Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 97 (2014) 291 – 298

Procedia Engineering

www.elsevier.com/locate/procedia

12th GLOBAL CONGRESS ON MANUFACTURING AND MANAGEMENT, GCMM 2014

Human Machine Interface for controlling a robot using image processing

Ambuj K Gautam*,V Vasu!, USN Raju#

*M.Tech, MED, National Institute of Technology, Warangal, AP 506004 INDIA

!Assistant Professor, MED, National Institute of Technology, Warangal, AP 506004 INDIA

#Assistant Professor, CSED, National Institute of Technology, Warangal, AP 506004 INDIA

Abstract

This paper introduces a head movement based human machine interface (HMI) that uses the right and left movements of head to control a robot motion. An approach for making an effective technique for real-time face orientation information system, to control a robot which can be efficiently used for electrical powered wheelchair (EPW). The project aims at application related to HMI, the system (machine) identifies the orientation of the face movement with respect to the pixel values of image in a certain areas. The whole image is divided into three parts on the basis of x value of image (x, y). On the basis of orientation of face, maximum pixel value of approximate same range lie in one of divided parts. This information will be transferred to the microcontroller through serial communication port and control the motion of robot in real time by using head movements.

Selection and peer-review under responsibility of the Organizing Committee of GCMM 2014

Keywords: Electrical Powered Wheelchair (EPW), Human Machine Interface (HMI), Microcontroller, Robotics;

1. Introduction

Presenting a good environment and facility, is our primary and sociological responsibility for a disable people. In this respect many researchers presented their novel view with various methodologies, which is helpful for the disable people.LaiWei and Huosheng Hu [1] have presented "A multi-model Human Machine Interface for

* Tel.: +91-779-926-3345; +91-949-106-5965; +91-944-014-9146

E-mail address: ambuj.kumar784@gmail.com; vvvasu@gmail.com; usnraju@yahoo.com

Selection and peer-review under responsibility of the Organizing Committee of GCMM 2014

doi:10.1016/j.proeng.2014.12.252

controlling an intelligent wheelchair using face movements".They used multi-mode of input, EMG sensor and face image information by using support vector machine (SVM) classifier and Adaptive Boosting learning approach. Lovendra solank et.al [2], have proposed "Feature-based head pose estimation for controlling movement of robot motion in real time".They have used Haar-classifier and Hough Transform techniques for simplifying their problem. Jae-woongmin et.al [3], have presented "Human friendly interface of wheelchair robotic system for handicapped person". They have proposed FSR (Force Sensing Resistor) to measure changes in the shoulder and head motion. All researchers are dedicating their work for the world welfare, so that they can provide a better facility for the disable people.

In this paper we are controlling a robot motion with user's head movement, which can easily use by the disable people for Electrical powered wheelchair motion control. We present a novel and better methodology using image processing for reducing the complications of disable people and feel the easiness, effectiveness and efficient for their comfort..

2. Experiment Setup

Figure.1 shows the experimental setup of the project in which first information generated from camera and goes to PC. With the help of Image Acquisition Tool and proposed Algorithm user's face recognised. Now by various head movements PC generates some signals which transfer to the microcontroller of the robot and after it transferred to motor drive. In this way for compilation project equipment are arranged.

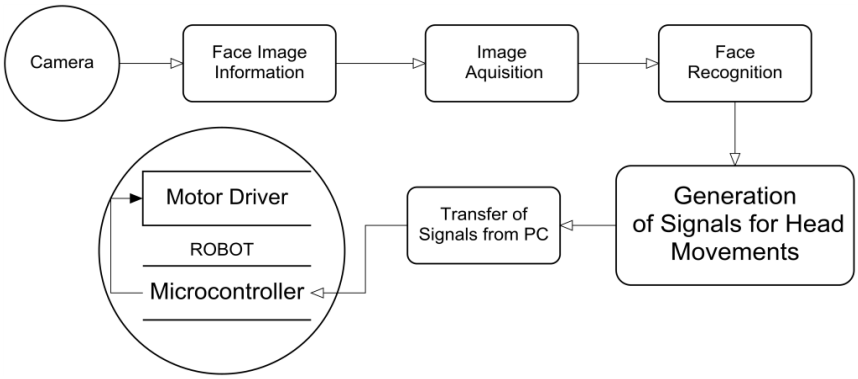

Figure 1: Experimental Setup

3. Human Machine Interface for Mobile robot control movements

Human Machine Interface is a technique which is use for controlling machines with human activities. In other words Input is human activities and output is machine operations. As shown in Table.1, The entire control strategy simulates the direction control from the Head movement. Four control commands which are Go Forward (F), Turn Right (R), Turn Left (L) and Stop (S) are used in this experiment as shown in third column. And four Head movements as shown in first column are Face at front (Straight Head), Right movement of Head, Left movement of Head and down movement of Head.

Table.1: Human Interface corresponding robot control commands

Head Movement	Image Patterns or Conditions	Control Commands
	Face at Front or in centre of image	Go Forward(F)
	Head turn to Right direction	Turn Right(R)
	Head moves to Left direction	Turn Left (L)
	Head Down	Stop(s)

The relation between the control command and robot movement can be expressed as follows:

- If Face is at front (Straight Head) then robot moves forward.
- If Head moves toward right then robot turns to right.
- If Head moves toward left then robot turns to left.
- If Head down and no face will appear in image then there is no motion in robot.

4. Methodology

In this paper, Image processing technique, which act as interface between Human and machine is used to control a robot with human head movement. The main idea is to identify the pixels only on face region and convert those pixels value to 255(for gray image) and rest of image pixels value to 0 using morphological operation [4] [7]. This indicates binary image in whole image as shown in Fig 2.

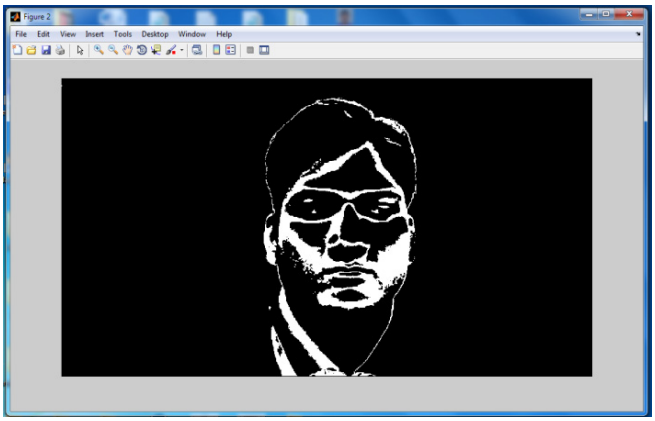

Figure 2: Binary image

The binary image is divided into three parts on the basis of x value of image (x, y), so that three regions Left, Center and Right are generated. Left region is indicated by coordinates ((0 to x/3), y), Center Regionis indicated by coordinates ((x/3 to 2x/3), y) and Right region is indicated by coordinates ((2x/3 to x), y). When user is in straight head position then face pixels (1) are lie in Center region, When user turn his head towards left then most of the part of his face pixels (1) lie in Left region, when user turn his head toward right then most of the part of his face pixels lie in Right region and when user head down then his face pixels disappear (whole image become black (0)). By using these four conditions four signals are generated and transmitted to the microcontroller of the robot through USART and which is used to control robot movements.

5. Proposed Algorithm for generation of four signal for Head movements

Human Computer Interface is achieved by using Image Processing techniques. MATLAB codes like 'videoinput('winvideo', 1)', getsnapshot(vid)', 'strel('disk', 5,4)', 'im2bw(im3)' are used for capturing image, store the image, creating the boundary and converting an image into binary image respectively. By identify the mean R, G & B values of face pixels, the face image will be recognised from the entire image. For removable of undesired things in image filter tools are applied [4, 5].

Figure 5 shows the flowchart for the MATLAB program for the proposed algorithm. The Proposed algorithm for generation of four signal of Head movement is as follows:

Step1: Capture image from camera.
Step2: Identify the mean R, G, and B values of face pixels in the image.
Step3: Apply condition for all face pixels value= 255(grayscale image) and rest are 0 in image.
Step4: Convert the RGB image to binary image.
Step5: Divide the image into three parts based on X value of image(x, y).
Step6: Apply the condition if face pixels are lie in left, centre & in right region of image(x, y) then it generate three different-different signals and these signal can transmit to microcontroller.

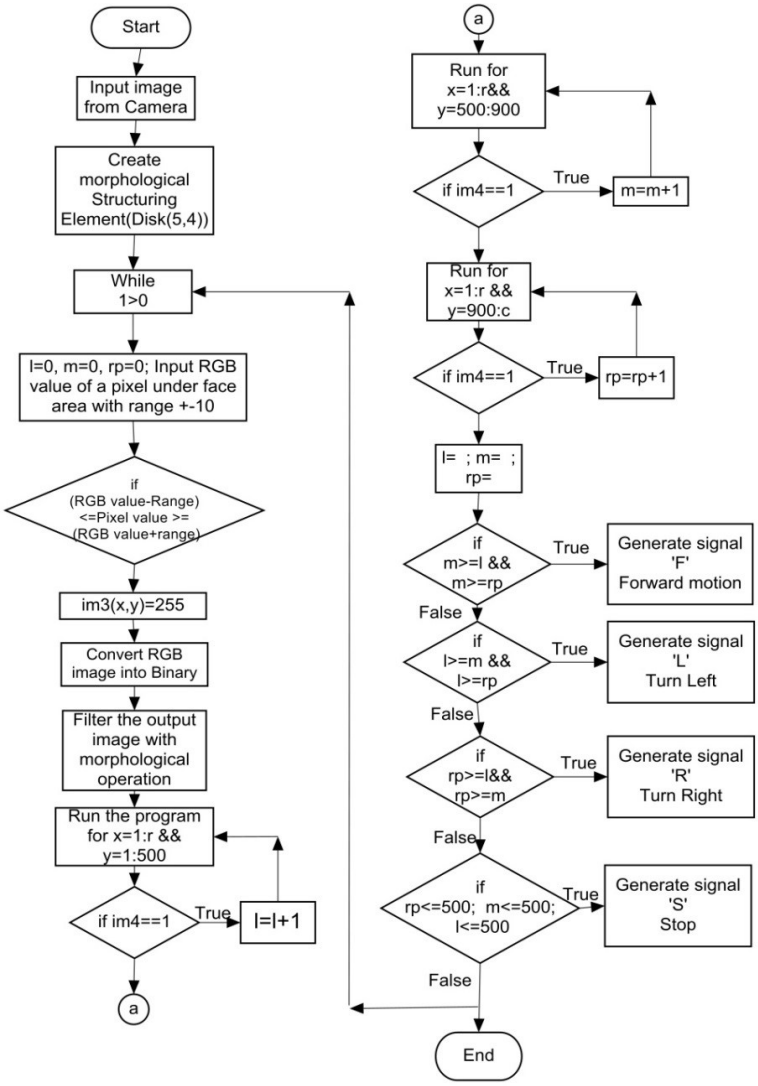

Figure 3: Flowchart of MATLAB coding.

6. Interfacing Robot with Head movement signals

The output signals L, F, R, & S obtained from above Head movement algorithm are given to full duplex USB-TTL Converter which converts the signals data from PC into binary signals suitable for microcontroller. The microcontroller generates specific signals and these signals go to a motor driver IC (L293D) [6], which gives variation in motion of the Robot based on the logic table shown in Table.2. Figure 6 show the hardware circuit and motion conditions for microcontroller output PORTB.

Table.2: Logic table for direction control & code for PORTB

Direction of Motor	Left Motor		Right Motor		PORTB
	FM	BM	FM	BM	
Forward	1	0	1	0	0xb00000101
Backward	0	1	0	1	0xb00001010
Soft Left	0	0	1	0	0xb00000100
Soft right	1	0	0	0	0xb00000001

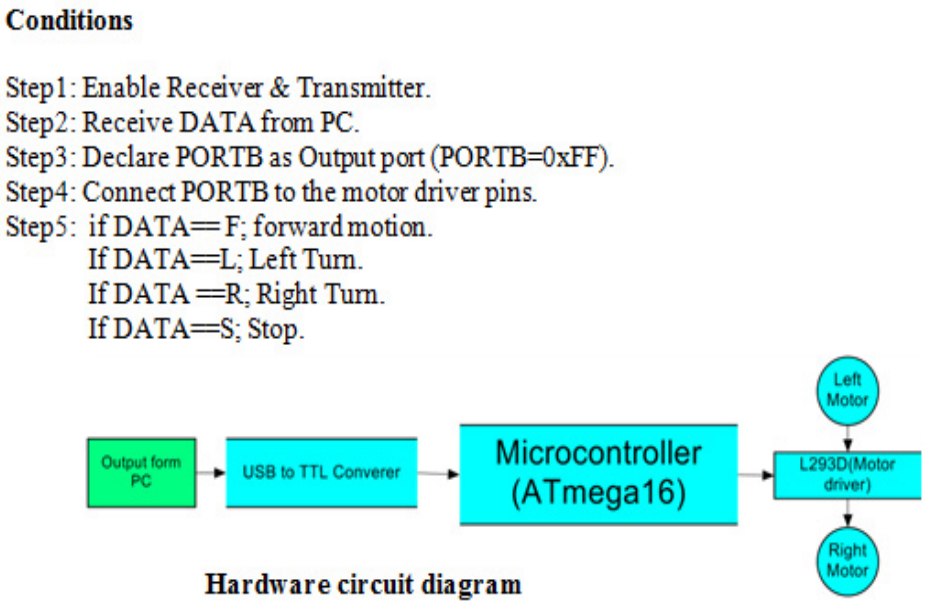

Figure 4: Condition for microcontroller and Hardware circuit diagram

7. Result

We have successfully implemented an algorithm which can detect the head movements. We are able to run the robot as per the movements of user head which finally signifies the face movements. This can be easily used to operate an EPW according to the head movements of physically challenged people. The code for head movement detection is written in MATLAB using image processing tools. The program for the control of robot is written in C language using AVR STUDIO compiler. Results of each head movement are shows in figures 6(a, b) to 8(a, b).

Figure 5: Complete setup of Experiment

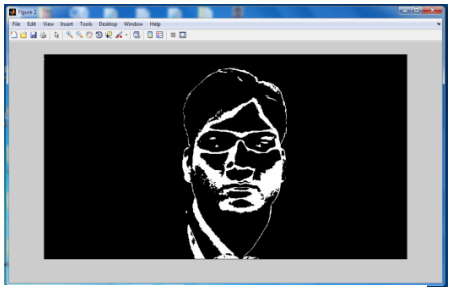

Figure 6(a): Head in front (Centre of the image(x, y))

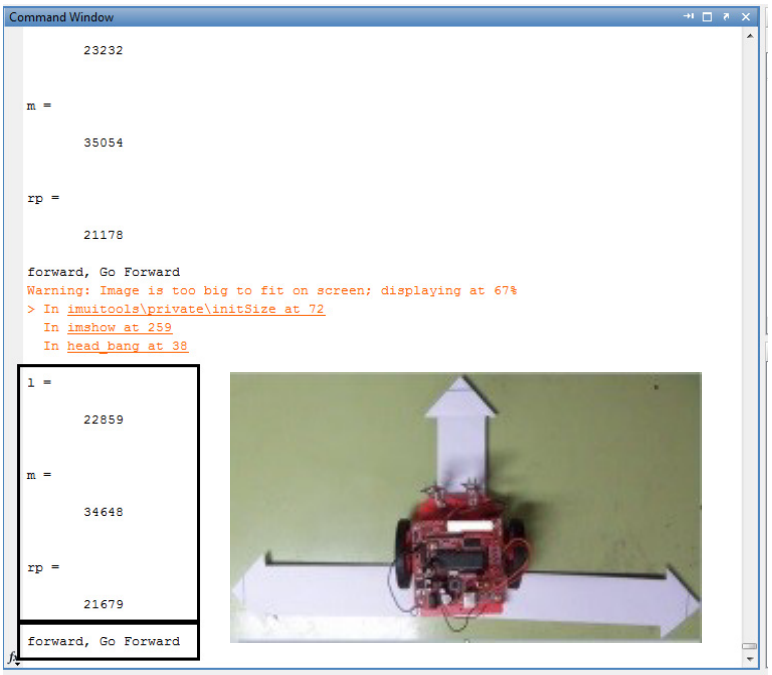

Figure 6 (b): Value of ‘m’ and display Go forward corresponding head in front

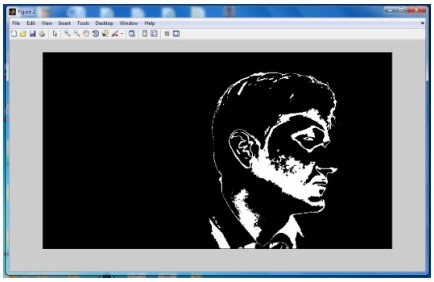

Figure 7(a): Head turn towards Right

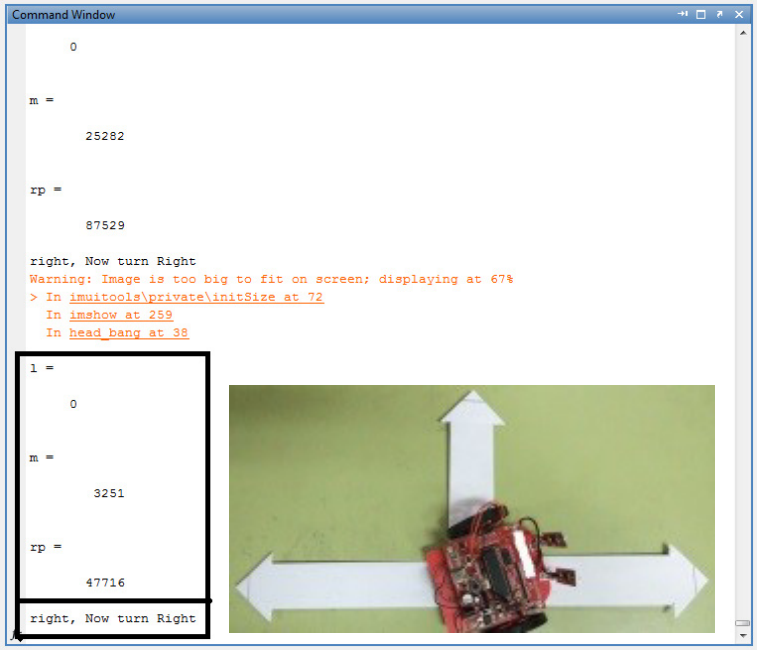

Figure 7(b): Value of 'rp' and display Turn Right corresponding Right turn of Head

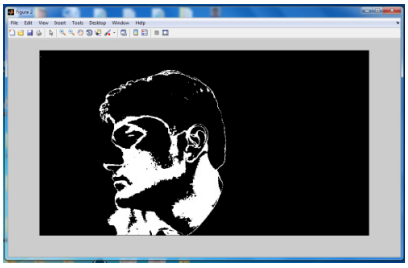

Figure 8(a): Head movement towards Left

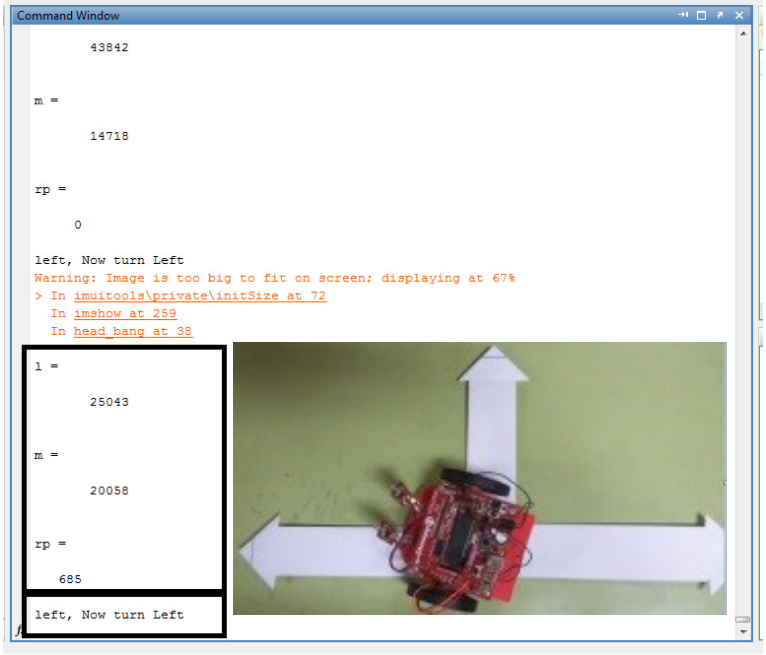

Figure 8(b): Value of 'l' and display Turn Left corresponding Left turn of Head

8. Conclusion and Future work

In this paper the method of HMI for controlling robot movements by user's head movements, is an idea for the elderly and disabled people who can control the EPW easily. In this way this paper presents a new method of HMI which will be helpful for disabled people.

In future many more control commands will be used for various motions and its accuracy can be improved. This system will be used with multi-modality input processes for more efficient system.

Acknowledgements

This research has completed in our college (NIT Warangal) mechatronics lab. This research has been financially supported by National Institute of Technology Warangal. We would like to thank the Director of NIT Warangal for his support.

References

[1] Lai Wei,Huosheng Hu, A multi-modal human machine interface for controlling an intelligent wheelchair using face movements, proceeding of IEEE International Conference on robotics and Biomimetics, Thailand, 2011, pp. 2850-2855.

[2] Lovendra Solanki, Dinesh Soni, S B Dandin, JL Raheja, Feature-based Head pose Estimation for controlling movement of robot motion in real time, IJECET, vol.4, pp. 08-19,oct 2013.

[3] Jae-Woong Min, Kyoobin Lee, Soo-Chul Lim and Dong-Soo Kwon, Human-Friendly Interfaces of Wheelchair Robotic System for Handicapped Persons,Proceeding of IEEE International conference on intelligent robot and system, EPFL Lausanne, Switzerland, Oct 2002, pp.1505–1510.

[4] R. C. Gonzalez, Richard, Eddins, Digital Image Processing using MATLAB, Pearson Education, Inc, ISBN 81-7758-898-2.

[5] MATLAB online help forum http://www.mathworks.in/help/vision/ref/vision.cascadeobjectdetectorclass.html

[6] Muhammad ali mazidi, Sarmad Naimi, Sepehr Naimi, The AVR microcontroller and embedded systems using assembly and C, Pearson Education, Inc, ISBN-13: 978-0-13-800331-9.