Hand Gesture Controlled Wheelchair System Using Image Processing

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Abstract- **Electric wheelchairs are designed to help paraplegics. Unfortunately, these cannot be used by persons with higher degree of destruction, such as quadriplegics, i.e. persons that, due to age or illness, cannot move some of the body parts. Medical devices designed to help them are very complicated, rare and expensive. In this paper hand gesture based wheelchair is proposed which is cost effective and efficient system. The purpose of hand movement based control electric wheelchair is to eliminate the necessity of the assistance required for the disabled person. And it provides great opportunity of the disabled to feel of independent accessible life. In Hand gesture mode, the user can control or move the wheelchair by using gestures of his/her palm(finger count), thereby interacting with the system. The command signals are generated from these gestures using image processing. These signals are then passed to the wheelchair to navigate it in the specified directions. In addition to this, for the safety purpose ultrasonic sensor is mounted in front of wheelchair to detect the obstacles and automatically stop the wheelchair movement.**

I. INTRODUCTION

The Wheelchair is dependent system used by elderly and physical disable persons. As per requirement of the disabilities different kind of automatic systems are available in market such as voice control and joystick control and head motion control wheelchair system.

In voice control wheelchair when user speak the command system will work according to it like left, right, back, forward, and stop. But in noisy environment the wheelchair system cannot respond properly. In hand gesture control using MEMS sensor wheelchair movement will control by hand gestures. But in this systems user need to wear sensor assembly in his/ her hand that makes system bulky.

Traditional electric-powered wheelchairs are normally controlled by users via joysticks, which cannot satisfy the needs of elderly and disabled users who have restricted limb movements caused by some diseases such as parkinson's disease and quadriplegics. This system presents a novel hands-free control system for intelligent wheelchairs based on visual recognition of head gestures. The traditional Adaboost face detection algorithm and Camshift object tracking algorithm are combined in the system to achieve accurate face detection, tracking and gesture recognition in real time. It is intended to be used as the human-friendly interface for elderly and disabled people to operate our intelligent wheelchair using their head gestures rather than their hands. The infrared non contact head sensors are also used to determine position of head. The placements of sensor are behind the head of user, so that the field of view is not limited. The head movement based system have limitation, when user can not able to access the system physically.[6]

Hand gesture has been one of the most common and natural communication media among human being. Hand gesture recognition research has gained a lot of attentions because of its applications for interactive human-machine interface and virtual environments In early years, there were numerous techniques used for gesture recognition and tracking. For example, instrumented gloves, optical markers etc. These techniques have there own advantages and drawbacks. The instrumented gloves contain number of sensors in it, which gives the information about hand location, orientation and finger tips. They have high accuracy. But, they are too expensive and they need wired connection. Optical markers works with infrared light, which is the complex process. These systems require complex configuration.

Over the last few years, number of researches are conducted on hand gesture recognition for human computer interaction. Several performance comparisons are conducted to improve the technique. Here is the survey on few papers.

In paper [1], the hand gesture images are taken by a camera. Image transformations are done by converting the rgb image into ycbcr image. The ycbcr image transformed into binary image. This algorithm needs uniform and plane background. Edge detection algorithm is used to find the edges in the image. By making use of edge detection the orientation of hand is detected. The features like centroid, peaks detection, Euclidean distance and thumb detection are found. In this paper, they have considered five bits to represent the hand image. That is first bit represents whether the thumb is present or not. If it is present, the bit is given as 1 else 0. Remaining four bits represents the four fingers. The success rate is 92% with computation time 2.76 seconds.

In paper [2], the author make use of K-means clustering algorithm to partition the input image for segmentation. They make use of bounding box to find the orientation.

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Features like centroid, Euclidean distance are measured for detection. Here the hand is represented by making use of seven bits. First bit represents the orientation of the hand. Second bit is for presence of thumb in the figure. And next three bits are for presenting number of fingers raised. Last two bits for differentiating the gestures which have equal number of fingers. This algorithm has success rate of 94% with computation time 0.60 seconds.

In paper [3], the author will make use of K-means clustering algorithm for segmentation of the image. They make use of bounding box to find the orientation. Features like centroid, Euclidean distance are measured for detection. Here the hand is represented by making use of five bits. First bit represents the presence of thumb in the hand gesture. Remaining four bits represents the four fingers. This algorithm has recognition rate of 94%.

In paper [4], this paper gives an algorithm for non uniform background or 3D complex space. Here author will make use of HMM based method to recognize the hand gestures with non uniform background. The input images are taken by a camera. Skin color is used for segmentation. The gestures are splitted by making use of spotting algorithm. They use data aligning algorithm to align features with success rate of 100% but in this method they assume stationary background and therefore they smaller search region.

Here introducing the design implementation models of totally independent Hand gesture control electric wheelchair. The purpose of this wheelchair is to eliminate the necessity of the assistance required for the disabled person. The implemented system will allow the disabled person to control the wheelchair without the assistance from other persons. In this system camera will capture the images of hand gesture and it will give as input to the raspberry pi. Raspberry pi will perform the operation on it and it will give the output signal to the motor driver circuit. According to the movement of hand wheelchair will move in particular direction. For Image processing open computer vision(OpenCv) library is used.

The rest of the paper is organized as follows. In section II discuss the system Architecture. The section III describes the technology used for overall system and the section IV represents the results and discussions of the proposed system, and last section of paper shows the conclusion of proposed implementation.
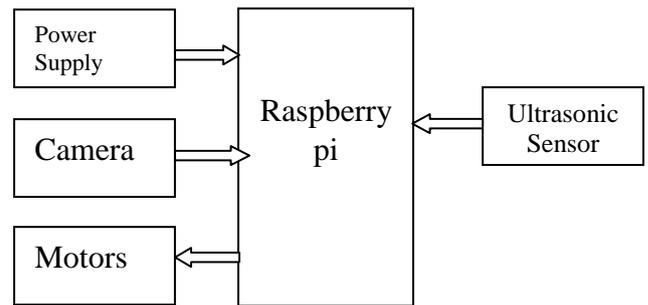
II. SYSTEM ARCHITECTURE

Figure 1 indicates the system architecture of the hardware system

This system is totally autonomous system, and all the module will work independent of each other. For the basic requirement of the any electronic system is Power supply. In this system there is mandatory to gives the proper power supply to individual components and the standard power supply should be used for Raspberry pi, camera, sensor, and motors.

This algorithm mainly consists of preprocessing, segmentation and feature extraction. In feature extraction, we will find moments of the gesture image, centroid of the image and Euclidean distance to find finger count. We make use of contours, convex hull and convexity defects to find the hand gesture.[1][5]

The Raspberry pi board is used to perform the control of the complete system operation. Digital Image processing based output signal sent to the Raspberry pi board. The Raspberry pi acquired the data and analyzes it. A real time data acquisition and analyzing the signal Raspberry pi 2 model board is very efficiently process the multiple image frames by frame. For capturing the image pi camera is used in our system. Moreover, High resolution web camera can be used but it increase the image memory size in Mega Bytes. So that system cannot read the image and process efficiently as per requirements, and it will also increase the processing time. Raspberry pi send the control signal to motor driving circuit based on the hand gestures. Depending on movement of hand it will decide to perform operation on motor like start the operation, go forward, go left, go right, go reverse and stop the operation. In a Wheelchair two individual motors are embedded on each wheel. The Ultrasonic sensor is also mounted on the wheelchair for detection of any static or mobile obstacle. If sensor gets the obstacle very close to the wheelchair, it will indicate to the raspberry pi and raspberry sends the signal to motor driving circuit to stop the motor.

III. TECHNOLOGIES USED

A.   Open CV

OpenCV (Open Source Computer Vision Library) is a library which mainly focuses at real-time computer vision. It is free for both academic and commercial use.

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It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. OpenCV was designed for computational efficiency and with a strong focus on real-time applications. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. It provides basic data structures for image processing with efficient optimizations.

B. Python

Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. The Python interpreter is easily extended with new functions and data types implemented in C or C++ (or other languages callable from C). Python is also suitable as an extension language for customizable applications.

IV. RESULTS AND DISCUSSIONS

A. HAND SEGMENTATION

In this algorithm, hand segmentation is used to extract the hand image from the background. There are several methods for segmentation. The important step in segmentation is transformation and thresholding. Segmentation partitions an image into distinct regions containing each pixel with similar attributes. To be meaningful and useful for image analysis and interpretation, the regions should strongly relate to depicted objects or features of interest

Here we are using three different types of thresholding global thresholding, adaptive mean and adaptive Gaussian thresholding.

In thresholding, if the pixel value is greater than the threshold value, it is assigned one value(white), else it is zero value(black).The function used is cv2.threshold. In global thresholding we used global value as threshold value. But it may not be good in all the conditions where image has different lighting conditios in different areas. In that case we go for adaptive thresholding. In this, the algorithm calculate the threshold for a small regions of image. So we get different thresholds for different regions of the same image and it gives us better results for images with varying illumination.
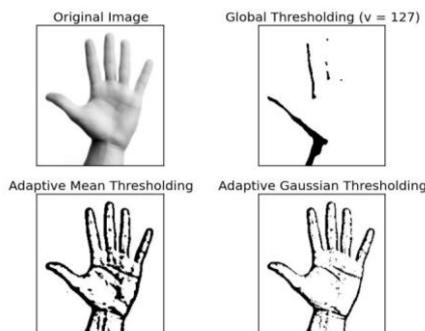
After performing thresholding of image this proposed algorithm will consists of the following steps to find the hand gesture movement. First we need to find contour of thresholded image then convex hull and defect point. According to defect points the number of finger count is identified. This is as explain in detail as follows:

B. Hand Detection

Contours

Contours are the curves joining all the continuous points along the boundary, having same color or intensity. The contours are a useful tool for shape analysis and object detection and recognition. The contour is drawn along the boundary of the hand image which is found after thresholding.
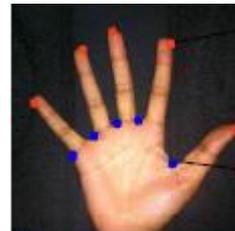

Convex Hull

The convex hull is the set of continuous points in the Euclidean space that is connected to contours. Convex hull is drawn around the contour. Contour points within the convex hull. Convex hull works as an envelope around the hand.
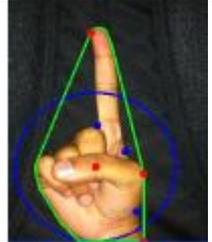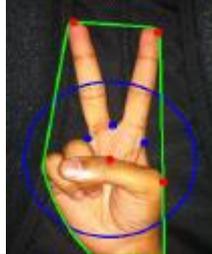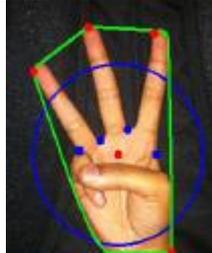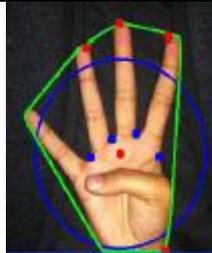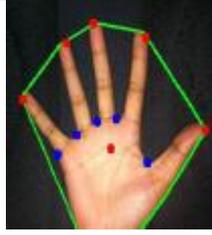

Convexity Defects

When the convex hull is drawn around the contour of the hand, it fits set of contour points of the hand within the hull. It uses minimum points to form the hull to include all contour points inside or on the hull and maintain the property of convexity. This causes the formation of defects in the convex hull with respect to the contour drawn on hand.

Finger Count

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In this method, the number of fingers present in the hand gesture is determined by making use of defect points present in the hand gesture.

Finger count one, two, three, four and five will express left, right, forward, backward and stop operation respectively.

Finger Count	Wheelchair movement
	Forward
	Left
	Right
	Reverse
	Stop

According to finger count we are analyzing the hand gesture and giving input to the raspberry pi. Raspberry pi will perform the operation on it and will give output signal to the motors. Here we are considering the five count and according to each count the wheelchair will move in particular direction.

In this proposed method we are controlling the movement of wheelchair by hand gesture (finger count).

We are using the only camera to take the input images. And raspberry pi will perform operation on it and will give output signal to the motors. This is the cost effective and efficient system as compare to the sensor based hand gesture control and other systems.

V. CONCLUSION

The concept of the hand gesture controlled wheelchair is not only represents the alternative resources but more important to help physically disabled persons to make their life independent. The aim of implementing an autonomous hand gesture controlled wheelchair is to highlight the features of digital Image processing. There are some real time design constants measured like a system takes some time (4second) to execute the system for processing the video in Real time Environment. Therefore the system perform the Wheelchair movement operation with some delay time. It's very hard to track the hand gesture in dark light places, so the system works perfect on environmental light and in a room light with fluorescent mercury vapour lights, which is low in infrared.

REFERENCES

[1] Meenakshi Panwar and Pawan Singh Mehra , ―Hand Gesture Recognition for Human Computer Interaction‖ , in Proceedings of IEEE International Conference on Image Information Processing(ICIIP 2011), Waknaghat, India, November 2011.

[2] Meenakshi Panwar, ―Hand Gesture Recognition based on Shape Parameters‖ .

[3] Meenakshi Panwar, ―Hand Gesture based Interface for Aiding Visually Impaired‖ .

[4] Zhong Yang, Yi Li, Weidong Chen, Yang Zheng, ―Dynamic Hand Gesture Recognition Using Hidden Markov Models‖ , in Proceedings of 7th International Conference on Computer Science & Education (ICCSE 2012) July 14-17, 2012. Melbourne, Australia

[5] Amiraj Dhawan, Vipul Honrao‖ implementation of hand detection based techniques for human computer interaction‖ , in International Journal of Computer Applications (0975 – 8887)

[6] Henrik Vie Christensen and Juan Carlos Garcia Infrared Non-Contact Head Sensor for Control of Wheelchair Movements, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 12, 2011

[7] Diksha Goyal and Dr. S.P.S. Saini, Accelerometer Based Hand Gesture Controlled Wheelchair, International Journal on Emerging Technologies 4(2): 15-20(2013)

Special Issue on International Journal of Electrical, Electronics and Computer Systems, ISSN (Print): 2347-2820 V-4 I-2
For 3rd National Conference on Advancements in Communication, Computing and Electronics Technology [ACCET-2016]
held at M. E. S. College of Engineering, Pune 11–12, February 2016
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[8]   Jayesh K. Kokate1, A. M. Agarkar, Voice operated wheel chair,International Journal of Research in Engineering and Technology ISSN: 2319-1163 | ISSN: 2321-7308 Volume: 03 Issue: 02 | Feb-2014

[9]   Henrik Vie Christensen and Juan Carlos Garcia Infrared Non-Contact Head Sensor for Control of Wheelchair Movements, (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 12, 2011

[10]   Shyam Narayan Patel and V. Prakash Autonomous Camera based Eye Controlled Wheelchair system using Raspberry-Pi IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems **ICIIECS'15**

[11]   Sarangi, P., Grassi, V., Kumar, V., Okamoto, J.:"Integrating Human Input with autonomous behaviours on an Intelligent Wheelchair Platform", Journal of IEEE Intelligent System, 22, 2, 33-41, [2007]

[12]   Kohei Arai, Ronny Mardiyanto, Eyes Based Eletric Wheel Chair Control System, IOS Press,2003

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