A REVIEW ON EYE BALL DETECTION BASED WHEELCHAIR CONTROL USING MATLAB AND ARDUINO PLATFORM FOR A PHYSICALLY DISABLED PERSONS

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Abstract— This review paper includes the electronic wheelchair that is implemented for the disabled person who cannot walk. The purpose of this eye ball controlled wheelchair is to eliminate the assistance required for the disabled person. In this system we are controlling the wheelchair by eye movement and central switch. A good resolution camera is mounted on wheelchair in front of the person, for capturing the images of eyes and tracking the position of eye pupil by using any image processing techniques using Matlab platform. According to eye pupil position of disabled person, motor will be moved in required direction such as left, right, backward and forward. We are also using Ultrasonic sensor. It is mounted in front of wheelchair for safety to detect static obstacle or mobile barriers and to stop the wheelchair movement automatically. A central button switch is also mounted on wheelchair handle for emergency purpose and to stop movement in require direction if any one call to stop and someone require attention on themselves. This is independent and cost effective wheelchair system. An Arduino board is used to control whole system.

Index Terms— Arduino, Computer vision library, Image Processing, Matlab, Eye gauge

I. INTRODUCTION

There are number of persons who are paralyzed or physically handicapped, therefore they depend on other people due to loss of self-mobility. This dependency is growing day by day with the population. The development of the wheelchair for paralyzed and disabled person is surprisingly increasing recently starting with the conventional manually powered wheelchairs and advancing to electrical wheelchairs. Conventional wheelchair use tends to focus exclusively on manual use, which assumes users still able to use their hands which excludes those unable to do so. Diseases or accidents injuring the nervous system also makes people to use wheelchair because people lose their ability to move their voluntary muscle. Because voluntary muscle is the main actuator enabling people to move their body. Paralysis may cause a person to not move their loco-motor organ such as arm, leg and others. Paralysis may be local, global, or may follow specific patterns. Most paralysis are constant, however there are other forms such as periodic paralysis (caused by genetic diseases), caused by various other factors. In our project the advance level of Image Processing open computer vision library is used for Face and Eye detection [1]. And several application and algorithms are used to find out accurate pupil location detection and tracking of that. One of them is Haar cascade like features detection algorithm used to detecting the exact Eye pupil and locate its center point is ultimate goal of this system. For automatically finding out eye pupil and tracking eye pupil, many computer vision library of Image processing are used like object detection, motion detection, image color conversion, edge detection, pattern matching etc. For eye pupil tracking there are several number of other techniques available [6] [15]. But they have its own limitation. One of them ECG, EEG and EOG sensor based eye pupil detection technique is available [6] [8], where voltage variation based output assumed to decide the location of pupil [9]. But for different paralyzed user, different output voltage will be generated, which will result in faulty location of the eye pupil. The head movement based system have limitation, where user cannot be able to access the system physically [11] [10].

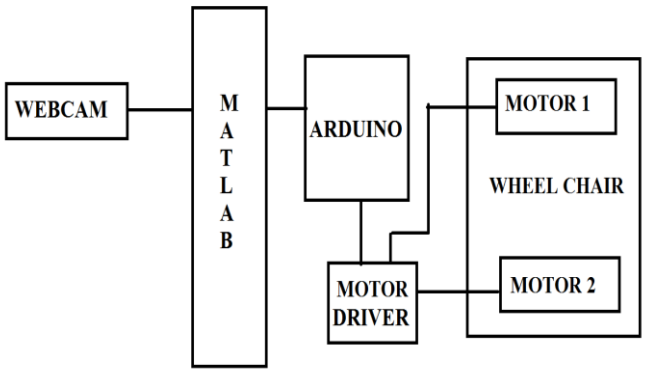

Figure 1: Block diagram of the Eye-Tracking System

The idea was to create a generalized tool that can be easily interfaced with other systems like electric wheelchair, movable patient bed, eye controlled alerting mechanisms for disabled ones etc. To validate the proposed idea, a motorized platform was interfaced with the eye-tracking system via microcontroller and specified motor drivers. The block diagram of the proposed system (figure 1) shows the network of the hardware and software integration.

Objective:

The main objective here is designing a GUI to capture or load an image and also establishing a system that can track the position of eye ball and recognize with respective movement. Thus, we can summarize our project as follows: the main objective of this project is "to design a vision based wheelchair system", using the camera to acquire disabled person's eye pupil position images and analyzing disabled person movement detection.

II. LITERATURE REVIEW

There were many previous works carried out on electric wheelchairs. A few of them helped us get ideas for our current prototype. In [12], Karthikeyan K C et.al, proposes an optical-type eye tracking system to control powered wheel chair. User's eye movement is translated to screen position using the optical type eye tracking system movement. In [16], a method is proposed to control the motorized wheelchair using EOG signals. The method allows the user to look around freely while the wheelchair navigates automatically to the desired goal point. Another control method of a robot is by means of an electric wheelchair, dedicated to severely disabled persons, equipped with a low-cost web camera, using only eye movements and gaze direction. In [5], iris recognition is by characterizing key local variations. The basic idea is that local sharp variation points, denoting the appearing or vanishing of an important image structure, are utilized to represent the characteristics of the iris. Using the ideas listed in the survey we developed a wheel chair for paralyzed persons based on eyeball detection technology.

III. IMAGE PROCESSING BASED EYE BALL TRACKING

In this research work a pupil has been identified via image processing in 2D domain to determine various required parameters [4] [3]. For this purpose MATLAB has been used which is more précised and accurate for image processing of tracking application [12]. A graphic user interface or GUI based eye tracking environment is developed in MATLAB that is able to detect pupil of an eye following the design steps as mentioned below.

1) Image acquisition: The image processing starts with the frame acquisition through a webcam that transferred data serially to MATLAB. The resolution was adjusted to 320x240 to speed-up the procedure and to make data processing simpler. An infinite triggering event for the camera is initiated for continuous stream of data whereas.

2) Plane separation: The stored RGB frame is then separated into its respective planes i.e. red, green and blue.

Among the three planes, red plane was selected for the feature extraction step because it had appropriate values of brightness, contrast and gamma presets that resulted in a clear identification of pupil.

3) Segmentation: Logical threshold function was applied on the red plane image. The GUI is capable of performing real time threshold of the continuous data stream. The value of threshold varies with amount of ambient light which needs to be tuned in the beginning of the GUI.

Algorithm:

We use viola-jones algorithm for detection of drowsy driver detection. It is based on machine learning approaches**,** where we can train many positive and negative images using cascade function. This algorithm is use to detect the object from the real time capture images and video. We need extract feature images from it. Each of feature [17] having a single value which is obtained by subtracting the sum of pixels under custom rectangle from the sum of pixels under black rectangle.

The function of this proposed system contains various stages such as skin color detection, face detection, mouth detection and eye detection etc. We will discuss all the blocks one by one to understand the complete process of detection of eye and mouth. So that the road accident due to drowsiness **[**10] can be avoided. For the proper detection of the status of eye and mouth or the facial expression a web cam is installed with are the controlled by computer vision.

Eye tracking

The high speed processing, to eliminate the processing of each frame to detect the position of eye from the captured image, to obtain this a new function is used [20]. This function is used in such a manner that the actual position of the eye can be tracked by recognizing the area which becomes impossible to track without using this function. [8] The eye tracking is a concept which defines the area of the facial image where eye search is made as per the central coordinated of the eye. This is necessary for this tracking system is to track the data from the captured image and compare it with the reference image. To track the actual position of the eye, [19] by detecting the next frame so that actual information can be obtained. The degree of openness will decide the tracking of the eye whether it is correct or not. If the degree of openness of eye varies between the specified range. Similarly, if eye remains out of range which means it is not traced correctly. The region of eye will start from some initial points so to detect [21], [25] this points a coordinate system is required. Once the image is captured, at specific distance from the head and mouth the position of the eye are located. Let this distance is (0.5 * height of captured image) from the top and (0.25 * width of captured image) from the left. The size of window is (0.35 * height of image) in height and (0.58 * width of image) in width. Before detecting the eye, the conversion is done. The specified configuration represents a complete frame of the image which are capture and over which all the operations are need to be performed.

IV. SYSTEM APPROACH

MATLAB 2013 equips an Image Processing Toolbox, which we have used majorly in this section of the Software Design. We use a Microsoft LifeCam HD-5000 web camera which is connected via a USB cable to the Computer on which the MATLAB script is running. We can stream continuous video signals on MATLAB coming from the camera using the video processing toolbox available. The function 'imaqhwinfo' is used to recognize all video capture adaptors. Identifying the correct device and then using it to stream the video signal is the next step.

The requirement of our design was to continuously look at different frames, based on which determine motion. It is practically impossible to do a lot of processing on a per frame basis. That is why we try to sample every 25th frame. So, a snapshot of every 25th frame is captured and processed. We used the 'getsnapshot' command to capture these snapshots.

The image is then converted to grayscale image, as we do not need color information to detect eye feature points. The conversion in fact makes the detection easier [22]. The 'imadjust' command is used then to contrast stretch the image to make darker sections even darker,

enhancing the eye feature points useful for the application. This pre-processing of the image makes the image easier to process and extract the eyes from.

After the initial pre-processing, we move towards the eye detection. The Eye Detection is done using the Computer vision Object Detection technique. Primarily this algorithm was designated for face detection though it is used for all sorts of object detections. The algorithm is designed to work on sum of pixels in a rectangular area. This algorithm [5], [20] that face can be detected by looking for rectangle. And then the large rectangle is made up of many such smaller rectangles, which are fundamentally feature points on a human face. The 'cascadeobjectdetector' [6], [24] on MATLAB, utilized this algorithm to extract and detect the eyes of the person. We then show the detected eye by plotting the rectangle at the appropriate position of the eye.

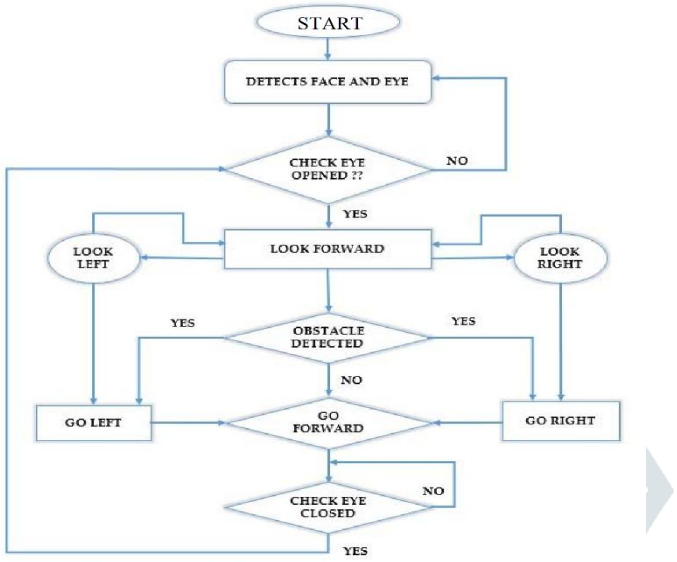

Figure 2: Flowchart of system working

Initially, all we do is monitor if any eye feature points have been detected or not. If not set a flag and display it on the debug screen. To increase the detection accuracy, we wanted to neglect all other points on the screen except the actual eye of the person. The reason being, if anyone except quadriplegic person comes in front of the camera, the person should not affect the system. Also certain things seemingly looking like eyes should be rejected as well. The way we incorporated this is taking into account the height and length of the eye. After repeated testing, we decide a length and height of a valid eye, sets a range around the threshold and reject everything which is outside it.
The blink detection section is not compute intensive. We use a flag which is set each time no valid eyes are detected. If in corresponding frames the flag value sets, it indicates a blink. A series of 3 such blinks command the motors to freeze, halting the wheel chair. What is assumed is that the position of the camera is fixed, relative to which the left and the right eye approximate positions can be estimated. Using this, we try to distinguish and store left and right eyes in different matrices. This helps getting a clear discrimination between both the eyes, helping in easy movement detection.

The movement detection is done with a very basic principle. We take in the feature points for both left and right eyes and save it. Thereafter take the difference in pixels of the left eye position and right eye position in the current snapshot from the previous snapshot. We define the threshold for the minimum movement of the eye required to be qualified as a valid attempt. In each snapshot the difference is evaluated, and if this difference above the threshold in any direction left or right, the flags indicating left movement or right movement are set. If the difference is not above the threshold, the flag which says that no movement has occurred is set.

Sometimes due to non-linarites, both the eyes are not detected. At such instances while evaluating the difference for detecting movement, we would give a bias to the eye which was detected in the previous snapshot. After detecting the eye movements, we can proceed to determining and sending serial signals to the Arduino. After determining which direction the wheel chair has to be moved in, the decision is transmitted to the Arduino via the serial port. The only thing sent is a one digit decision, saying right, left or straight movement.

Today the ability to measure and analyze eye movements is increasingly important for the on-task assessment of human factors in operating vehicles, interacting with products or in ergonomics. Since hand and eye coordination is the key issue in sports and in professional training, eye tracking can play a major role in analyzing and improving performance of the players. Eye tracking also allows market researchers to pre-test their clients' designs by measuring what the target audiences see and so improve the impact before the launch [4].

V. DISCUSSIONS

In this paper, we review and survey the many of issues on previous technique [5] [7]. We are trying to design an innovative technique to control the wheelchair with low cost, to solve the previous issue. We develop a compact GUI based model, which help the user for easily capturing the eye images and control the direction of wheel chair.

VI. EXPECTED OUTCOME

In this review paper we have tried finding out a technique of controlling wheelchair system using eye ball movement which enables the disabled patient to move their wheelchair independently in their own respected direction. In the real time application, we can be use camera, emergency switch and ultrasonic sensor depends on their application. The aim of this project is to contribute to the society in our small way by setting out an idea for a system which could actually better the lives of millions of people across the globe. We believe we have done great justice to the idea, and ended up we will getting more than satisfying results.

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