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Eye Controlled Wheelchair using Image Processing

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Abstract: This paper delivers a method to guide and control the wheelchair for disabled people based on movement of eye. The proposed system involves three stages: image detection, image processing and sending of control signals wheelchair. Though there are many methods available in recent times to enable their motility, they require efficient and accurate control which is most of the times not possible. The proposed model is a possible alternative for this. The camera signals are monitored by a JAVA script, which will then guide the motors wired to the AtMega328P Microcontroller over the Serial Interface to move in a particular direction. The system is cost effective and thus can be used by patients spread over a large economy range.
Key words: Eye controlled, Eye ball tracking, Electronic wheel chair, Euclidean Distance Algorithm, Web camera

I. INTRODUCTION

There are number of persons who are paralyzed and therefore dependent on others due to loss of self-mobility which is increasing nowadays. Evolution of the wheelchair for paralyzed users was recently started with the conventional powered wheelchairs which were handled manually to advanced electrical wheelchairs. The use of conventional wheelchair focuses exclusively on manual use which assumes users who are able to use their hands. Diseases or accidents injuring the nervous system cause people to lose their ability to move their voluntary muscles. Because voluntary muscle is the main factor which enables people to move their body, paralysis may cause a person not move their locomotive organ such as arm, leg and others. Hence, we use powered wheelchair. Powered wheelchair uses independent mobility amongst the handicapped. This thus, increases vocational, educational opportunities and reduces dependence and promotes feelings of self-reliance.

Scientist Stephen W. Hawking is a well-known victim of major paralysis. In 1962, Hawking was diagnosed with incurable Amyotrophic Lateral Sclerosis (ALS), thereafter using a wheelchair to move. Many people suffering from complete or partial paralysis usually can control their eye movements which gave us an idea to construct an eye-controlled wheelchair. This idea of an eye-controlled wheelchair was inspired by our past project voice controlled robot. In that project, the voice commands of handicapped person were used to guide the robot or wheel chair in the desired direction. We wanted to improvise the idea by making the system completely isolated from the person physically, and thus improving the usability of the system.

II. PROBLEM STATEMENT

The main objective of this project is to make a wheelchair which will be controlled by the movement of an eye i.e. on movement of pupil.

III. RELATED WORKS

For developing automated wheelchair there are various approaches which are as follows:

A. Voice Controlled Wheelchair

In this technique, the voice-controlled wheelchair robot is developed for particular elder or physically challenged person by predefining their voices in the system. The voice of the person is detected by voice capture module and that is compared with the voice recognition module with predefined voices loaded into the system. The commands such as front, backward, right, left and hold on are given by the person sitting on the wheelchair. This particular type of wheelchair is useful for paralyzed people or those suffering from disabilities in the arms or legs and is also useful for elderly people. It is not useful for people with speaking disabilities. Background noise is the main hindrance in this particular technique.

B. Joystick Controlled Wheelchair

In this particular type, a joystick is provided with which the user can control the movements of the wheelchair. The main advantage of this wheelchair is that it moves precisely in whichever direction the user wants. Proper skills are required to handle the joystick. People with disabilities in their arms cannot make use of joystick controlled wheelchair .The experimental joystick is an IJ with a

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voltage output proportional to the force exerted on the stick by the human subject. The joystick obtains its power from the batteries and runs on 12 V dc. The test wheelchair used a Dynamic Controls DMC-60 controller with a 7 V nominal center voltage.

C. Eeg Based Wheelchair

The wheelchair movements are controlled by the signals of brain. This technique is known as Electroencephalogram (EEG). So, basically EEG signals in form of voltages are sent to the wheelchair assembly to move. Here multiple electrodes are connected to the brain in order to know the appropriate commands. So if in case user wants to take any decision, then he/she has to think accordingly so that the required amount of voltage is given to the wheelchair motors to move. This is more precise technique compared to all as it doesn't need any body movement or eye movement but needs accuracy in generating the appropriate commands.

D. Gesture Controlled Wheelchair

The wheelchair movements are controlled by hand gestures of the user sitting on it. It is a reliable means for human and computer interfacing which is based on hand gestures made in three dimensions. Now in this method, they have used web camera for detecting the hand gestures. AdaBoost algorithm is used to detect the hand location. The image is in 320*240 resolution which is divided into 9 blocks and the algorithm will check in which block the hand is located.

E. Eye Controlled Wheelchair

In this proposed system, wheelchair will move according to the eye movements. First the image is taken using camera which will be mounted in front of any of the two eyes. Then the image will be processed in the Microsoft visual studio 2010 and openCV. For detecting the location of the pupil Daugman's algorithm is used. As the user is not supposed to do any kind of body gestures, making this system more reliable. Hence making comfort to people who have arm disability or who can't make precise body gestures.

IV. INTRODUCTION TO THE SYSTEM

In our approach for developing eye controlled wheelchair we are going to develop prototype of a wheelchair. By using Qualcomm webcam we will capture the images of an eye. Captured images will be processed in Processing 3.0.1. According to movement of user's eye, corresponding commands are generated which are then sent to Arduino and RF module for communication and wheelchair is controlled.



FIG 1.1

A. System Description

Following are the steps in our approach:

1) Use web-Camera to get the real time video.
2) Processing the individual image frame.
3) Extraction of iris from captured image.
4) Connection to the wheelchair.
5) Forming a rectangular grid to check the position of eye ball.
6) Sending commands to Arduino on receiver side via RF.

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V. PROPOSED SYSTEM

A. Proposed Method

The method which we are using for controlling wheelchair is based on eye. i.e. eye controlled wheelchair. We are using Euclidean's distance algorithm for comparing colours. We will be running that algorithm in Processing 3.0.1. The basic components which we are using includes a camera, a wheelchair, a microcontroller-Arduino Uno. The serial communication between Processing 3.0.1 and Arduino is done via serial ports.

B. System Overview

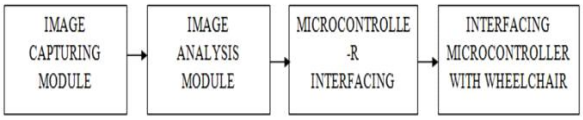
1) *Web camera:* Spectacle mounted camera is used for capturing images.



2) *Processing 3.0.1:*Processing 3.0.1 is used for programming using openCV libraries. First we were using MATLAB application for image processing but due to lagging problems in processing and its large size, open CV is used.
3) *Arduino uno:* The microcontroller will take a USB output from the laptop and it will convert the obtained digital output to electric signals that will be sent to the wheels. The microcontroller which we are using is Arduino Uno. Arduino Uno is a microcontroller board based on the ATmega328P.
4) *Radio Frequency Module:* RF modules are used for wireless communication. We can easily transmit signals within a particular range.
5) *Wheelchair:* A wheelchair prototype instead of an actual wheelchair is used in this project.

C. Block Diagram

In Image Capturing Module, we capture the images using camera and after perfect capturing of image, it is sent to Image Analysis Module where segmentation of image is done. Processing for finding the colour of the pupil and its direction is found out. In Microcontroller Interfacing, how to interface the generated electric digital output to electric input is discussed. And finally Microcontroller interfacing with wheelchair is discussed in that module.



VI. METHODOLOGY

A. Image Capturing Module:

Image Capturing is to capture a sequence of iris images from the subject using a specially designed camera. In colour tracking image capturing is a very important step. Since eye ball is small in size and dark in colour, it is difficult to acquire good image. It is to capture a sequence of iris images from the subject using a specifically arranged camera. A camera must have enough resolution to capture the details.

B. Euclidean distance algorithm:

Euclidean distance or Euclidean metric is the "ordinary" straight-line distance between two points in Euclidean space. With this distance, Euclidean space becomes a metric space. Euclidean distance algorithm computes the minimum distance between a column

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vector x and a collection of column vectors in the code book matrix cb. The algorithm computes the minimum distance to x and find the column vector in CB that is closest to x.

$$d(p,q) = d(q,p)$$
$$= \sqrt{(q_1 - p_1)^2 + (q_3 - p_3)^2 + \cdots + (q_n - p_n)^2}$$
$$= \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

C. Image Analysis Module

The algorithm finds the colour of the eye ball with the click of the mouse button. The second algorithm takes the information of the colour and tries to find direction in which the eye looks.

Finding colour of the eye ball.

Finding the direction in which eye look.

VII. HARDWARE

Once the commands are received on serial port, they are sent to Arduino connected to the particular port. It will accept the commands and it will be sent to the RF connected. And then wirelessly it is transmitted to another RF on the receiver side mounted on wheelchair.



VIII. RESULT

A. User looking in upward direction. Selected pixel will cross the upper boundary of the rectangle. So wheelchair will move forward.

B. User looking in downward direction. Selected pixel will cross the lower boundary of the rectangle. So wheelchair will move backward.

C. User looking in left direction. Selected pixel will cross the left boundary of the rectangle. So wheelchair will move in left direction.

D. User looking in right direction. Selected pixel will cross the right boundary of the rectangle. So wheelchair will move in right direction.

E. User looking in forward direction. Selected pixel will be within the boundary of the rectangle. So wheelchair will stop.

IX. CONCLUSION

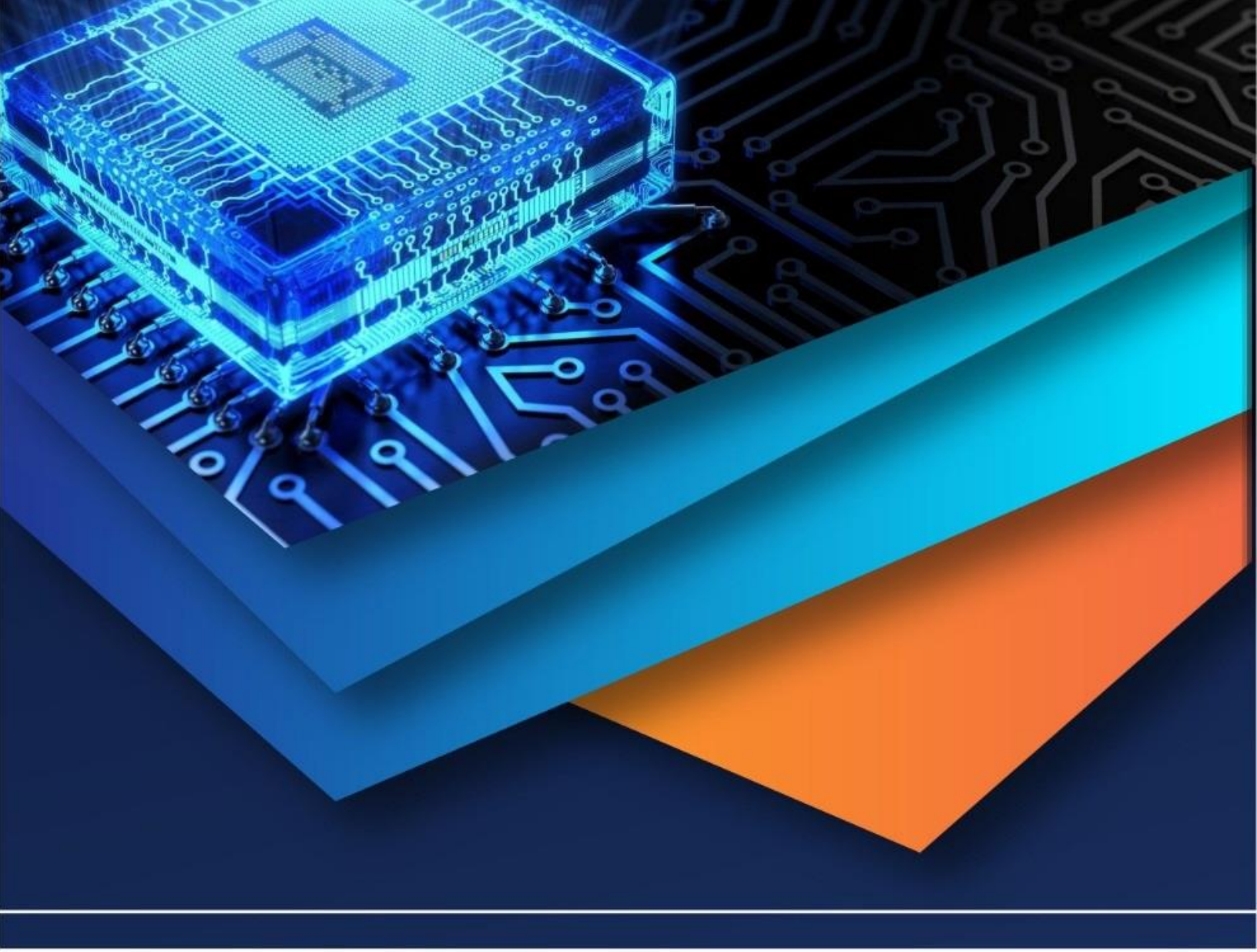
Eye controlled wheelchair method is convenient for handicapped people compare to other methods mentioned. As there is no need of any other body parts for handling the movement of the chair.

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