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AUTONOMOUS EYE

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Abstract*: Autonomous Eye is a powered wheel chair system, its movement is controlled using the eye movements. The system is implemented mainly for the paralyzed persons. The system helps the disabled persons to move independently. The system consists of a wheelchair, RF modem and a PC, which is connected to a webcam[12]. User's eye movements are converted to screen position using matlab software. When user looks at appropriate direction, using some image processing techniques the computer system will detect the direction, based on the coordinate position of centre of the iris[1] i.e., when user moves his eyes balls up then move forward, left then move left, right then move right, down then move backward and in all other cases wheel chair will stop[16]. The series of images captured by the camera is being processed and then it is fed to the RF modem. The RF transmitter transmits the processed data and it is received by the RF receiver on the wheelchair part. The decoder decodes the data and feds to the microcontroller. The microcontroller will produce the corresponding control information for the wheelchair motors. Ultrasonic sensors are connected to the microcontroller to detect the static and moving obstacle on the path of the wheelchair. The wheelchair consists of four wheels, two front wheels and two rear wheels. The front wheels helps to steering left and right and the forward movement is controlled by the rear wheels.*

Key words*: MATLAB, ATMega328, RF module*

1. INTRODUCTION

The Wheelchair is dependent system used by elderly and physically disabled persons. Here the implemented system is a totally independent eye controlled electric wheelchair[2]. As per requirement of the disabilities, different kind of automatic systems are available in market such as voice control or joystick control system. Considering the totally paralysed persons, they feel some difficulty to use that type of systems. Here the Eye controlled system make their life easy and more convenient.

In this system, the Camera captures a continues series of images in real time and do some image processing techniques like binarisation and edge detection then the processed image is then send to the RF modem as a serial data[1]. The RF transmitter encodes the data and send to the wheelchair. In the wheelchair part, the RF receiver receives the data and decodes it. This

data is taken as the input to the ATmega 328 microcontroller, the microcontroller which produces the corresponding control signals for the motor drivers[3]. The system consist of two motor drivers and four motor two of them are for forward and backward motion, the other two are for steering towards left and right[4].

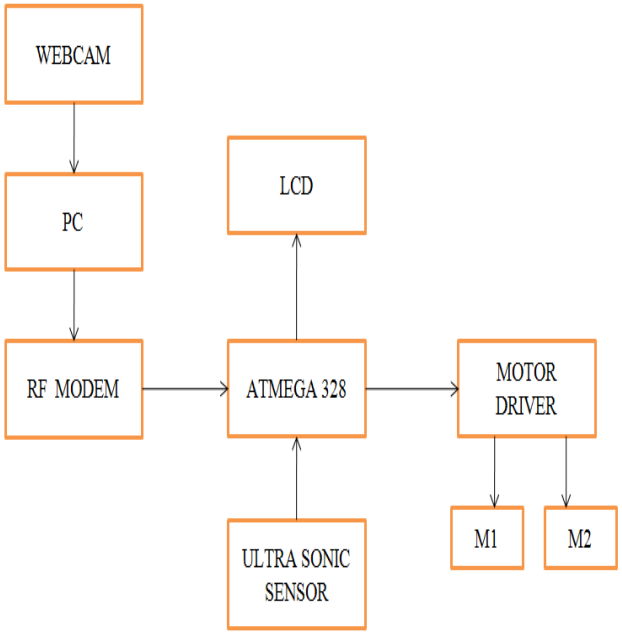

Figure 1: Shows the architecture diagram of the system.

The system uses an ultrasonic sensor to detect obstacle on the path of the wheelchair, the ultrasonic rays being reflected is being sensed by the sensors. The sensor is connected to the back of the wheelchair for avoiding collision when it moves backward.

The LCD display is used to display the direction of the wheelchair, which is connected to the microcontroller. If the system moves forward then it shows forward, moves backward shows backward and so on. If any obstacle detects then the system stops and display obstacle detected.

2) SYSTEM REQUIREMENTS

A)HARDWARE REQUIREMENTS

A) ATmega 328 microcontroller

In this system the processed data is taken as the input for the microcontroller and which produces the corresponding commands for the motor driver[4].

B) RF Modem

RF data modem working at 2.4Ghz frequency in half duplex mode i.e, data transmission occurs in both direction but not simultaneously with automatic switching of receiver/transmitter mode with a LED indication. Receiver receives and Transmitter transmits serial data of adjustable baud rate of 9600/4800/2400/19200 bps at 5V or 3V level is used for direct interfacing of the microcontroller.

This model works with Sunrom model 1252(USB). RF modem can be used for applications that needs two way wireless data transmission. It features high data rate and longer distance data transmission. The communication protocol used here is self controlled and completely transparent to user interface. The module makes the data transmission through wireless communication set up as an easy one.

C) Web camera

Web camera is used for capturing a continuous series of images[8]. We can also use an optical camera, it increase the memory size, these images are processed using matlab software.

D) Ultrasonic sensor

Ultrasonic sensors are used to detect obstacle in the path of wheelchair. Sensor is directly connected to the microcontroller[5]. It receives the data by sending Ultra sonic waves and measuring the distance between wheelchair and obstacle[6].. If any obstacle is detected very close to wheelchair, motors will stop to run the wheels. In this system the sensor is used to control the backward motion[7].

E) LCD (Liquid crystal display)

LCD is used to show the direction of the wheelchair. Here the system uses a 2*16 format i.e, two rows and 16 columns. The LCD is connected to the microcontroller. If the wheelchair moves forward then LCD shows forward, if it moves left then shows left and so on[5].

F) Motor

Four 12 volt DC motor is used in this system to demonstrate running of wheelchair in forward, backward, left and right direction. L293D motor driver is used to interface with microcontroller. Here the system uses H-bridge arrangement of L293D motor driver[3].

B) SOFTWARE REQUIREMENTS

A) Putty software

Putty is a free and open source terminal emulator, which is used for network file transfer application. Putty software is used to connect the desktop to microcontroller. It supports several network protocols, using SCP, **SSH**, **Telnet**, rlogin, and raw socket connection. It can connect to a serial port.

B) MATLAB software

MATLAB is a multi-paradigm numerical computing environment, developed by Math Works and it allows matrix manipulations, plotting of functions and data, implementation of algorithms. Although MATLAB is intended primarily for numerical computing, it is an optional toolbox uses the MuPAD symbolic engine, which allows access to symbolic computing abilities. An additional packages, Simulink, adds graphical multi-domain simulations and model-based design for dynamic and embedded systems. In this system captured images are processed in MATLAB environment[8].

3) IMPLEMENTATION AND SYSTEM DESCRIPTION

Here introducing the implementation of totally independent Eye controlled electric wheelchair. As per requirement of the disabilities, different kind of automatic systems are available in market such as voice control or joystick control system. Sometime for totally paralyzed person may have very difficulty to use that type of

systems. Here the Eye control system provides the independence to make their life easy and more convenient.

Camera will start to capture the series of eye images and then it is fed to the PC,Here the system uses winvideo interface to interface the camera to the matlab. Using some morphological operations in image processing, the captured RGB image is converted to a binary image. These binary image then undergoes edge detection after this process calculate the centroid of iris images and send it as a serial data to the microcontroller through RF transmitter. The transmitter encodes the data and send as an RF signal. The RF receiver at the wheelchair part receives the signal and decodes it. The RF modem here the system used helps to transmit the data through a serial port. After decoding the processed data is fed to the ATMEGA 328 microcontroller, which produces the corresponding control commands for the motor drivers[4].

For detecting static and dynamic objects on the path and their by avoiding collision the wheelchair system uses an Ultrasonic sensor. The sensor which transmit the ultrasonic waves, if any obstacles are in the path the waves are reflected back and then the wheelchair stops[5]. The sensor is connected to the microcontroller.

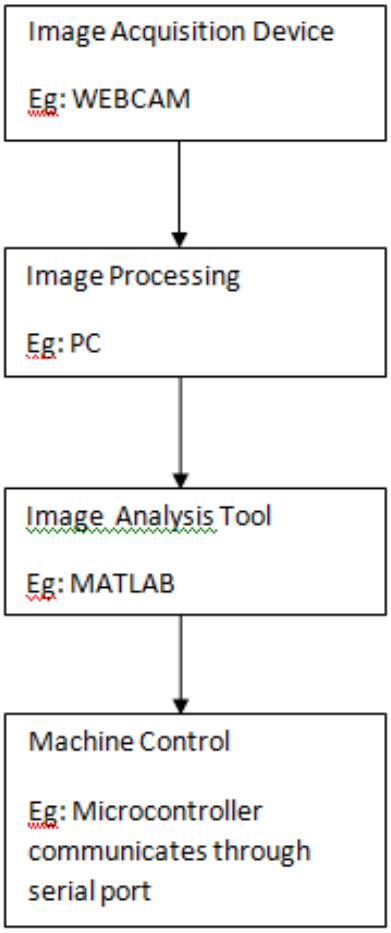

Figure 2: Flow chart of the system

This is an efficient as well as a cost effective system. Here real time image capturing of eye and iris detection occurs with minimum delay of time.

4) DESIGN METHODS

Following are the types of morphological operations used for our system:

A) BINARISATION

Binarization is the process of converting a pixel image to a binary image[1].

BW = im2bw(I, level) converts the grayscale image named as I to a binary image. The output image is BW, which replaces all pixels in the input image with luminance greater than a threshold level with the value 1 (white) and replaces all other pixels with the value 0 (black) to specify level in the range [0,1]. This range is relative to the signal levels possible for the image classes. Therefore, a level value of 0.5 is a midway between black and white, regardless of class. For computing the level of argument, use the function graythresh. If you do not specify the level, then im2bw uses the value 0.5 as default.

BW = im2bw(X, map, level) converts the indexed image X with colormap to a binary image through maping.

BW = im2bw(RGB, level) converts the truecolor image RGB to a binary image.

If the input image is not a grayscale image, im2bw converts the input image to a grayscale image, and then converts this grayscale image to binary by thresholding.

B) EDGE DETECTION

Edge detection is a morphological operation used for finding the boundaries of objects within the images[1]. It works by detecting discontinuities in brightness of each image pixels. Edge detection is used for image segmentation and data extraction in image processing, computer vision, and machine vision.

C) EYE TRACKING

To track the eye movements we uses the coordinate system. Which decide the location of centre point of user's eye image. Figure 3 indicates the location of the center of iris using coordinate system graph. Where A1 and A2 are the corner points of iris in X direction, B1 and B2 is corner points of iris in Y direction. The X and Y calibration point represents the direction of eye movements[14]. The eyeball position at the (A0, B0) points is:

A0 = (A1+A2) / 2
B0 = (B1+B2) / 2

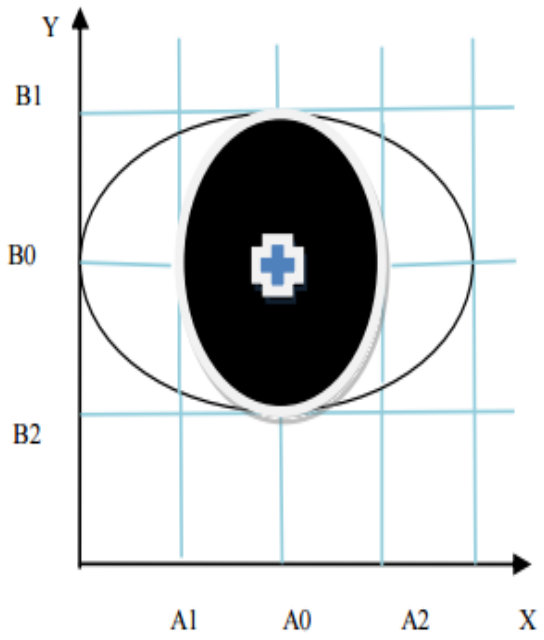

Figure 3: Coordinate system with respect to eye position

5) RESULTS

The wheelchair system received the processed data of the captured images. Based on the centroid location, the microcontroller sends the commands to the motor driving circuit. Then wheelchair moves in required direction according to eye movements. An Ultrasonic sensor is used for obstacle detection. It measure the distance between wheelchair and obstacle. When obstacle is very close to wheelchair, motors will stop the wheelchair.

6) ADVANTAGES

- The most challenging aspects are finding a good way to differentiate iris and its center locations, determining the eye‘s movement and controlling the wheelchair’s wheels in proper direction. Our system acquires it.
- Night vision is possible by mounting infrared cameras.
- Ultrasonic sensors detects mobile as well as static obstacles, thus stops the wheelchair.
- For getting external assistance, audio options are provided.

7) APPLICATIONS

- Neuroscience or Neuropsychology
- For vision research
- Used in experimental psychology
- Used in Cognitive Psychology
- For psycholinguistics
- Psychiatry specially in Mental Health
- Transportation: Flight simulators or Driving simulators
- Robotics – Remote Vision Control
- Video and arcade games

8) CONCLUSION AND FUTURE WORKS

A) CONCLUSION

Our project, Autonomous Eye consists of a wheelchair, the motion of which is controlled by the eye movements of the user. Autonomous eye is implemented to help physically disabled persons to make their life independent. A sequence of images of the eye will be captured and it is processed in MATLAB to obtain the direction of movement of the wheelchair[10]. There the system used the ultrasonic sensor for obstacle detection[7]. Low cost RF transmitter and receiver are capable of handling some basic wireless communication such as sending basic instruction to MCU of the robotic wheelchair.

B) FUTURE WORKS

The system can be extended to control the equipments around such as fans, lights, etc. The software can also be modified, and along with sound synthesis can be used to produce voice commands. To make the system more interactive with the patient we need to add some additional sensors. Time delay may be further reduced to a second. Operation of the system depends on eye movements of totally paralyzed patients. Thus wheelchair moves in all required direction with a good response.

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