Scientific Journal Impact Factor (SJIF): 1.711
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745 ISSN (PRINT) : 2393 - 8161

ROBOT NAVIGATION CONTROL USING HAND GESTURES

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Abstract-With the ever-increasing diffusion of computers into the society, the present popular mode of interactions with computers (mouse and keyboard) will become a bottleneck in the effective utilization of information flow between the computers and the human. The use of hand gestures provides an attractive alternative to cumbersome interface for human-computer interaction (HCI). The hand can be used to communicate, with much more information by itself compared to computer mouse, joysticks, etc. allowing a greater number of possibilities for computer interaction. Developing new techniques for human-computer interaction is very challenging, in order to use hands for interaction, it is necessary to be able to recognize them in images. In this project, a robust hand gesture recognition system is designed and presented for recognizing hand gestures based on Zernike moments (ZMs) for feature extraction & Artificial Neural Network (ANN) for training & classification of gestures. The proposed system is able to recognize the gesture irrespective of the angles in which the hand gesture image is captured, which makes the system more flexible with uniform background and we have implemented a system through which the user can give commands to a wireless robot using gestures. Through this method, the user can control or navigate the robot by using gestures of his/her palm, thereby interacting with the robotic system. The command signals are generated from these gestures using image processing. These signals are then passed to the robot to navigate it in the specified directions.

***Keywords**:* Hand Gesture Recognition, Human Computer Interaction, Artificial Neural Network, Zernike Moment

I. INTRODUCTION

The way humans interact with computers is constantly evolving, with the general purpose i.e., being to increase the efficiency and effectiveness by which interactive tasks are completed. The purpose of this review is to introduce the field of gesture recognition as a mechanism for interaction with computers. Gestures are expressive, meaningful body motions involving physical movements of the finger, hands, arms, head, face, or body with the intent of: 1) conveying meaningful information or 2) interacting with the environment. Hand gesture recognition finds applications in varied domains including virtual environments, smart surveillance, sign language translation, medical systems etc. Hand gestures are an attractive method for communication with the deaf and dumb. Hand Gestures can be used for remote controls for television sets, Stereos and room lights, Household robots could be controlled with hand gestures.

In today's age, the robotic industry has been developing many new trends to increase the efficiency, accessibility and accuracy of the systems. Robots can be a replacement to human, they still need to be controlled by humans itself. Robots can be wired or wireless, both having a controller device.

Volume 02, Issue 06, [June– 2015] ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

This mainly involves Image Processing and Machine Learning for the system or application development. Beyond this, it also requires some kind of hardware for interfacing with the system for gesture control. There are some systems that have been developed in the same field using various techniques.

II. PROPOSED APPROACH

With the development of ubiquitous computing, current user interaction approaches with keyboard, mouse and pen are not sufficient. Due to the limitation of these devices the usable command set is also limited. Direct use of hands can be used as an input device for providing natural interaction. This work aims to develop a real-time system capable of understanding commands by hand gestures, and expand the ways that people are able to interact with Robots. The work here is summarized as detecting and recognizing hand gesture from real time gesture images and with the help of neural network analyzes the efficiency of the network for the hand gesture recognition problem. Further a sample application of controlling Robot through hand gesture is modeled here.
This approach is based on three main steps: Capture hand image, Preprocessing & segmentation, Command signal Generation, Passing signal to robot, Navigation of Robot.

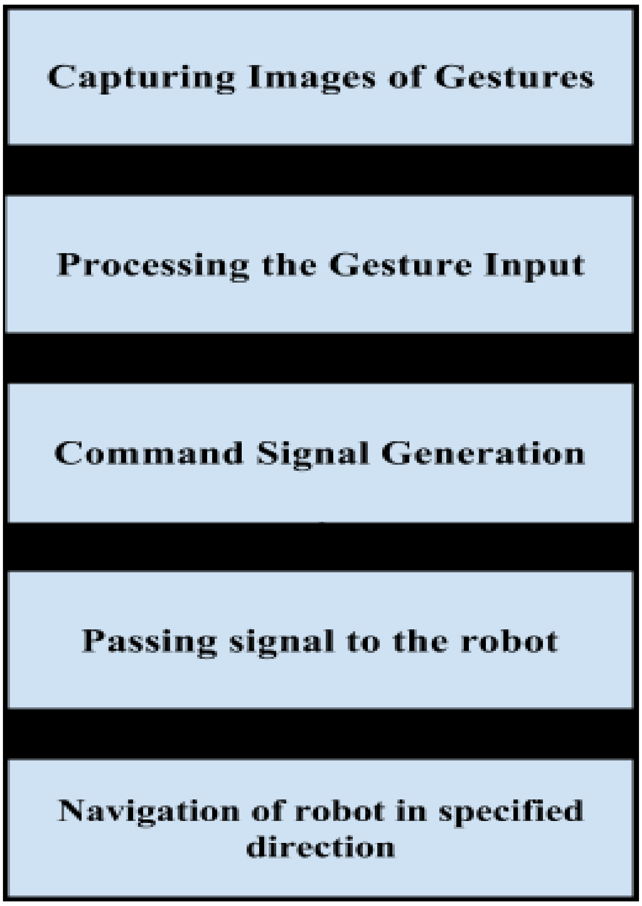

Figure 1: Block Diagram of Proposed System

III. IMPLEMENTATION

3.1. Capturing Gesture Movements:

Image frame is taken as input from the webcam on the control station and further processing is done on each input frame to detect hand palm. Figure 2 is an example of input frame. This involves some background constraints to identify the hand palm correctly with minimum noise in the image.

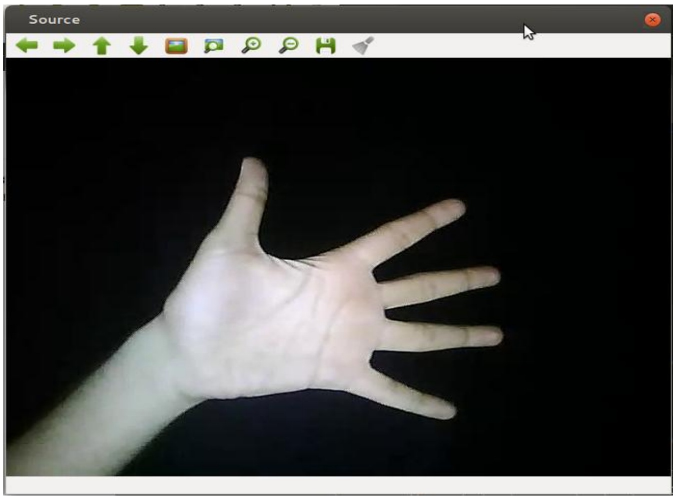

Figure 2: Input Image Frame.

3.2. Hand Palm Detection

After capturing the image frame from the webcam, some basic operations are performed on this frame to prepare it for further processing of command detection. These operations are necessary for implementing both the techniques of gesture control, following two main processes are done to detect hand palm.

1) Thresholded Image:

Image frame taken as input from webcam is thresholded starting from minimum thresh value till single contour is formed in an image, same is in the case of intensity based thresholding. In the Figure 2 fingers are shown by the user as a gesture command having dark background. That image is thresholded so that only a single contour can be formed on it. This thresholding is done on the basis of intensity in the image, which neglects the dark background and thresholds the fingers. Thresholded image is shown in Figure 3.

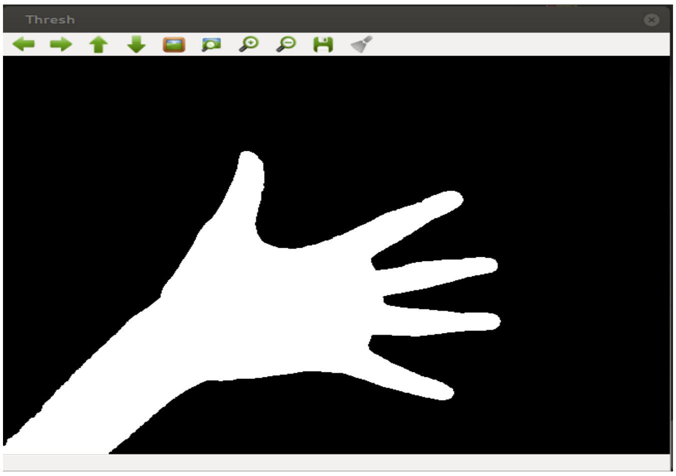

Figure 3: Image Thresholding.

2) Drawing Contour and Convex Hull:

As shown in Figure 4, after obtaining thresholded image two main things are done, drawing the Contour on the thresholded part and fitting this contour in the Convex Hull. Contour is drawn in the thresholded image. This is done on the intermediate image, this image is then passed for drawing the convex hull. This covers the whole contour by joining the minimal points to form Convex Hull. These two basic operations are performed on every image frame taken from the webcam, and then depending on the kind of gesture technique chosen by the user, further processing on the images is done. These two techniques are Finger Count based gesture control and Direction of Hand Palm Gesture Control.

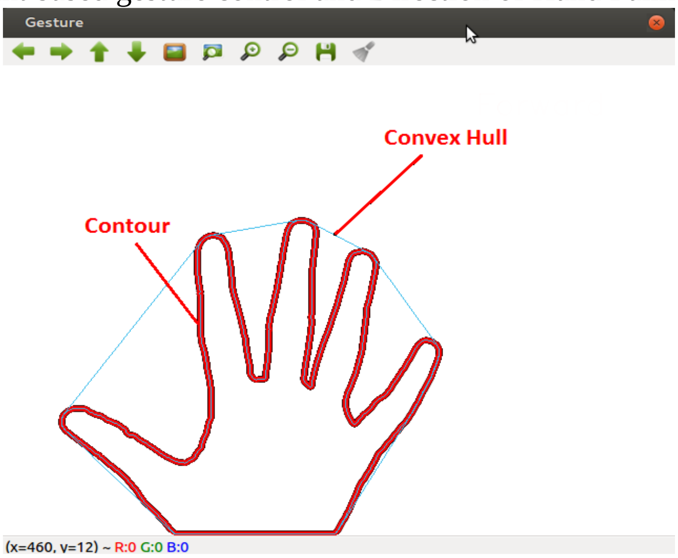

Figure 4:Contour & Convex Hull

3.3. Command Detection using Specific Method:

After completion of pre-processing of an input frame, further processing is done on the extracted image according to specified technique.

1) Direction of Hand Palm:

In this technique of gesture command, orientation of hand palm is taken into the consideration for recognition of the command signal. Thus an orientation of hand palm gives direction in which robot is to be moved. This command can be given with minimum two fingers or with the whole palm.

In the Figure 5, gesture command of this technique is given using fingers. Orientation of these fingers is towards right side, so the command signal for right is generated and passed to the robot. For deciding orientation of the palm two things are used, depth point and end points of the line of defect. These parameters have been found out by initial processing of the gesture command recognition. Midpoint of line of defect is calculated by taking average of two end points. Then this midpoint's coordinate position is compared with depth point's position. Each time two main conditions are checked for each frame. For small difference between y-coordinate and large difference between x-coordinate, possible commands are Right or Left. In Figure 5, depth point and midpoint has small y-coordinate difference and large positive difference between them, so orientation of fingers is towards right is predicted correctly. For the difference between y-coordinate of the point, which is negative, orientation is in the left direction specifying command as left. Similarly in the Figure 6, the orientation of fingers is down, that is a command given to the robot is backward. In this image frame, there is a small change in x-coordinate and large positive change in y-coordinate of the depth point and midpoint of the line of defect. So the orientation of the fingers is downwards, specifying command as backward. Similarly for the difference between y-coordinate of the point as negative, orientation is in the upward direction specifying command as forward.

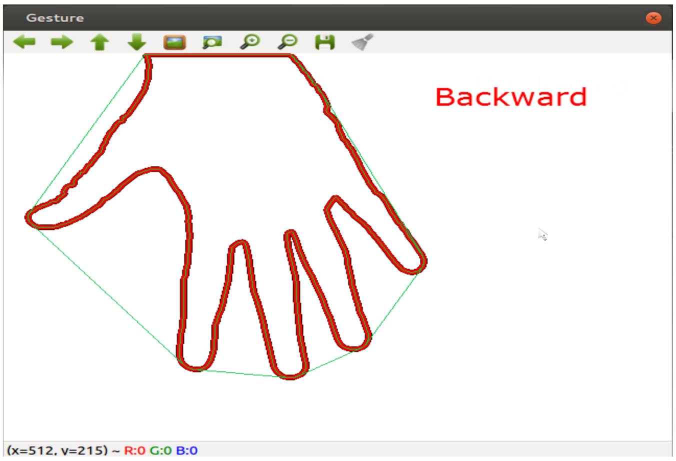

Figure 5: Direction of Hand Palm I

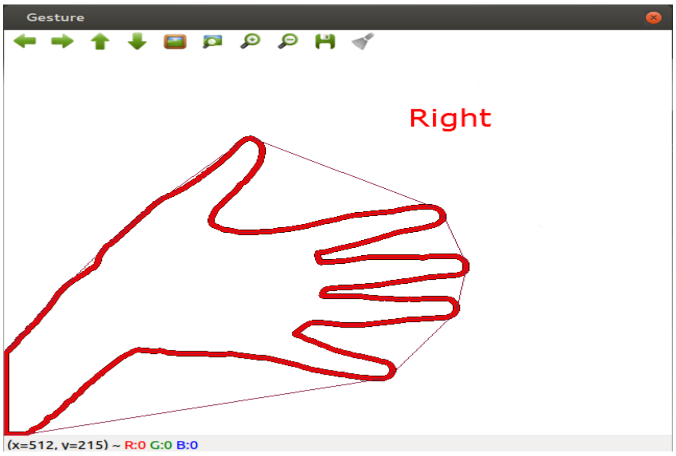

Figure 6: Direction of Hand Palm II

3.4. Generate Specific Signal:

After detecting gesture command specific signal value is generated, unique for every gesture command. This signal value is written in the file using C++ file reading/writing functions.

3.5. Wi-Fi Shield: WiFly

As soon as the command is generated on the control station, it is written in a file with tagged word with it. This file is read by WiFly after regular interval. As it is a wireless communication, so WiFly communicates with the control station using a hotspot where control station is also in the same network. This hotspot can be a wireless router or any kind of Smartphone having tethering facility. Both control station and WiFly is provided with an IP address by using this IP address WiFly accesses the information from the control station using provided IP address of control station.

3.6. Micro-Controller: Arduino- Duemilanove

WiFly is connected to the Arduino through stackable pins shown in Figure 7. When the process of communication starts, WiFly tries to connect itself with the hotspot. For that it requires ssid and passphrase of the hotspot. These are provided in the burned code of the Arduino. After forming a successful connection with the hotspot, WiFly tries to get the access of the control station, with the provided IP address of the control station and port number of HTTP port which is by default 80.

As soon as WiFly gets connected to the control station, it continuously pings a PHP webpage on the control station which has a small PHP script, which returns the value of signal command written in the file with a tagged word. These received signal values are then passed to Arduino, which extracts command and calls which are specified for that command. Arduino sends four digital signals as an input to the L293D motor driver.

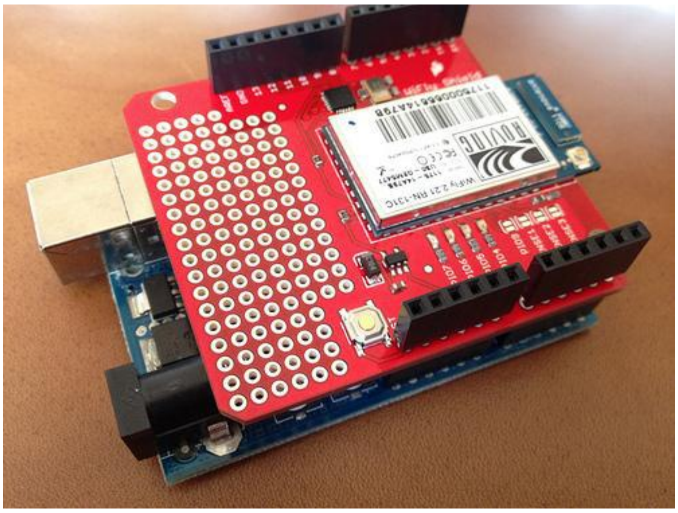

Figure 7: Wifly Interfaced with Arduino

3.7. Motor Driver: L293D

It takes digital signal as an input from the Arduino and gives digital output to the DC motors of the robot. Power supply to the circuit is given by rechargeable batteries. In this system some rechargeable mobile batteries are used as power supply each of 3.7V. To provide more voltage to drive the motors, 2-3 such batteries are connected in series.

3.8. DC Motors in Robot:

This is the final end product of robot consisting of all the hardware WiFly, Arduino and L293D motor Driver circuit on the robot chassis having power supply provided by the rechargeable batteries. Four DC motors are connected to this robot chassis as shown in Figure 8. This is controlled through gestures by the user at control station.

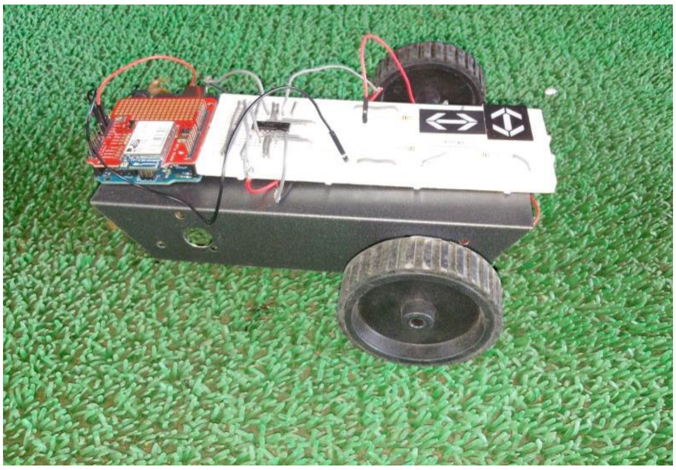

Figure 8: ROBOT

IV. CONCLUSION

In this project work the area of hand-gesture recognition for applications in human-computer interaction is explored. The system developed here is a real time hand gesture recognition based Robot control. The main problem of gesture recognition lies in the complexity of the classification algorithms, especially when using high dimensional feature vectors which become necessary in order to be able to distinguish several hundreds of gestures.

The Gesture Controlled Robot System gives an alternative way of controlling robots. Gesture control being a more natural way of controlling devices makes control of robots more efficient and easy. We have provided a technique for giving gesture input, direction of hand palm based gesture control.

In which direction based technique directly gives the direction in which robot is to be moved.

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