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Hand Gesture Robot Control Using Color Recognition System

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ABSTRACT: Recently, the interaction between humans and robots has become an important issue for extending the use of robots. The purpose of this project is to show how a real-time human-robot interaction with hand gesture recognition which can be constructed using color recognition System. Hence, it is required that the following two major questions be resolved in this study. Firstly, either staying in indoor or outdoor lighting conditions, the robot must be able to detect *and spot hand gestures with a specific color from data of robot vision system*. Secondly, it is necessary that the robot also can interpret hand gestures performed by *humans*.

KEYWORDS: Digital Image Processing, hand gesture control, open cv, color recognition.

1 INTRODUCTION

In today's world generally robots are controlled using remote controls or joysticks. But if the remote gets damaged or if it doesn't work then there is no medium to give commands to the robots. So we have come up with a project which would control the robots on the basis of commands given through hand gestures.

In this article a camera is placed in front of the controller of the robot. The controller of the robot will make gestures which will be captured by the camera placed in front of the controller. Then the gestures will be recognized using image processing algorithms to convert them into appropriate commands for the robot. The commands will be then given to the robot and accordingly the robot will execute.

Thus by using our project the limitation of using a remote or a joystick will overcome which will improve the efficiency of the robot as the distance at which a joystick or remotecommunicates is limited. By using our project the distance at which we can communicate can be improved at a range of 5– 6 Km.

A. Existing System

Robot Control using remote Control or Joystick

In today's world generally robots are controlled usin remote controls or joysticks. Although remote control system is very much popula , it has some limitations.

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Fig1. Robot Control through Robot

Limitation of remote control system :

If the remote gets damaged or if it doesn't work then there is no medium to give commands to the robots.

Also Remote control robots are a bit more complex to control than some other devices. There are more moving parts on these devices in most cases, as well as more actions for them to perform

B. Proposed Hand Gesture Robot Control System

To overcome the limitations of existing system, we have come up with a project which would control the robots on the basis of commands given through hand gestures.

In this proposed system, a camera is placed in front of the controller of the robot. The controller of the robot will make gestures which will be captured by the camera placed in front of the controller. Then the gestures will be recognized using image processing algorithms to convert them into appropriate commands for the robot. The commands will be then given to the robot and accordingly the robot will execute.

Thus by using this technique the limitation of using a remote or a joystick will overcome which will improve the efficiency of the robot as the distance at which a joystick or remote communicates is limited. By using this technique the distance at which we can communicate can be improved at a range of 5 – 6 Km.

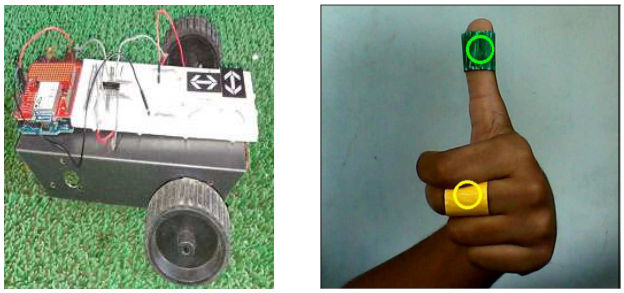

Fig 2. Robot Control through Hand Gesture

Requirements for this system:

Software requirement: - .net framework, Open CV SDK

Hardware requirement:- Robot, webcam, 1 Gb RAM, Pentium4 processor with parallel port

Advantage: - Easy to use, Friendly interaction. No need forremotes so cost effective

Disadvantage: - High processing power required for imageprocessing.

Flow for the software development:-

Training module

1) Initialize camera
2) Capture frame
3) RGB to Grey conversion
4) Grey to Binary conversion
5) Train colors to system

2 TECHNOLOGIES USED

In this project, we propose a gestures recognition method to recognize a number of well-defined hand gestures representing a limited set of commands that the humans can give to the mobile robot Firstly, by analyzing the distribution of the specific color in hue saturation intensity (HSV) colorSpace, a color multithresholding method was developed for detecting hand gestures in video sequence under varying lighting conditions. Secondly, the feature extraction of hand gestures was performed by the detection algorithm and by applying threshold value. Thirdly we can obtain the particular signal for robot movement subtracting the coordinates of the two colors. Finally, a real-time vision system on hand gesture recognition for a human-robot interaction is presented. The frames captured by the camera are in HSV format. We convert it to grayscale image. Then applying threshold value for one color the gray image is converted to binary image. In binary image the threshold color turns white & the background becomes black. Now using moments we can find the co-ordinates of this blob. Same thing has to be done for the other color. Now we have the co-ordinates of the two colors. On subtraction of x & y co-ordinates we get the direction of the vector. Thus then we give command to the robot in this way.

Flow chart for recognizing gesture & give commands to the robot Algorithm for the program which converts the gestures to commands for the robot is as follows:

1) Capture a frame from camera. It's in BGR format.

2) Convert this BGR image to HSV OR RGB. (HSV is preferred since it is more noise free than RGB).

3) Convert this image to binary image by applying lower range & upper range of desired color

(i.e. to make desired color white & rest black).

Flo Flow chart for recognizing gesture & give commands to the robot

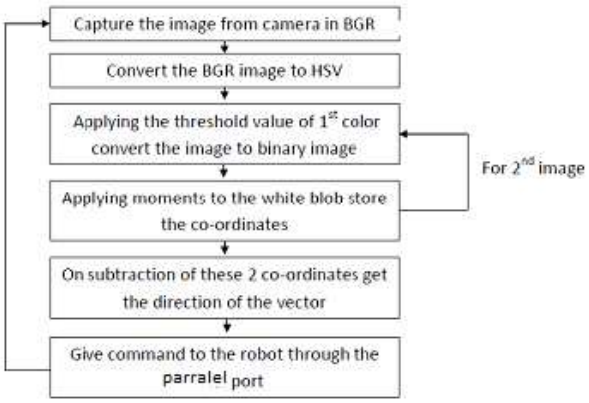

Fig 3: Flow chart for recognizing gesture

4) Find out the moment of each color on thumb and nuckel.
5) From the moments find out the coordinates of the each color viz X coordinate and Y coordinate
6) Subtract the coordinates to find out the direction of the movement of the robot.

BGR TO HSV CONVERSION

This module consists of two phases namely the image acquisition and image processing phases. The acquired images using a web cam for each hand gesture are in BGR format. We will convert it to HSV or RGB image. We prefer HSV since it is more noise free than RGB. The image is thensubjected to an image enhancement process to adjust the intensity values in HSV image to increasethe contrast of the output image. Figure 2 shows an acquired image of a sample hand gesture afterenhancement where the captured green portion is marked by a green circle & yellow portion byyellow circle. This gesture represents a vector in forward direction.

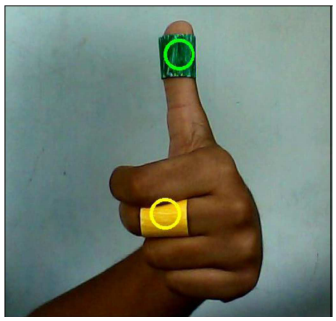

Fig 4 original hsv image

HSV TO BINARY CONVERSION (Thresholding)

Since we deal with the segmentation of color on thumb and nuckel color, a threshold value of the particular color level is chosen to convert the image to binary. The threshold value for the two colors must be different. This threshold value should be chosen carefully to avoid effect noise or any other color detection in the territory. We can convert this image to binary image by applying lower range & upper range of desired color (i.e. to make desired color white & rest black).

We are going to use software opencv because opencv has a function to convert the HSV OR RGB image (step 2) into binary image directly. i.e. no need to convert image to grayscale & then to binary. The removal of these extra results in reduction in time complexity & space complexity.

FILTERING THE BINARY IMAGE

The binary image obtained as shown in fig.4 can be filtered with help of median smoothing algorithm. This filtering is required to remove the noise if any introduce by thresholding the grayscale image. Median smoothing algorithm is the simple algorithm used for removal of the noise from the signal or an image.

FINDING THE COORDINATES

Once we obtain the binary image from thresholding the colors we get two white blobs of two colors as shown in figure. By applying logic in physics we can find out the moment of the white blob. An Image moment is a number calculated using a certain formula. With help of the moment of the blob we can find out the co- ordinates of the color on the thumb with equation 1 and 2

$$\text{X coordinate} = \frac{\text{Moment of X (1)}}{\text{Total area of the white bolb}} \qquad (1)$$

$$\text{Y coordinate} = \frac{\text{Moment of Y (2)}}{\text{Total area of the white bolb}} \qquad (2)$$

COORDINATE SUBTRACTION

Find out which movement should be there (X, Y), we will need to subtract the coordinates of the two colors.

X= X1- X2, Y= Y1-Y2

After subtracting the coordinates for two colors we are able to find direction of movement of the robot. According to the decisions made in the program the robot will move. Same procedure is followed for all the robot movements.

Once we obtain the coordinates (X1, Y1) for the color on thumb, we are able to find out the coordinates of the other color on the nuckel(X2, Y2). Fig5 shows the coordinates obtained for the green color and yellow colored ring in the fig 2 for forward direction.

3 HARDWARE ARCHITECTURE

The hardware architecture of this project is consist of two basic parts namely Transmitter unit, Receiver unit. The block diagram of these parts is as shown in figure 5 and figure 6 respectively. On the transmitter side it is consist of PC with gesture recognition software connected to web camera which in turn connected to RF transceiver through parallel port whereas the receiver unit is consist of blocks like RF transceiver module, L293 motor driver along with DC geared motor ,5V regulated power supply.

RF TRANSMITTOR

The RF transmitter used in our project is TWS-434A. This RF transmitter transmits data in the frequency range of 433.92 MHz with a range of approximately 400 foot (open area) outdoors. Indoors, the range is approximately 200 foot, and will go through most walls. TWS-434A has features TWS-434A has features which includes small in size, low power consumption i.e. 8mW and operate from 1.5 to 12 Volts DC, excellent for applications requiring short-range RF signal. Data to be send is Amplitude modulation with the carrier RF signal.

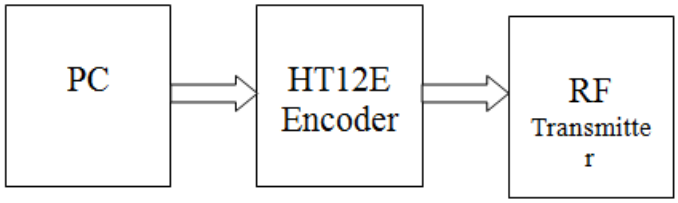

Fig 5 : Block Diagram of Transmitter Side

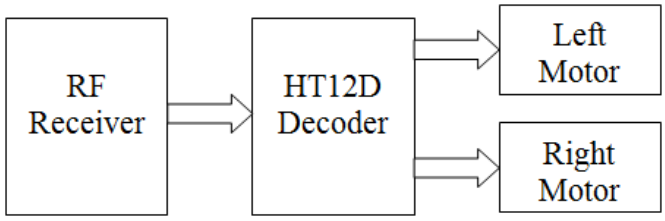

Fig 6: Block Diagram of Receiver Side

RF RECEIVER

The RF receiver receives an RF signal, converts the RF signal to an IF signal, and then converts the IF signal to a base band signal, which it then provides to the base band processor.

The RF receiver used is RWS-434. This RF receiver receives RF signal which is in the frequency of 434.92 MHz and has a sensitivity of 3uV. The RWS-434 receiver operates from 4.5 to 5.5 volts-DC, and has both linear and digital outputs and its tunable to match the frequency of the transmitter unit.

ENCODER

An encoder can be a device used to change a signal (such as a bit stream) or data into a code. Encoder used here is HT 12E. The HT12E encoder is a CMOS IC It is capable of encoding 8 bits of address (A0-A7) and 4-bits of data (AD8-AD11) information. Each address/data input can be set to one of the two logic states, 0 or 1. Grounding the pins is taken as a 0 while a high can be given by giving +5V or leaving the pins open (no connection). Upon reception of transmit enable (TE-active low), the programmed address/data are transmitted together with the header bits via an RF medium.

DECODER

A decoder is a device which does the reverse of an encoder, undoing the encoding so that the original information can be retrieved.. The decoder used here is HT 12D. The HT12D is a decoder IC made especially to pair with the HT 12E encoder. It is a CMOS IC. The decoder is capable of decoding 8 bits of address (A0 - A7) and 4 bits of data (AD8 - AD11) information. For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen. The decoders receive serial addresses and data from programmed encoders that are transmitted by a carrier using an RF or an IR transmission medium. They compare the serial input data three times continuously with their local addresses. If no error or

unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission. The decoders are capable of decoding information that consists of N bits of address and 12_N bits of data. Of this series, the HT 12D is arranged to provide 8 address bits and 4 data bits.

MOTOR DRIVER L293

The L293 is an integrated circuit motor driver that can be used for simultaneous, bidirectional control of two small motors. The L293 is limited to 600 mA, but in reality can only handle much small currents unless you have done some serious heat sinking to keep the case temperature down. Unsure about whether the L293 will work with your motor? Hook up the circuit and run your motor while keeping your finger on the chip. If it gets too hot to touch, you can't use it with your motor. The L293 comes in a standard 16-pin, dual-in line integrated circuit package.

DC GEARED MOTOR

Carbon brush of DC motor for the main role to play for, for referring to the rotating armature winding components from one slip to another slip, the brush in the process of short-circuit current generated by components within Change of direction. For the poor performance at run-time is the electrical spark happened. Level and sparks more than a certain limit will cause the carbon brush and commutator surface damage, with the result that should not continue to run the motor. When the motor for the situation well, sparks larger, an increase of the electrical brush wear. Especially when the commutator surface oxide film is damaged, the wear will be increased significantly.

4 CONCLUSION

The Hand Gesture Controlled Robot System gives an alternative way of controlling robots. Hand Gesture control being a more natural way of controlling devices makes control of robots more efficient and easy. This project presented a gesture controlled wireless robot that does not require any special markers or gloves and can operate in real-time on a commodity PC with low-cost camera. Specifically, the system can track the coordinates of each color on the thumb and nuckel for each hand, assuming that a calibrated camera is viewing the hands from above with the palms facing downward. The algorithm for gesture recognition is implemented in opencv and .net. This project presents a fast, robust and accurate method for hand gestures recognition under unconstrained scenes. The failure of the system to recognize the gesture is mainly due to the very changeable lighting conditions and moving objects (persons) entering the scene, operator's failure to move the hand to the proper posture. It must be emphasize that after a short experience operators get used to the system. Future work will be focused on algorithm improvement, by using a combination of segmentation techniques and robot motion control by tracking the arm movement and its speed.

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