenging research areas in field of image processing and pattern recognition in the recent years. It contributes immensely to the advancement of an automation process and can improve the interface between man and machine in numerous applications. Several research works have been focusing on new techniques and methods that would reduce the processing time while providing higher recognition accuracy.

IV. SYSTEM METHODOLOGY

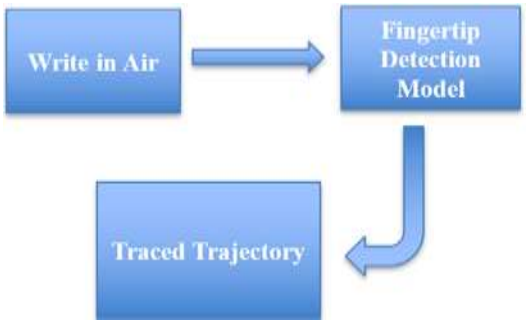

Fig. 2. System Methodology

The system mainly consists of three parts:

A. Write in air:

Writing in air is the first step where user starts the application, wears the cap on finger and starts drawing or writing in air so that the path is traced on the canvas. This can be treated as an input for our application.

B. Fingertip Detection Model:

The fingertip detection model is the most crucial part of the system architecture because it stores the coordinates of the movement of cap in a queue and then these coordinates are used for tracing the path.

C. Traced Trajectory:

Each pixel is then colored in a first in first out manner that are stored in the queue by the fingertip detection model. The stored coordinates are then colored pixel by pixel in a FIFO i.e.first in first out manner since they are stored in a queue and we get a traced trajectory of the finger.

V. ALGORITHMIC STEPS

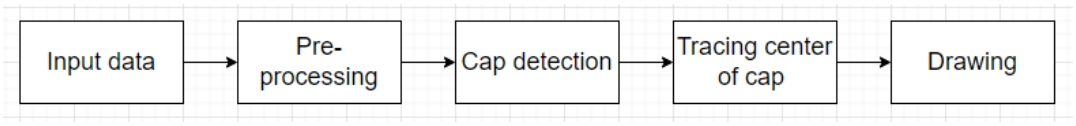

Fig. 3. Algorithmic Steps

A. Input Data:

To get a live input for the application to run, we need a live recording from the camera. The video capture function from the OpenCV library provides a straightforward interface to capture live stream with the camera. It converts video into grayscale and displays it. Once the camera is open, we need to set up an infinite while loop and use the cv2.read() function to read the frames using the video capture object. We need to use the cv2.imShow() method to show the frames.

B. Data pre-processing:

The input data received in the form of live video needs to be preprocessed for the system to use it efficiently. A number of functions are used for this purpose.

1) *numpy.ones() :* returns an array filled with ones i.e. 1.
2) *cv2.erode() :* The erode function is used to accentuate features of an image. It works by convolving a kernel(matrix of odd size) with the input data. If all pixels under a kernel is 1, only then it is considered. In this way blur parts and boundary regions are discarded from the live video. This increases the object area.
3) *cv2.dilate() :* dilate() function works exactly opposite to the erode() function. In dilate(), similarly an odd matrix which is called kernel, is convolved with the input data. Even if a single pixel under a kernel has value equal to 1, it is considered. It increases the white region in the live video or the size of the foreground object increases.

4) *cv2.morphologyEx():* Morphological gradient is differ- ent from other operations because it first applies erosion and dilation individually on the the input video and then computer the difference between the eroded and dilated image. The output will be an outline of the image. This is used to get the outline of the object which is detected i.e. the cap in this case.

C. Cap Detection

Cap detection is the most important part of the project. For detection of the cap which is worn on the finger, two arrays are created. One which contains the lower hsv i.e. hue, saturation and value color ranges of cap while the second array contains the upper bound of hsv colors for cap. We create an array which stores value 1 for any object in the camera's proximity as '255' and all other coordinated as '0'. The inRange() function is used for this purpose.

D. Tracing Center of Cap

The coordinates that are stored in the array store the center of the detected object i.e. it eventually stores the center of the cap. Hence the path that would be stored would be of the center of the cap.

E. Drawing

The coordinates that are stored in the array are used for tracing the path of move- ment of finger. All the coordinates in the array returned by the inRange() method that have value 255 need to be colored because these are the coordinates that is the path of the finger. These specific coordinates are stored in a queue and then colored in a first in first out manner.

VI. SYSTEM MODES

Writing involves a lot of functionalities. So, the number of gestures used for controlling the system is equal to these number of actions involved. The basic functionalities we included in our system are:

A. Writing mode:

In this functionality, the coordinates of our cap i.e. fingertip are traced in the order they were stored in the queue.

B. . Color mode:

This functionality provides a user interface where a user can change the color of the text.

C. Clear button:

Using the clear button, we can clear the console or the window on which we have painted.

D. End button:

This functionality is used to close the project after the work is done. In our project, pressing 'q' letter will close the project.

VII. CONCLUSION

To avoid the use of mouse and difficulty to draw using it in the existing systems , this project Air Canvas helps us a lot. We can easily draw or present our imagination just by waving our hand . This uses the easy methods or libraries like OpenCV making the project efficient than existing one. In this system we have implemented an air canvas system using hand tracking algorithms which is efficient way to track hand positions . Open CV also helps us to reduce the process of image processing to detect the positions of fingers . This can be used in different aspects like teaching, drawing etc. This helps us to reduce the use of hardware components like mouse, touch screen etc. This can also be used as base project for various system that require hand tracking. The project discussed in this paper also helps to improve creativity in people. This helps us to teach and draw easily than earlier. In future, we can also use this project as base project for many other hand tracking projects. we can also use this in sign language detection.

VIII. OUTPUTS/ SCREENSHOTS

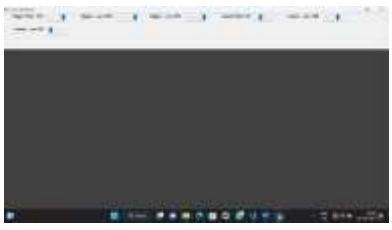

Fig. 4. Color Detectors - used to dynamically change the color of tab.

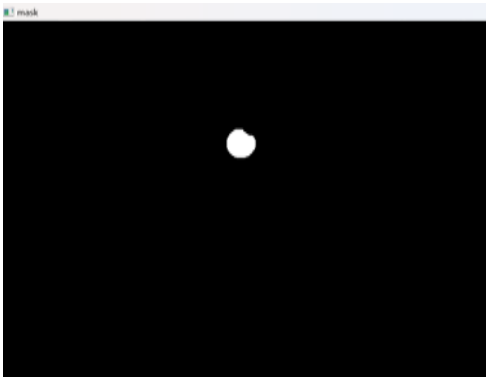

Fig. 5. Mask Window - shows the position of cap in the frame.

Fig. 6. Paint Window - interactive canvas where user can draw.

Fig. 7. Live Frame - displays the live recording from camera.

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