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Real-Time Eye Tracking System for People with Several Disabilities using Single Web Cam

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Abstract - Eye tracking system is the system which tracks the movement of user's eye. The handicap people with several disabilities cannot enjoy the benefits provided by computer. So, the proposed system will allow people with several disabilities to use their eye movement to handle computer. This system requires only low-cost webcam and personal computer. The proposed system has five stage algorithms that is used to developed estimate the direction of eye movements & then uses the direction information to manipulate the computer. The proposed system can detect eye movement accurately eye movement in real time.

Keyword **- Face Detection, Eye & Pupil Detection, Eye Gaze Detection, Mouse Controlling.**

1. Introduction

Eye tracking is the process of measuring either the point of gaze where user is looking. Eye gaze detection technique expresses the interest of a user. An eye tracking system is a system that can track the movement of a user's eye. The potential applications of eye tracking system widely range from drivers fatigue detection system to learning emotion monitoring system. Many accidents are due to driver inattentiveness. Eye tracking is used in communication systems for disabled persons: allowing the user to speak, sending e-mail, browsing the web pages and performing other such activities, using only their eyes. The "Eye Mouse" system has been developed to provide computer access for people with severe disabilities. Eye Movement are frequently used in Human-Computer Interaction studies involving handicapped or disabled user, who can use only their eye for input. Eye controlling has already accommodated the lives of thousands of people with disabilities.

The system tracks the computer user's movements with a camera and translates them into the movements of the mouse pointer on the screen. An eye tracking & eye movement-based interaction using Human and computer dialogue have the potential to become an important component in future perceptual user friendly. So by this determination designing a real-time eye tracking software compatible with a standard computer environment.

2. Literature Survey

In the past year, number of approaches has been used to create a system using the human system interaction. That included various methods which include head movement detection and hand gesture detection techniques. Head movement detection this method also attract user or researcher's focus and interest it simplest and effective method of human and machine interaction. Head movement detection includes recognizing the head portion from image and extracting the associated information about the coordinates from the same. Series of such processing gives you resultant data that can be used for synchronizing head and computer synchronization. Viola-Jones object detection algorithm [1] is mainly used to for head detection. Object detection is the process of finding instances of real-world object such as faces, bicycles etc. Object detection algorithm use extracted features and learning to recognize instances of an object of that category.

Fig.. 1 Viola-Jones object detection algorithm

Further improvement was made by introducing gesture detection instead of head movement which was more accurate and wiser applicable approach rather than head movement. Hand gesture detection was the major part which was and is being used for system Control. 3d model based algorithm, skeleton based algorithm [2] and appearance based algorithm are commonly used algorithm for hand gesture detection. In skeleton based algorithm [2] joint angle parameters along with segment lengths are used to depict virtual skeleton of the person is computed and parts of the body are mapped to certain segment.

Fig. 2 Virtual Hand skeleton mapped using Skeleton based algorithm.

The 3D model approach use volumetric or skeletal models, or combination of the two. Volumetric approaches are heavily used in computer animation industry and for computer vision purposes. The models are generally created of complicated 3D surfaces. The drawback of this method is that is very computational intensive and systems for live analyses are still to be developed.

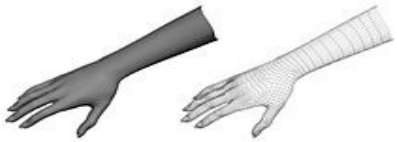

Fig. 3 .Hand mapped using 3D based modeling algorithm

Recent years more emphasis is given on eye detection and retina detection. The major algorithm proposed use the concept of static images and motion based tracking. Algorithm that has been concentrating on static images used the first image as base and other images as the reference for the detection the direction of motion. This aims the segmentation of the area belonging to eye by low intensity area by converting image into gray scale and intensity of pixels inside the segment. In algorithm that is based on motion, there is requirement of several frames which are used to find the frame difference. Frame difference is the technique in which two frames are subtracted to assume whether there is any motion or the direction of the motion. It is a method that uses localization of key points that characterize the eye and estimate its position by referencing next frames. Another way of detecting eyes are based on the templates that are learned from the set of training images which should be captured and that is used to variably represent the eye appearance. Its major drawback is the huge requirement of huge training set which needs to be prepared in advance.

These models don't use a spatial representation of the body anymore, because they derive the parameters directly from the images or videos using a template database. Some are based on the deformable 2D templates of the human parts of the body, particularly hands. Deformable templates are sets of points on the outline of an object, used as interpolation nodes for the object's outline approximation. One of the simplest interpolation function is linear, which performs an averages have from point sets, point variability parameters and external deformators. These template-based models are mostly used for hand-tracking, but could also be of use for simple gesture classification.

A second approach in gesture detecting using appearance-based models uses image sequences as gesture templates. Parameters for this method are either the images themselves, or certain features derived from these. Most of the time, only one (monoscopic) or two (stereoscopic) views are used. The detection of the direction of gaze has been used in a variety of different domains. Gaze detection is a part of Human Computer Interfaces (HCI). The measure of gaze patterns, fixations duration, saccades and blinking frequencies has been the topic of many works (Young and Sheena, 1975).

Real-time gaze detection used in writing systems for disabled people. Gaze detection systems can be divided into non intrusive and head mounted devices. Non intrusive systems usually use an external camera filming the user and detecting the direction of the eyes with respect to a known position. Most modern systems use infra red (IR) lighting to illuminate the pupil and then extract the eye orientation by triangulation of the IR spotlights reflections or other geometrical properties. When IR lighting is impracticable, image based methods have been used to estimate the direction of the eyes.

Fig. 4 A child, wearing the Wear Cam with eye-mirror.

3. Proposed Methodology

3.1 Face Detection

The colour of human skin is a distinct feature for face detection.

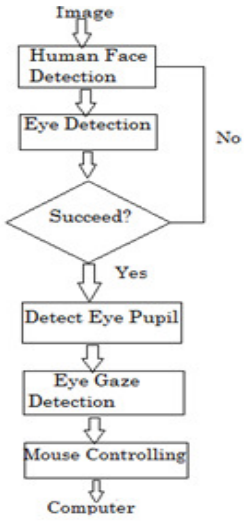

Fig. 4 .Five Stage Algorithm For Proposed Eye Tracking System

Many face detection systems are based on one of the RGB, YCbCr, and HSV colour space. YCbCr colour space has been defined in response to increasing demands for digital algorithms in handling video captured information, and has since become a mostly used model in digital videos. It refers to the family of television transmission colour spaces. The family includes others such as YUV and YIQ. In our system, we adopted the YUV-based skin colour detection method proposed in [14][5] .Using this technique we detect a face region.

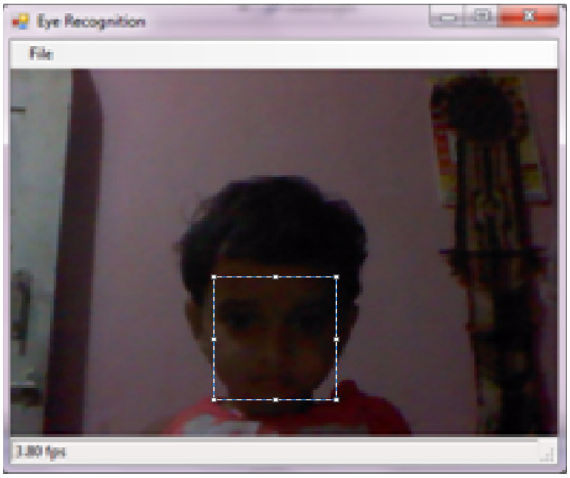

Fig. 5 Face Detected By Captured Webcam Image

3.2 Eye Detection

A human eye is an organ that senses light. An image of eye captured by digital camera is shown in following Fig.

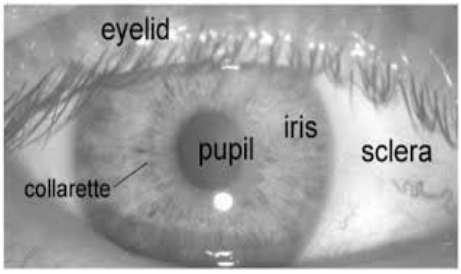

Fig. 6 Eye Structure

the eyes in the face are clearly visible, such that the eyelids do not cover the user's pupils. For eye detection following stage are follows. Once the image has been captured and a fast facial recognition method is applied to it, we get an image that has only the user's face, with the eyes clearly visible. So after facial recognition, the image is converted to a gray scale image. This is essentially for two reasons: first, the colour of the skin, hair, eyes, etc. are not important for us. Colour in an image thus becomes plain noise. Secondly, processing a grayscale image is much, much faster in terms of speed than processing an RGB image.

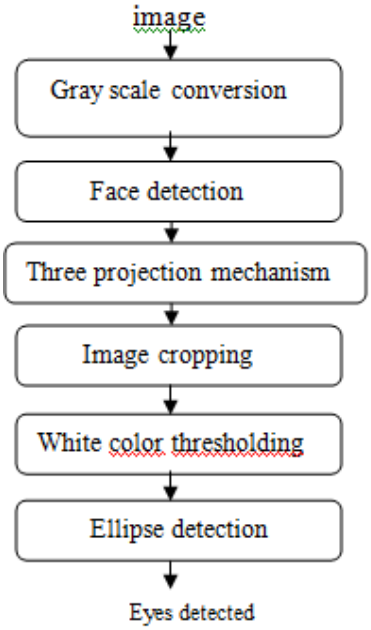

Fig. 7 Flowchart Of Eye Detection Technique

The grayscale image then undergoes K-Means clustering and thresholding. K-Means Clustering divides the image into n clusters of similar intensity. This makes it easier to convert it into a binary image. After the clustering operation, the image undergoes thresholding [3].

Once the threshold is found, all the pixels below this threshold are set to 255 (white) and the ones above it to 0 (black). We're basically making the lighter regions of the face white, and the darker regions (pupils, eye brows, etc.) black.

Once we get a binary image that highlights the areas that we want- the pupils of the eyes, that is, we proceed to perform 'cropping'[4].& after this process finally eye is detected.

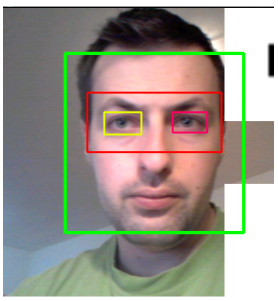

Fig. .8 Eye Detected Snapshot

After Eye Detection Next step is pupil detection. When eyes are detect then find out or extract the darker portion

of Eye. The Pupil Detection method done by extracting nine direction of eye that is top, left, bottom etc.

The Eye Gaze Detection Technique is done by geometric feature extraction algorithm. To estimate eye-gaze direction, we design three coordinates and finding their relationship. These coordinates done with the help of following steps:

- Image captured by Webcam.
- Eye image based on directions of two eye's corner.
- Coordinates of monitor.

Mouse controlling is the last methodology of this paper. Mouse controlling is done by extracting the direction of gaze where user is looking. From that direction mouse cursor or pointer move. Mouse controlling is done with the help of human-computer interaction. The mouse controlling is done with the help of low-cost webcam it is simplest and effective method to interact with computer environment.

4. Application of Eye Tracking

So, the real life situation of eye tracking system. Eye tracking is test usability of software, interactive TV, video game, advertisement and other such activity [6]. Eye tracking are used for reading techniques. Eye tracking uses to examine usability of websites where user will focus their attention on. The motivation from image viewing behaviour, expectation of regarding web site and how use view web site [7]. This technology is used to exam the eye movement of drivers. The fatigue inattention system could help to reduce motor vehicle accident [8].

5. Conclusion

In this paper, an eye motion based on low-cost eye tracking system is presented. In this system we proposed five stage algorithms. The user with several disabilities can use this system for handling computer. A real time eye motion detection technique is presented. In this, paper proposed an eye-gaze detection algorithm using image captured by a single web camera attached to the system. By using mouse cursor movement with the proportional eye movement.

6. Future Work

In future, the performance of proposed method will be improving and will be extended for physically challenged or handicapped people being able to control their household appliances. The technology used in this paper could be extended to controlling an electric wheel-chair by just looking in the direction in which disabled people want to go or move.

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