# Gesture Controlled Robotic Arm

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***Abstract-*** *Vision based technique is a natural and powerful tool for controlling robots. In our project, we present a visual gesture recognition system for controlling robot and its arm, by merely showing hand gestures in front of a camera. This is an immense aid for those whom mobility is a great challenge. The system proposed here uses the command given by the user to control a wireless robotic system using gestures. Here the user controls the robotic base and arm for navigation by using gestures. The motto of developing hand gesture recognition system is to create an indigenous communication between human and computerized systems. The recognized gestures are used to control the motion of a robotic system. It is programmed with python programming language which is supported by OpenCV library. The robotic system navigation is satisfied with different directions such as Forward, Backward, Right, Left and Stop.*

***Keywords***- DC Motor, Gestures, L293D, OpenCV, PIC, RF Transmitter and Receiver.

## I. INTRODUCTION

The "Gesture Controlled Robotic Arm" is a device where the arm is mounted on a moving vehicle (robotic base) and is controlled by hand gesture that are interfaced through PC using image processing techniques.

Vision based techniques do not depend upon wearing of any sensors on hand, but use a set of video cameras and computer vision techniques for recognizing gestures. Hand gestures can be classified in two types Static Gestures and Dynamic Gestures. A static gesture is a fixed hand position with specific sign, characterized by a single image while a dynamic gesture is gesture motion, characterized by a sequence of images. Here we cynosure on the recognition of a static gesture. The motive of using gestures is to provide an indigenous way to communicate with the robotic system. This substantially incorporates Image Processing and a particular hardware to interface with the system for gesture control.

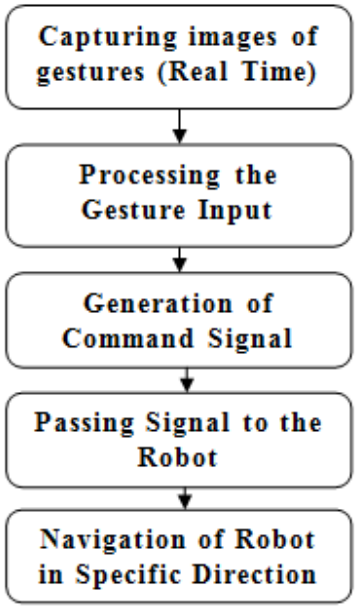


***Fig1. Flow chart of the robotic system***

A. Existing Systems:

There are many existing system used for supervising the robotic system through gestures. Some of the existing systems in image processing and recognition of gesture involves, colour segmentation using adaptive methods, finding the position of hand and labelling with blocking, morphological filtering, and the actions are identified by template matching and skeletonising. But the template matching doesn't provide robustness to the given gesture inputs. There are other methods where accelerometer will be used to control the robotic system movements by wearing the accelerometer on hand with gloves.The other methods used for gesture recognition are Microsoft Xbox 360 Kinect(C). Kinect gathers the colour and depth information using an RGB and Infra-Red camera respectively. This system though is not very cost effective.

B. Proposed System:

We propound a system, which can be used to control the wireless robotic system using various gesture commands. The motto of our system is to present a more reliable and an

indigenous technique to control a wireless robotic system using gestures.

The user operates the robotic base and its arm using pc that is programmed for image processing and captures the input image with a good quality in-built camera or camera attached and interfaced to the pc externally and supports in capturing the image. This camera captures real time video clip of hand gestures to procreate commands for the robotic system. Gesture commands are given by the controller. Principally there are two sorts of gestures i.e. static and dynamic gestures. Independent of the type of gesture given, the robotic base is moved in four possible directions using commands like Forward, Backward, Right and Left. The input given is an image frame showing gesture that is processed through Image Processing strategy. This processed image is utilized to obtain the gesture command. Here the image processing is done utilizing python programming. The gesture command will be one among the commands as indicated.

The H-bridge dual motor driver is used to control and drive the DC motors connected to the robotic system. It receives the digital output signals from the PIC as input to drive the dc motors. The robotic base moves in the particular direction based on the given gesture and continues in the same direction until the next command is sent. Fig.1 shows flow of the robotic system.

## II. TECHNOLOGIES USED

A. Microcontroller: PIC microcontroller

PIC is a Peripheral Interface Microcontroller which was developed by the General Instruments Microcontrollers. PIC is controlled by software and programmed in such a way that it controls and performs different tasks. PIC microcontrollers are used in many applications like medical and mobile technologies and it is very convenient to use as the programming of this controller is easier. The main advantage is that the write-erase operation can be done any number of times, as it uses FLASH memory technology.[6]

B. Open CV: Python

OpenCV (Open Source Computer Vision Library) was developed by Intel. The library focuses on real time image processing and computer vision. OpenCV is a platform free software and supports wide variety of programming languages. OpenCV-Python is the Python API of OpenCV. It incorporates the best endowment of OpenCV C++ API and Python language. Therefore we use python programming to control the robotic system.[2]

C. RF Module:

RF stands for Radio Frequency. RF module comprises of a transmitter and receiver. RF signals are capable of travelling long distances by making it suitable for large applications. These signals can pass through any obstructions between transmitter and receiver. It is available in distinctive operating frequencies with many operating ranges. An RF module operating at 433MHz frequency is used for transmission and reception.

D. Motor Driver:L293D

The L293D is a solid, integrated, high voltage, high current and is a 2 channel driver. This implies, by adopting L293D we can handle at most two DC motors and give supply of up to 36V. The dual motor driver chip utilizes H-Bridge. The H-Bridge is an electrical circuit that empowers the voltage given athwart a load either in clockwise or anticlockwise directions to an output, e.g. DC motor. That implies, by reversing the polarity of current, the direction of motor is also reversed.

## III.SYSTEM ARCHITECTURE

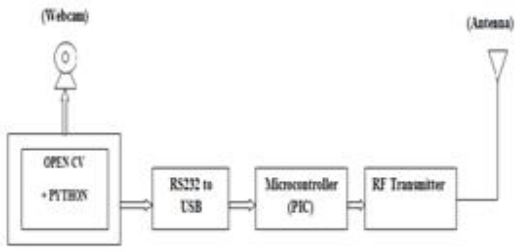


*Fig2. Block Diagram of Transmitter*

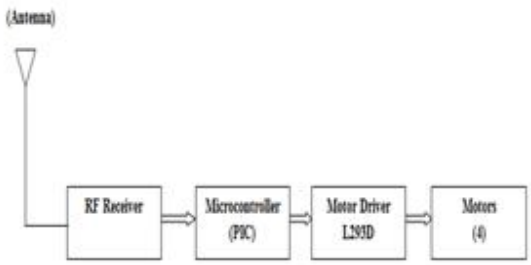


*Fig3. Block Diagram of Receiver*

The system design consists of two main parts:

**1. Generation of command**: After capturing the image [gesture], it is processed using python programming and data is extracted from the image. The command signal is generated using PIC microcontroller on the transmitter side.

**2. Transmitter and Receiver block**: The command signal which is obtained by PIC is transmitted by a RF transmitter and the signal is received by RF receiver through wireless communication. The command signal generated by PIC on receiver side is given to motor driver i.e., H-Bridge [L239D] to run the motors on the robotic system.

## IV. IMPLEMENTATION

The primary aim of our design is to recognize the gestures. Here Command is generated from the PC and passed to the robotic system using RF Transmitter. The robotic base is moved in the allowed direction according to the command. The steps involved in the implementation are as follows:

A. Capturing Hand Gestures: The essential aim of gesture recognition system is to generate a command which is sent to the robotic system. Usually there are four basic gesture commands given (Forward, Backward, Right and Left). Here we make use of Finger count based gesture recognition to generate the command. Firstly we interface the webcam to OpenCV and capture the image frame from the webcam further each input frame is processed to identify the region of interest. Figure.4 shows the sample of input frame. There are a few background constraints to recognize the hand palm correctly.[5]

B. Pre-Filtering the Input Frame: Gaussian Filter is used to smoothen the edges of the extracted image. This step is necessary in order to reduce image noise and the number of unwanted convexity points.

C. Extracting the Region of Interest: ROI can be extracted by image thresholding. An image frame is captured using webcam. Binary Image Thresholding is applied image in order to detect the hand palm. Here image frame is converted to threshold image by varying the threshold value until we get the clear binary image which consists of our Region of Interest (White in colour); this is same as intensity based image thresholding which neglects darkened background and thresholds the fingers.

1. Drawing Contour and Convex Hull: Contours are most useful for object detection and recognition. After image thresholding, the image frame contour is resolved and drawn on the mask image( a binary image where only the interested area is white and all other is area black) by using drawContour() function in the OpenCV library. This is useful to perform operations only on the image without affecting other parts. Many contours will be produced due to noise hence we increase the threshold value and repeat the procedure until only one contour is generated. The next step is to draw convex hull around the contour points which acts as envelope around the hand. The images of contour and convex hull are shown in fig.5.

2. Convexity Defects: The convex hull is drawn on the mask image in such a way that it fits all the contour points of the hand within the hull. The convexity is sustained by making use of minimum points to form the hull. Hence defects are formed in the convex hull with respect to the contour drawn on hand.

3. Fingers Count: The defect points in the hand gesture are utilized to count the number of fingers present in the hand gesture.[1]

*Fig4. Input image and threshold image*

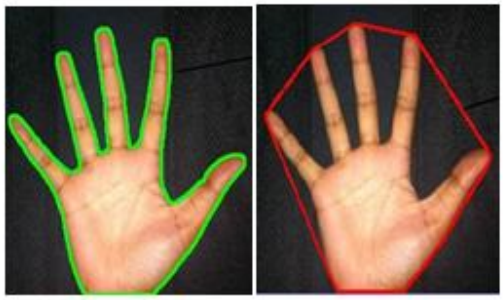

*Fig5. Contour Image and convex hull*

D. Generation of Signals:

The generated commands (analog output) are given to the PIC microcontroller using USB [RS232]. From the serial data, processing is done for the directions forward, left,

right and stop to control the robotic system. That particular signal is generated and given to RF module.

E. Transmission and Reception:

The input data from the micro controller is given to the four data pins of Encoder IC [HT12E] which converts the 4-bit parallel data into serial data using 4-data pins. The obtained serial data is given to the RF transmitter module of 433MHz which modulates the input signal using ASK (Amplitude Shift Keying) modulation, the modulated signal is transmitted through the antenna. The range of the radio signal is 100m and it doesn't require a line of sight. This transmitted signal is received by the antenna of the RF receiver module and demodulation is done using envelope detector technique. The demodulated signal is decoded as a 4-bit parallel data using Decoder IC HT12D.

F. Robot navigation:

The decoded data is processed by the PIC microcontroller on the receiver side and the digital signal from PIC is given as input to the dual motor driver, which delivers digital output to the DC motors for base and arm movements of the robot. The motor driver IC is used to provide required current to the DC motors of 1000rpm for the movement of robotic base and arm. The current provided by IC to motor to move right, left, forward and back is calculated using the received data. The action of the robotic system is not changed until a new gesture is found. For the arm movement that is mounted on the robotic base, same gestures can be used as that of base, by using a switch.[1]

| Directions | Port D.0 | Port D.1 | Port D.2 | Port D.3 |
|---|---|---|---|---|
| *Port B.0=0 (Robot Movement)* | | | | |
| Forward | 0 | 0 | 0 | 1 |
| Backward | 0 | 0 | 1 | 0 |
| Left | 0 | 0 | 1 | 1 |
| Right | 0 | 1 | 0 | 0 |
| *Port B.0=1 (Arm Movement)* | | | | |
| Clockwise | 0 | 1 | 0 | 1 |
| Anti-Clockwise | 0 | 1 | 1 | 0 |
| Up | 0 | 1 | 1 | 1 |
| Down | 1 | 0 | 0 | 0 |
| Stop | 0 | 0 | 0 | 0 |

Table 1: Gesture Commands (Transmitter)

*Robot Movement*

| Direction | Port D.0 | Port D.1 | Port D.2 | Port D.3 |
|---|---|---|---|---|
| Forward (0001) | 1 | 0 | 1 | 0 |
| Backward (0010) | 0 | 1 | 0 | 1 |
| Left (0011) | 1 | 0 | 0 | 1 |
| Right (0100) | 0 | 1 | 1 | 0 |

*Arm Movement*

| Direction | Port C.0 | Port C.1 | Port C.2 | Port C.3 |
|---|---|---|---|---|
| Clockwise (0101) | 1 | 0 | 1 | 0 |
| Anticlockwise (0110) | 0 | 1 | 0 | 1 |
| Up (0111) | 1 | 0 | 0 | 1 |
| Down (1000) | 0 | 1 | 1 | 0 |
| Stop (0000) | 0 | 0 | 0 | 0 |

Table 2: Gesture Commands (Receiver)

## VI. CONCLUSION

The "Gesture Controlled Robotic arm" is an alternative way of controlling robotic base with its arm by recognising the hand gestures. Gesture control is an indigenous way which eases the control of robotic system in a more reliable way with higher efficiency.

## VII. ACKNOWEDGMENT

Presenting a paper is a golden opportunity for learning and self-development. The successful completion of any project would be incomplete without the mention of people who made it possible and whose constant encouragement and guidance has been a source of inspiration. We would like to thank Dr.N.R.Shetty, Director, NMIT, for providing such a wonderful environment to make this project a fruitful one. We would like to express our gratitude to Dr.H.C.Nagaraj, principal of NMIT, for his support in bringing this project to completion. We wish to express our gratitude to the Head of the department, Dr.Sandya S, Dept. of ECE for providing a congenial working environment.

It gives us a great pleasure to express our gratitude to our project guide Mrs.Naina R Karkal, Associate Professor, Electronics and Communication Engineering Department, Nitte Meenakshi Institute of Technology, Bengaluru for her suggestions which helped us to complete the project. We would also like to acknowledge and thank our Parents and Friends who have been a source of inspiration in successful completion of this project.

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