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Contour Drawing Robot with Canny Edge Detection

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ABSTRACT: The robot is capable of drawing the face of a person standing in front of it. It has a webcam to capture images, the main processing element in the project is a Raspberry Pi, and the image processing program running on it detects and segments the face. Once a face is segmented, it is further processed to control the 3 servo motors to draw the image on the paper. The control signals to direct the motors is sent to a dSPIC30F2010 by the Raspberry Pi (via UART), the microcontroller directly controls the servo motors as required.

KEYWORDS: Image Acquisition, Image Processing, Face Segmentation, Face Detection.

I. INTRODUCTION

One of the abilities that distinguish humans from robots is the ability to create art. Sure, robots do some cool stuff, but there's usually a practical reason, rather than an aesthetic one. Until fairly recently, humans figured that the desire and ability to create art separated us from robots too, but robotic musicians and other art-generating robots call this once-unique ability into question. Still, most of those robots are programmed to play, and it's not as though they're mechanical Beethoven, applying what they've learned about musical theory to their own skills to create unique scores. Recently, we decided to create a robot that can autonomously create artwork inspired by its own interpretation of its environment.

In this paper, it proposes efficient system to draw the real time face of a human. It uses 3 sections; initially the face acquisition is done using a web cam. Then the image is processed that is the image is divided into segments for easy processing then from the image face is detected for real time drawing of human. Then the image is converted into grey scale image, from the grey scale image the edges of the face or any image is identified then the images are converted into contours. Then we will find out the space coordinates and the corresponding signals are sent to microcontroller. The microcontroller will generate the corresponding PWM signal and it is given to the servo motor for the robotic arm movement and pen movement.

II. SYSTEM MODEL AND COMPONENTS

Our proposed system is a mixture of electronics engineering, computer engineering and mechanical engineering. The entire system consist of a Raspberry Pi which is a credit card sized minicomputer, a PIC microcontroller DSPIC16F2010, a camera for image capturing, then the robotic arm mechanism which consist of 3 servo motors and arm like structure. The Raspberry Pi is used for the image processing and contour detection. The PIC microcontroller is used for the controlling of servo motors.

The electronics section consist of regulators and connectors, as the system consist of Raspberry Pi, servo motors and PIC microcontroller it needs power for working but the three systems needs three variant of power supply. To provide three different voltage supply voltage regulators are installed. The connectors from Raspberry Pi is a UART module because inside a Raspberry Pi the communication is parallel and PIC microcontroller the communication is serial so to convert the parallel communication to serial communication UART module is used.

The computer section includes the programming section of PIC microcontroller and Raspberry Pi. The programming of Raspberry Pi and PIC microcontroller is done in C language.

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The mechanical section consists of servo motors and human hand like structure the controlling of the motor is done by PIC microcontroller. The servo motor controls the robotic arm like a human hand. The three servo motor helps to move the hand like structure like a human hand. The PIC microcontroller gives the output as a PWM signal and the servo motor moves as per the signal from PIC microcontroller.

III. IMAGE PROCESSING

A. Image Acquisition

Image acquisition [4] in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. The image that is acquired is completely unprocessed and is the result of whatever hardware was used to generate it, which can be very important in some fields to have a consistent baseline from which to work. One of the ultimate goals of this process is to have a source of input that operates within such controlled and measured guidelines that the same image can, if necessary, be nearly perfectly reproduced under the same conditions so anomalous factors are easier to locate and eliminate.

One of the forms of image acquisition in image processing is known as real-time image acquisition. This usually involves retrieving images from a camera. Real-time image acquisition creates a stream of files that can be automatically processed, queued for later work, or stitched into a single media format. One common technology that is used with real-time image processing is known as background image acquisition, which describes both software and hardware that can quickly preserve the images flooding into a system.

B. Grey Scaling

In photography grey scaling means to determine the different colour the variant of grey colours are used. Here the result of image acquisition is a RGB image for edge detection the system needs a grey scale image so the RGB image is converted into a grey scale image. In our proposed system we convert with the help of C++ programming. The code to convert the system is given by:

```
Mat image = imread("lena.jpg");
Mat gray;
cvtColor(image,gray,CV_BGR2GRAY);
```

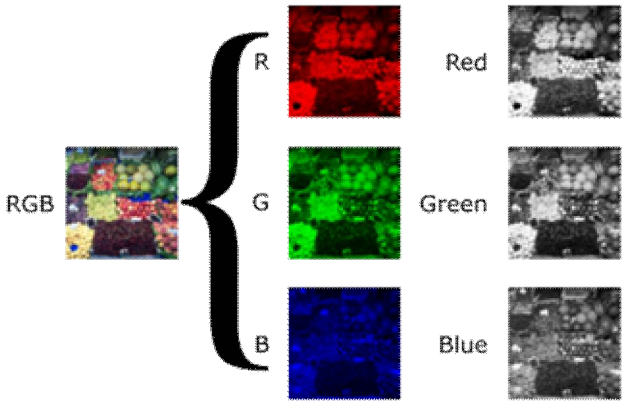

Fig. 1: Composition of RGB from 3 grey scale images

C. Face Detection

After grey scaling the image the faces in the image is detected using the classifiers. The main classifier we used here is cascade classifier. Object Detection using Haar [1] feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection uses a Boosted Cascade of Simple Features" in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. The code used to detect face is given by

```
      faces = face_cascade.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
      cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
```

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```
roi_gray = gray[y:y+h, x:x+w]
roi_color = img[y:y+h, x:x+w]
eyes = eye_cascade.detectMultiScale(roi_gray)
for (ex,ey,ew,eh) in eyes:
cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)
      cv2.imshow('img',img)
      cv2.waitKey(0)
      cv2.destroyAllWindows()
```

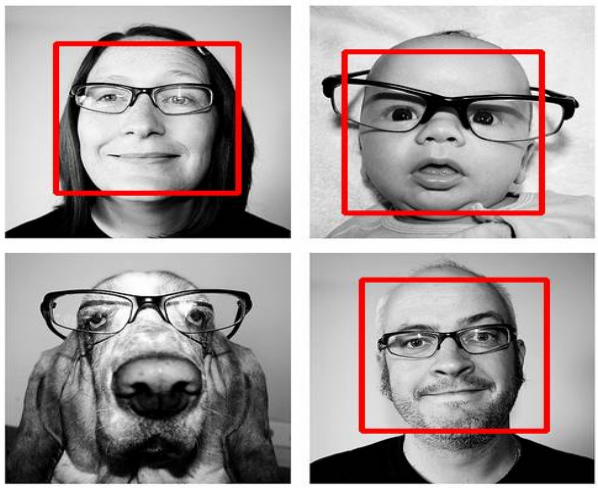

Fig. 2: Face detection

D. Image Segmentation

For the easy processing of the image the segmentation [5] is done. This is typically used to identify objects or other relevant information in digital images

E. Edge Detection

The sharp change in the values of neighbouring two pixels is called as an edge of an image. These edges will be drawn by the system. The algorithm used for the edge detection is canny edge [2] detection. The Process of Canny edge detection algorithm can be broken down to 5 different steps:

1. Apply Gaussian filter to smooth the image in order to remove the noise
2. Find the intensity gradients of the image
3. Apply non-maximum suppression to get rid of spurious response to edge detection
4. Apply double threshold to determine potential edges
5. Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

Fig. 3: Canny edge detection

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F. Contour Detection

Mainly contours [3] are the defined as an outline representing or bounding the shape. Contours are often obtained from edges, but they are aimed at being object contours. Thus, they need to be closed curves. You can think of them as boundaries (some Image Processing algorithms & libraries call them like that). When they are obtained from edges, you need to connect the edges in order to obtain a closed contour.

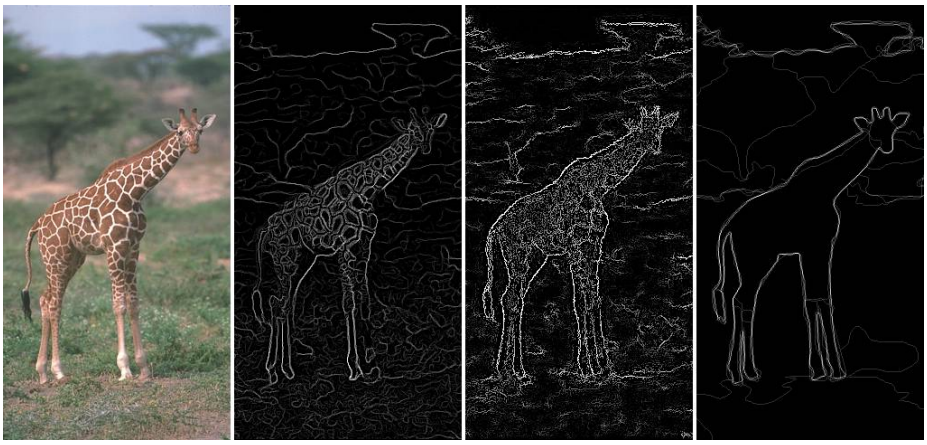

Fig. 4: Contour detection in step by step process

IV. ROBOTIC HAND

Physically the system is a robotic hand moving like a human hand in horizontal direction. The movement of the hand is accessed by three servo motors. The servo motors are used because the servo motors use the absolute positioning. In absolute positioning system the hands will be in the same position as per the PPM signal.

A. Positioning

The main difficulty face in this proposed system is to find out the position of each contour and the corresponding position of the hand. So for each pixel values the hand has to be a fixed angel of rotation by the two servo motors. To find the angle of rotation by two servo motors we have to consider it as a triangle and from the two triangles and its sides we can find out two angles of rotation. The each angle has the corresponding PPM signal. According to each PPM signal given to each servos the servos will attain certain rotation according to that change the structure will move like a hand.

V. RESULT AND DISCUSSION

A drawing robot that draws portraits like a human artist is presented in this paper. This application concerns entertainment. The “drawing robot” draws every day the portraits of the visitors by using a camera and a pen attached to end-effector. It has been developed first in the context of collaboration with the Future scope Park. A second version of the “drawing robot” was designed for being used in international shows or exhibitions. Because of the “human like” behaviour, the artist robot meets a real success with the public and its ability to reproduce a human portrait by using in the same time robot motion control and image processing provides realistic result for the portrait rendering. Based on the specifications, the whole application is detailed. The robot and its environment are described; and software engineering and image processing are discussed. Finally results illustrate the efficiency and the success of the Drawing Robot.

VI. CONCLUSION

Thus the project is all about a drawing robot, the sole purpose of which has an entertainment basis. The precision of the drawing is mainly due to the use of Raspberry Pi and servo motors. It finds use at international shows and exhibitions.

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