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Controlling Mechanized Division Using Gesture Recognition

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Abstract - **In this paper, we present a new method to interact with the robotic hand by using a human hand gesture mirroring technique. This method uses a camera to get the input from the user and the robotic hand uses a microcontroller and servo motors. Such interface not only enables users to manipulate a remote robot by demonstration, but also ensures user-friendly interaction and software reusability in developing a networked robot system. The gesture-based remote human-robot interaction is uses any conventional monocular 2D camera. Experiments show an accuracy that outperforms a conventional light fall-off baseline, and is comparable to high-quality consumer cameras, but with a dramatically reduced cost, power consumption, and form-factor.**

Keywords: Augmented reality, Gesture Control, Mechanized Division, Human Robot Interaction.

I. INTRODUCTION

In order to reduce the burden of learning how to operate particular devices, control over our home appliances, playing a video game with our bare hands, entertainment, gesture and voice recognition are considered as promising alternative approaches to surmount such difficulties and the human-device interaction will be similar to human-human interaction which is done through the human organs like hand gesturing, head movement, face expressions, voice communication and overall body pose. Hand gesture systems have been classified roughly into two major categories, which is vision based and glove based systems, each one can be used to build 2D or 3D model, a 3D estimation out of 2D cluttered image is done in they consider this problem as indexing problem and a large database is used for this purpose to find the corresponding 3D matching of 2D presented gesture. A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm. Servo motor is used for joint rotation. It has about same number of degree of freedom as in human arm. Humans pick things up without thinking about the steps involved. In order for a robot or a robotic arm to pick up or move something, someone has to tell it to perform several actions in a particular order from moving the arm, to rotating the “wrist” to opening and closing the “hand” or “fingers”. So, we can control each joint through computer interface.

II. RELATED WORK

Human gesture recognition has many challenges, illumination, rotation, translation, and scaling challenges, illumination challenges can be cured by using of normalized RGB as well as converting the RGB color model to other models that have brightness parameter which can be ignored to get rid of this illumination problem such as HSV, YCbCr, HSL and YIQ. Translation and scaling affections are dependent on correct segmentation/clustering of the hand object and can be cured by trimming and fixing the image to a standard scale respectively, rotation affection is considered of the major problem and need a special consideration, many systems have been built by employing a large number of samples per posture for overcome of rotation problem; 7*40 total number of gestures are used as training patterns in, tenfold of training patters are used in, and hundreds of images is used in, thousands of training gestures have been employed in, this increasing number of training patterns can be reduced by unifying the direction of the hand posture as suggested by us in. The latter challenge can be classified as posture challenges, other kind of challenge is the system challenge which is the speed of the system, the reaction should be with acceptable time for the reaction commenced and so, the system can be classified as real time system in this case. We have applied a novel approach for hand fingers detection and tracking using dynamic circle templates and then we have extracted the fingers of the hand and the palm as well, our system achieved 82 milliseconds for detecting the hand fingers from the segmented hand object.

A. Key Terms

The various major and often repeating terms in this paper are:

- Center Of Palm(COP)
- Human-robot Interaction
- Hand Gesture Recognition
- Finger and Palm Detectionn

Now a day’s Robotic Systems are occupying a place in various industries such Automobile, Textile, Product Assembling, etc. This will be very helpful to do the work faster and in precise manner with fewer efforts. Taking these features of Robots into account, we can also use such systems in an environments that are most dangerous and worst to human being, such as Nuclear Plants or Research Labs, Bomb Diffusion, Poisonous Chemical/Gas plants, Mining, etc. This can save human lives and reduce labor problems. For handling, such kind of situations there should be proper interaction between human and the robotic system as robots cannot take decisions on their own. Solution to this can be achieved by controlling the robots according instructions provided by human, in real time, to the robots. In most of the areas, robots are controlled using manual switches or directly programming the robots to do the specific tasks repeatedly. The main objective of our project is to design and develop the Robotic Arm that is used to move using wireless system by recognizing human's actual hand motion that makes the maximum use of robot to help people do their work in an efficient way in their day to day life.

In this paper it is proposed that the Robotic arm movements can be controlled by the gestures of human arm. The gestures of the human arm are captured from a modified web camera. The robotic arm will follow a pattern from the captured gesture to make it move according to the human arm. The communication between human arm and robot arm will be connected by a serial port. It works in different ambient light conditions and the cost needed to capture the gesture is low.

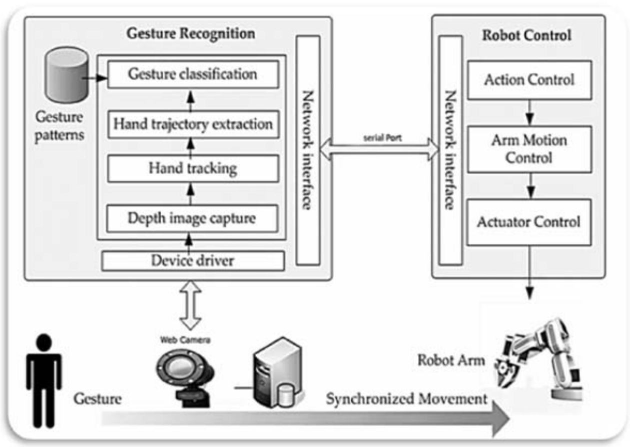

Fig.1.a Architecture Diagram

III. IMPLEMENTATION TECHNIQUES

The work can be implemented by,

- Capturing the gesture
- Move the robotic arm according to the recognized gesture

A. Capturing Gesture

Human hand will be used for gesture, The gestures will be made in front of the web camera, The camera will find the trajectory from the human hand and The hand gestures will find the finger and label it using the COP and labeling algorithm.

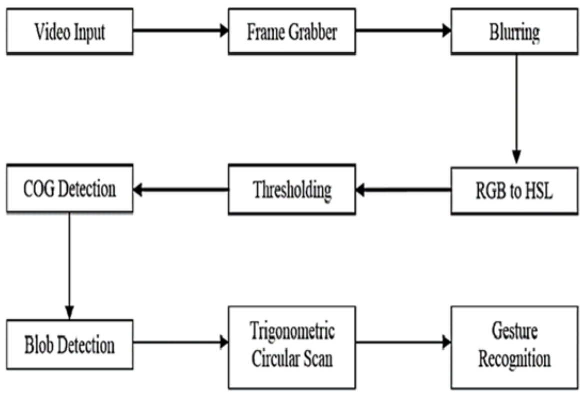

Fig. 3.a.Gesture Processing Technique

B. Video Input

Input from Web Camera to desired machine is obtained for further processing of Gesture. As it involves not only static but also dynamic approach we want video input.

C. Frame Grabbing

In Frame Grabbing individual digital frames are captured from a digital video stream. The Required frame from video is obtained for further processing of gesture. The Grabbing should be accurate because it can affect further processing.

D. Gaussian Blur

Blurring is nothing but to spread pixels from source image and mix it with surrounding pixels which is also called as Smoothing. Gaussian Blur is an image blurring filter technique which uses Gaussian function for mapping original image to blurred image. In graphics software it widely used effect minimize image noise.

Gaussian function equation in one dimension is

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

In two dimensions, Gaussian Function equation is the product of two such Gaussians, one in each dimension:

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

E. RGB to HSL Conversion

As we know RGB is basic color model where R is for Red, G is for Green, B is for Blue and HSL stands from Hue Saturation Lightness. From these basic colors we can from n number of colors. Due to varying light intensity the actual image and image captured may differ so it is a need to convert RGB color space to HSV or HSL color space. Conversion of RGB to HSL or vice versa is easy to perform due to following simple equations,

Let us define some values as,
M = max(R, G, B)
m = min(R, G, B)
C = M – m

1) Hue:

$$H' = \begin{cases} \text{undefined}, & \text{if } C=0 \\ \frac{G-B}{C} \bmod 6, & \text{if } M=R \\ \frac{B-R}{C} + 2, & \text{if } M=G \\ \frac{R-G}{C} + 4, & \text{if } M=R \end{cases}$$

H = 60° × H′

2) Lightness:

$$L = \frac{1}{2}(M + m)$$

3) Saturation:

$$S = \begin{cases} 0, & if\ C = 0 \\ \frac{C}{1 - |2L - 1|}, & \text{otherwise} \end{cases}$$

F. Thresholding:

Thresholding is simplest method used for image segmentation. In Thresholding grayscale image, are used to create binary images.

G. COG Detection:

COG is nothing but Center of Gravity. For every image we have find out where COG of image lies. The COG is calculated by:

COG_X = COG_X + (I*x)
COG_Y = COG_Y + (I*y)
Total = Total + I   Where I = (R+G+B)/3 and x, y is the current pixel location for each pixel.
COG_X = COG_X/Total
COG_Y = COG_Y/Total

H. Blob Detection

Blob Detection refers to a field in area of computer vision, which is aimed to detect points or regions in the images that differ from properties such as brightness or color in comparison with the surrounding. With the more recent terminology used Blob Detection they can also know as interest point Detection. Main Reason to use Blob Detector is it provides clear information about regions, which is not obtained clearly from edge detectors or corner detectors.

I. Trigonometric Circular Scan Algorithm

Trigonometric Circular Scan is algorithm for Gesture Recognition in which a circle is formed that intersects all fingers and the wrist [10]. Algorithm works as follows,

1) Find Center of Gravity Use above COG Detection formulas for Calculating COG.
2) Calculate farthest distance from COG farthest distance is extreme point in a hand from center.
3) Construct Circle with center COG. For Constructing circle use radius as, R = 0.7 × Farthest distance.

J. Gesture Recognition

After using Trigonometric Circular Scan Algorithm use vector Calculation to count number of fingers the circle is intersecting to hand.

IV. MOVE THE ROBOTIC ARM ACCORDING TO THE RECOGNIZED GESTURE

A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm. Servo motor is used for joint rotation. It has about same number of degree of freedom as in human arm. Humans pick things up without thinking about the steps involved. In order for a robot or a robotic arm to pick up or move something, someone has to tell it to perform several actions in a particular order — from moving the arm, to rotating the “wrist” to opening and closing the “hand” or “fingers”. So, this can control each joint through computer interface. The arm has five servos which are controlled through the use of only one Arduino mega 2560 board**.** Enabling the base rotation without the help of any gears or ball bearing, also using only low torque servo motors and three castor wheels for rotating the whole body.

A. Servo Motors

Servo refers to an error sensing feedback control which is used to correct the performance of a system. Servo or RC Servo Motor sare DC motors equipped with a servo mechanism for precise control of angular position. The RC servo motors usually have a rotation limit from 90° to 180°. But servos do not rotate continually. Their rotation is restricted in between the fixed angles.

B. Servo Motor wiring and plugs

The Servo Motors come with three wires or leads. Two of these wires are to provide ground and positive supply to the servo DC motor. The third wire is for the control signal. These wires of a servo motor are colour coded. The red wire is the DC supply lead and must be connected to a DC voltage supply in the range of 4.8 V to 6V. The black wire is to provide ground. The colour for the third wire (to provide control signal) varies for different manufacturers. It can be yellow (in case of Hitec), white (in case of Futaba), brown etc.

Futaba provides a J-type plug with an extra flange for proper connection of the servo. Hitec has an S-type connector. A Futaba connector can be used with a Hitec servo by clipping of the extra flange. Also a Hitec connector can be used with a Futaba servo just by filing off the extra width so that it fits in well.

Hitec splines have 24 teeth while Futaba splines are of 25 teeth. Therefore splines made for one servo type cannot be used with another. Spline is the place where a servo arm is connected. It is analogous to the shaft of a common DC motor.

Unlike DC motors, reversing the ground and positive supply connections does not change the direction (of rotation) of a servo. This may, in fact, damage the servo motor. That is why it is important to properly account for the order of wires in a servo motor.

C. Servo Control

A servo motor mainly consists of a DC motor, gear system, a position sensor which is mostly a potentiometer, and control electronics. The DC motor is connected with a gear mechanism which provides feedback to a position sensor which is mostly a potentiometer. From the gear box, the output of the motor is delivered via servo spline to the servo arm. The potentiometer changes position corresponding to the current position of the motor. So the change in resistance produces an equivalent change in voltage from the potentiometer. A pulse width modulated signal is fed through the control wire. The pulse width is converted into an equivalent voltage that is compared with that of signal from the potentiometer in an error amplifier.

The servo motor can be moved to a desired angular position by sending PWM (pulse width modulated) signals on the control wire. The servo understands the language of pulse position modulation. A pulse of width varying from 1 millisecond to 2 milliseconds in a repeated time frame is sent to the servo for around 50 times in a second. The width of the pulse determines the angular position.

For example, a pulse of 1 millisecond moves the servo towards 0°, while a 2 milliseconds wide pulse would take it to 180°. The pulse width for in between angular positions can be interpolated accordingly. Thus a pulse of width 1.5 milliseconds will shift the servo to 90°. It must be noted that these values are only the approximations. The actual behavior of the servos differs based on their manufacturer. A sequence of such pulses (50 in one second) is required to be passed to the servo to sustain a particular angular position. When the servo receives a pulse, it can retain the corresponding angular position for next 20 milliseconds. So a pulse in every 20 millisecond time frame must be fed to the servo.

V. Conclusion And Future Enhancement

In this work a mirroring approach is applied for fingers/palm detecting, we have obtained the fingertip location, finger base location, finger center, and palm location using dynamic cop with non-overlapping matching for reducing the system processing time, with noise removal, the hand fingertips are located with their bases coordinates and the palm is located as well, we have traced the fingers and labeled them from left to right using our novel algorithm form finding the two neighborhood fingers, the first neighborhood finger is caught by minimum distance from each finger, while the other one is caught by finding the minimum distance in the opposite direction since the neighborhood fingers cannot be at the same direction. Our system is designed to deliver the mirror of hand gesture in wired. But the main idea is to deliver it in wireless.

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