

# Head gesture recognition for hands-free control of robot movements

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**Abstract:** *Now a days because of vast and intelligent use of technology things are becoming extremely easy and user friendly. The pace in which development of technology had been done is certainly giving the way for invention of many amazing and revolutionary products which may help people in their day to day life. Robotics is one of such field which makes lives of people to surprising ease and comfort, so this field promises to be one of the most stalwart fields of engineering. With the development of high speed computers and because of which increasing their computational capacity have given us a way to think in a way to recognize gestures and make their use for other applications. So with combination of robotics and image processing we can make a robot move on the head movements by recognizing head gestures. Application of this can be done in field of human computer interaction and usability (HCIU) and create intelligent wheelchair (IW) that will move by recognizing the head movements done instead of traditional electronically powered wheelchairs that move on joysticks. So this paper presents a book of reference for hands free control of robot movement using head gesture recognition.*

**Keywords:** Head gesture recognition, robotics, image-processing, hands-free control, HCIU

## 1. Introduction

In day to day life the lives of people are changing rapidly because of vast use of technology. And so, rapidly developing and changing technology has become a very important aspect of life. Today with this advent of drastically changing technology there can be invention of many more revolutionary products which can be life changing or life saving ones in human life. So, this technology can be used to change human life's way of living.

Human tries to communicate with each other to let express his feelings and mental and psychological situation in particular situation. This human communication can be categorized as verbal and non-verbal communication. What we express through speaking, talking is a verbal communication which is through words, sounds. And what we express through gestures, actions is non verbal communication. Simple nod of head from

a person can be used to categories the expressions of a person such as agreement or disagreement. Same way combination of both these ways of communication and some technology will give some ways creating a thing that will help people in their day to day's life.

The successful deployment of both the above mentioned things will give a way to head gesture recognition depending on which we can control robot movements (example of robot can be taken as wheel chairs). Image processing technology can be used to detect the actual head movement and what step should be taken depending on the detected head movements that's to be decide.

The head gesture recognition based robot control should be able to deal with uncertainties in practical application of it like (i) The head of the user can be found out of the image view, or only profile face is captured in the image.

- (ii) The color of the face may vary person to person and it may change dramatically in changing illumination conditions of light.
- (iii) The person in question may have various kind of facial attributes changing such as user may have glasses, mustache and so.
- (iv) There may be background noise (number of user, whose head to detect from it?) when the robot will move in actual world

The highlighting performances of this robot can be as-

- (i) Autonomous navigation of robot as it will move according to head gestures.
- (ii) So, it will provide flexibility, safety and mobility with ease etc.
- (iii) It will give an intelligent interface with user such in manner as vision based (as it will use camera to detect it), voice based (audio commands can also be used).

This proposed system can be useful in various sectors of society like-

- (i) Tracking of a military application
- (ii) It can be used for search and rescue purpose
- (iii) Real time systems
- (iv) Robot guidance and surveying

Such developed application can be used in below mentioned areas like-

- (i) It can be used for physically handicapped people who are unable to handle their wheel-chairs
- (ii) Developed application thus can be implemented on those wheel-chairs and can be used.

The aim of our project is to develop a robot which moves on head gestures recognized in the hands free control. So, this paper proposes a system that will control robot movements in hands free environment by recognizing head gestures. Which will use image processing techniques to detecting head gestures and accordingly it will convey to the computer what has actually happened and how it is needed to behave in order to make the movements of an autonomous robot

## 1.1 Background and Related Work

There had been very tremendous efforts done by various scientists and researchers to improve human life by interaction with computers. There had been great efforts taken in research towards devices and techniques to improve existing human computer interaction and usability. Recognition of the gestures can be very good and promising option to help us in this direction. Gestures are meaningful and expressive things that may convey useful information or may help in interaction purpose as in our case.

There have been various previous methods used to interact with computers and so through to robots and controlling them. Some of these systems can be given as Dr. Stephen Hawking's intelligent wheelchair which works on the brain computer interface (BCI) rather than any gesture recognition. Others are systems such as which works on hand gesture recognition. In this system accelerations of a hand in motion in three perpendicular directions are detected by the accelerometer and then working on this signals are transmitted to computer via Bluetooth [5]. In some of the other methods there is 3D model based camera mouse is used for the purpose of face tracking and then that to be used for head gesture recognition for robot control. This system have introduced a visual face tracking system that can accurately retrieve these motion parameters from video at real-time. After calibration, the retrieved head

orientation and translation can be employed to navigate the mouse cursor, and the detection of mouth movement can be utilized to trigger mouse events. 3 mouse control modes are investigated and compared in this technique. Experiments in Windows XP environment have verified that the convenience of navigation and operations using this face mouse system [6]. There is also another method used which is Bi-modal human machine interface for controlling robot movements. In this technique the head movements and the facial expressions are detected by using the gyroscope and the cognitive suite of the Emotive sensor. By using the cognitive suite, the user can choose his facial expressions. Three head movements are used to stop the robot (wheelchair as termed here) and display the turning commands in the graphical interface (GI) of the human machine interface, while two facial expressions are employed to move forward the wheelchair and confirm the execution of the turning command displayed on the GI of the human machine interface[7].

The existing system does not allow the robust and an autonomous way of mobility and flexibility in a secure manner. The existing system needs somebody personally handle it. What if the person in question is a handicap person or is unable to move it (such in case of wheelchairs for physically handicapped person). Then he/she will need another person to help him/her for movement or transmission.

The techniques or methodologies by which some of these existing systems have been developed are rather tough and complex in order to implement them for such as described for our project so we are trying to do it other way round.

The new application will provide us a way to create a robot which will move autonomously that is on its own by recognizing head gesture that is just done and move according to that.

The new application will provide hands free control of robot movements faster than the existing one. It will use head as a mouse instead of using conventional mouse to provide user hands free control of the robot movements. So it will provide user ease of using an application or the proposed system. This system allows user secure mobility and flexibility and that is in secure manner. Also such in case of physically handicapped people it will not be needed to assist them whenever they have to move from one place to other. They themselves can do it very easily just by moving their head sideways or up down according to path where they have to go. And so it will help people for better human computer interaction and usability.

## 2. Image processing and commands for motion controlling

Image processing is any form of processing information which is in form of images in both cases such as input and output. These images can be of forms such as photographs or part of video. Most of given image processing methods are reliable, versatile and accurate.

- (i) Grayscale-

Grayscale or grayscale image is one in which the value of each pixel is a single sample. The images of this type are formed of shades of gray color varying from black which denotes weakest intensity to the whiter one which denotes the strongest intensity. Even though shades can be displayed from any color that is available with all these different colors used for different intensities.

- (ii) Thresholding-

This is the technique in image processing which is used for converting a grayscale or binary image based on threshold value defined. If pixel in image has value less than that of threshold then it is set to black. And if pixel value is greater than or equal to threshold value then it is set to white one.

All these image processing techniques are used to detect and guess what head movement is actually performed and to enact in that way properly.

Commands for motion- The robot will act and move according to following motion rules such as:-

- (i) Move front/ahead – If head movement up is recognized
- (ii) Move back – If head movement down is recognized
- (iii) Turn left – If head movement left is recognized
- (iv) Turn right – If head movement right is recognized

### 3. Face detection and previous techniques-

To guess the head movement that just has been performed we have to detect some part of head instead of detecting whole head which can be called as face detection. To detect the appropriate head gesture performed we have to extract and concentrate on particular part of face. We can do so by concentrating to nose and eyes part of our face. The movement of this part of our face will give us the best idea about how actually head movement is done that is sideways or up down. We can form a trapezium around this part of face and by calculating changes that may occur in sides of the trapezium will give us an actual idea about which way the head movements has been done. If there is change in bottom and top sides (that is lines parallel to eyes and mouth) then there is sideways head movement has been done. Otherwise if there is change in other two sides than this then there is up-down head movement done.

#### Previous techniques-

There are previous techniques used for face detection such as Adaboost, camshift, Lucas-Kanade, gentleboost.

Adaboost-It is face detection method with high accuracy and fast speed. It has the sequences of steps to be performed as image capturing, filtering, rectangular features extraction, cascade classifier design and classification.

Camshift- It is colour tracking method. It has fast ability to track object. To know the gradients if density to find peak probability distribution called as mean shift algorithm. Limitations of camshift- It does not work properly in background noisy situations and has less accuracy when there is change in illumination condition

### 4. Architecture

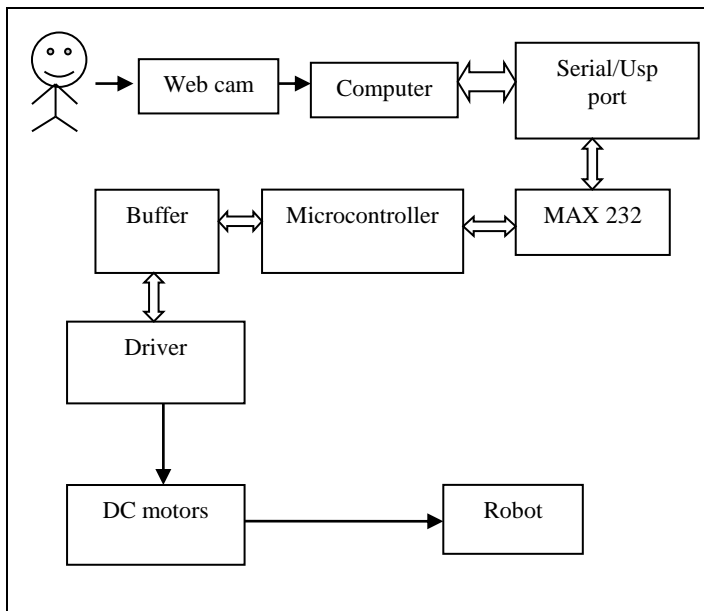


Figure 1: Block diagram of the system

Webcam captures the face of the user and its movements which are then sent to computer. Then the communication between computer and microcontroller happens through serial/usb port to establish the voltage levels between these two we need something that will manage voltages at both sides so, we are using MAX 232 to do that. Buffer is used to store the various image frames that have been captured by camera and matching them with the correct ones to detect the actual head gesture that just has been performed. These head gestures recognized should be conveyed to robot so, to do that we have used drivers between the computer and the D.C. motor which is mounted on the robot. Because of these drivers it will make compatible for the computer to perform action on D.C. motors or to give commands for some actions.

### 5. Algorithm (steps):-

Steps to get to this system can be given as like determined here-

- (i) Data collection from video input
- (ii) Capturing the image from this video input
- (iii) Pre-processing or the filtering this image
- (iv) Feature extraction of the image i.e. detecting the desired parts of face
- (v) Post processing of this captured image
- (vi) Perform image processing steps

### 6. Conclusion and future work

So this paper presents the references the design and implementation of head gesture recognition for hands-free control of robot movements. This system when developed will be useful in various sectors of society such as human health that is for physically handicapped people, army object tracking and detection, search and rescue operations, real time systems and robot control. Also it will be used as better human computer interaction and usability with devices. Although future work on it can be done as audio commands can also be

used with support to proposed system. Also to provide highest of accuracy for more background noisy situations such as those are at outdoor situations such as streets, parks etc.

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