International Journal of Computer Communication and Information System (IJCCIS)
– Vol2. No1. ISSN: 0976–1349 July – Dec 2010

Hand And Finger Gesture Recognition System for Robotic Application

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***Abstract*—Vision-based gesture recognition system is the attractive solution for human computer interaction and machine vision application like robotic application. The common systems assumption under such a systems are a constant environment, like persons wearing non-skin-colored clothes with long sleeves and a fixed camera position under constant lighting conditions. In this paper we are evaluating the performance of a simple hand and figure gesture recognition system that can be mapped to various tasks for robotic application. One of the main constrain for implementing the vision based gesture recognition system on robotic platform is the computational complexity associated with the system because of the low computation power available on the tiny embedded system on robots. So here we are evaluating a simple hand gestures for that purpose based on a simple heuristic algorithm.**

***Index Terms*—hand gesture, figure gesture, Heuristic algorithm, machine vision, robotic application.**

I. INTRODUCTION

Vision-based hand gesture recognition is an active area of research in human-computer interaction (HCI), as direct use of hands is a natural means for humans to communicate with each other and more recently, with devices in intelligent environments. The trend in HCI is moving towards real-time hand gesture recognition and tracking for use in interacting with video games, remote-less control of television sets, robot interaction and interacting with other similar environments. This system generally involves measurement of hand location and shape. Achieving high accuracy and speed in measuring hand postures are two important aspects of these systems.

Numerous approaches have been explored to extract human hand regions either by background subtraction or skin-color segmentation [1, 2]. Methods based on background subtraction are not feasible when applied to images with complex backgrounds or real-world scenarios.

II. SYSTEM MODEL

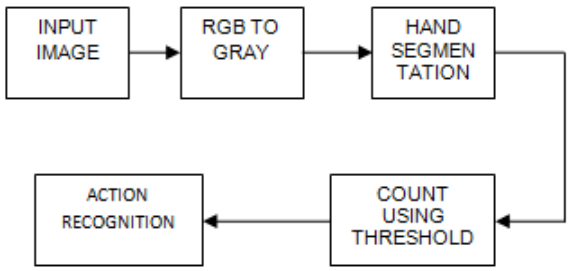

Fig.1 Hand Gesture Recognition system model

Our system uses very simple heuristic algorithm for gesture recognition. Here hand portion of the image is segmented by the simple algorithm sated as below in section IV and figure gesture recognition algorithm in section VI.

III. PATTERN RECOGNITION

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest from their background, and make sound and reasonable decisions about the categories of the patterns. Automatic (machine) recognition, description, classification, and grouping of patterns are important problems in a variety of engineering and scientific disciplines such as biology, psychology, medicine, marketing, computer vision, artificial intelligence, and remote sensing.

The rapid growing and available compute power, while enabling faster processing of huge data sheets, has also facilitated the use of elaborate and diverse methods for data analysis and classification. At the same time, demands on automatic pattern recognition systems are rising enormously due to the availability of large databases and stringent performance requirements (speed, accuracy, and cost).Here in the system very simplest algorithm is used as pattern recognition.

IV.HAND SEGMENTATION CLASSIFICATION ALGORITHM

STEP 1. Convert the RGB image into gray scale image.

STEP 2. Segment the image into three equal slices.

STEP 3. Take the right corner second level slice as left hand image

STEP 4. Take the left corner second level slice as right hand image.

STEP 5. By considering threshold (120) and comparing with each pixel we count the number of pixels in the sliced parts.

STEP 6. Based on the pixel count specification we classify either left hand or right hand is raised or both.

V. RECOGNIZING HAND GESTURE

We propose a fast algorithm for automatically recognizing a limited set of gestures from hand images for a robot control application. Hand gesture recognizing is a challenging problem in its general form. We consider a fixed set of manual commands and a regionally structured environment, and develop a simple, effective, procedure for gesture recognition .Our approach contains steps for segmenting the hand region and classifying the gesture.

Region based hand gesture recognition has been a very active research topic in recent years with motivating applications such as Human Computer Interaction (HCI), Robot control and sign language interpretation.

We are comparing each pixel of segmented image to a threshold value (120). If the pixel value is less than the threshold value then we increment the count by 1 unit. Similarly the same processes are performed for all the pixels of segmented image.

TABLE I : COUNT RANGE FOR HAND POSES

Different hand poses	Count range
No hand is present	0 to 1000(In left hand slice and right hand slice)
Left hand is present	10000 to 11000(In the left hand slice)
Right hand is present	12000 to 14000(In the right hand slice)

For the count between (12000 to 14000) the system recognizes it is right hand .For the count between (10000 to 14000) the system recognizes it as left hand. For the count less than the two ranges neither of the hand is raised .

For the count greater than above two ranges thus the person is standing on right edge/left edge of the image.

Here very simplest hand gestures are considered for reduce computational complexity. Only four type of gestures are considered for this system are left hand raised on left side ,right hand raised on right side ,both the hand raised on both the side and none of the hand raised.

VI. FINGURE GESTURE RECOGNITION

Our proposed method of figure gesture recognition consist of following stages

- Localizing Hand-like regions based on learned skin colored statistics
- Finding the total count based on threshold (50)value for each hand pose.
- Based on each figure gesture recognition the given instruction is executed.

1) For single finger pose “move forward “ instruction is executed.
2) For two finger pose “move backward “ instruction is executed.
3) For three finger pose “move right “ instruction is executed.
4) For four finger pose “move left “ instruction is executed.
5) For zero finger pose “stop“ instruction is executed.

Considering a robot navigation problem in which a robot responds to the hand pose signs given by humans ,visually observed by the robot through a camera .The above algorithm enables a robot to identify a hand pose sign and get the required instruction to operate.

VII. SIMULATION RESULTS

Input images with size of different hand gesture are applied to the simulation program.

Fig .2.Input image showing both hand taken for simulation

Fig.3 Segmented simulation results showing left hand

Fig .4.Segm268

hand

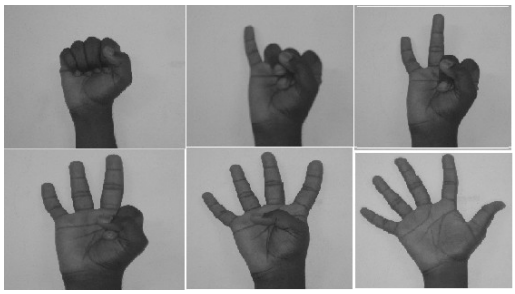

Fig .5. different fingure gesture poses taken for simulation

The above figures shows the segmented simulation results of the hand gesture algorithm. Here the gesture with both hand raised image is taken as input and hand portions is segmented.

TABLE II : COUNT RANGE FOR DIFFERENT FINGER POSES

Fingure gesture type	Count range
Zero fingure raised	403000 to 40500
One fingure raised	338000 to 340000
Two fingures raised	267000 to 26900
Three fingure raised	214000 to 216000
Four fingures raised	150000 to 154000
Five fingures raised	9000 to 9500

TABLE III : COMPUTATIONAL COMPLEXITY TABLE FOR FINGURE GESTURE RECOGNITION

Fingure gesture type	Time taken to execute the program
Zero fingure raised	0.256
One fingure raised	0.243
Two fingures raised	0.236
Three fingure raised	0.210
Four fingures raised	0.196
Five fingures raised	0.183

VIII. COMPUTATIONAL COMPLEXITY

size by profiling the code. The result of profile is presented in table. III &IV. This table list computational complexity of various processes involved in the system.

TABLE NO.IV
COMPUTATIONAL COMPLEXITY ANALYSIS OF VARIOUS PROCESSES

Type of processes	Time take(sec)
Image segmentation part	0.126
Pixel counting part	1.559

IX. CONCLUSION

Here we used very simple algorithms that will be suitable for real time implementation of robotics applications. This algorithm only identify simple hand gesture like left hand raised, right hand raised, both hand raised and no hand raised cases. Here no specific actions are defined for the gesture it is open to robotic application developers. They can assign simple task like making movement on right hand side for right hand gesture, left hand side for left hand gesture, or to make the robot to stand still for both hand raised gesture and no action for none of the hand raised gesture. Similarly we used different figure poses for the figure gesture algorithm. The overall computation time of the algorithm shows it is feasible to implement in a low end embedded system based robotics in real time. Our future work is focused on embedded platform implementation of the algorithm on some real robotic system and exploring of other kind of gesture with simple algorithm of low computational complexity.

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