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CURSOR CONTROL SYSTEM USING FACIAL EXPRESSIONS FOR HUMAN-COMPUTER INTERACTION

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***Abstract* — A vision based human–computer interface is presented in this paper. The interface detects eye movements and interprets them as cursor control commands. The employed image processing methods include webcam for detecting the face, and template matching method [1] based eye region detection. The Haar feature technique is used for eye feature extraction. SVM classification method is used for classifying the eye movements. The classification of eye movements such as eye open, eye close, eyeball left, and eyeball right movements are used for cursor top, bottom, left and right movement respectively. The interface is based on a notebook equipped with a typical web camera and requires no extra light sources. In Hough transform, circular method is used to control the cursor movements. This method is used for physically challenged persons to operate the computers effectively with their eye movements.**

***Index Terms* — Cursor Control System, Eye Detection, Eye Movements, Face Detection, Human-Computer Interaction, Support Vector Machine (SVM).**

I. INTRODUCTION

Human–Computer Interface (HCI) can be described as the point of communication between the human user and a computer. Commonly used input devices include the following:

1). Keyboard,
2). Computer mouse,
3). Trackball,
4). Touchpad, and
5). Touch-screen.

All these devices require manual control and cannot be used by persons impaired in movement capacity. There is a need for developing alternative methods of communication between human and computer that would be suitable for the persons with motor impairments and would give them the opportunity to become a part of the Information Society. In recent years, the development of alternative human–computer interfaces is attracting attention of researchers all over the world.

A vision-based system for detection of eye-movements is presented, together with its implementation as a Human–Computer Interface for people with disabilities. The proposed work includes face detection [1], face tracking, eye-blink detection [1], and interpretation of a sequence of blinks in real time to control a non-intrusive human–computer interface.

To replace the traditional mouse with the human eye movements to interact the Computer. It is to assist the physically challenged persons without hands to use the computer efficiently and also easily.

II. RELATED WORK

Computer has influenced our life in such a way that it is very difficult to sustain without a computer. For physically challenged persons, especially persons without hands and legs. Keyboard and mouse are the most essential input devices to work with a computer. By the use of on-screen keyboard, a pointing input device such as mouse is sufficient to operate a computer with GUI software. The basic actions of a mouse are Mouse Movement and Mouse Button Click. This method is on developing an assistive technology that replaces the mouse movement by head movement using OpenCV. The Mouse Button Click is implemented by any facial expression such as blinking eye, opening mouth and head movement [2]. This method describes an eye-control method based on Electrooculography (EOG) to develop a system for assisted mobility. The system consists of a standard electric wheelchair with an on-board computer, sensors and a graphic user interface run by the computer. a control system is presented that allows the handicapped, especially those with only eye-motor coordination, to control a wheelchair and, in general, to live more independently [3]. This method introduces a novel camera mouse driven by 3D model based visual face tracking technique. While camera becomes standard configuration for personal computer(PC) and computer speed becomes faster and faster, achieving human machine interaction through visual face tracking becomes a feasible solution to hand-free control. In this method, we use a 3D model based visual face tracker to control the mouse and carry out mouse operations. Based on the estimated rigid and non-rigid facial motion parameters, 3 mouse control modes:

(1) Direct mode
(2) Joystick mode and
(3) Differential mode

are implemented for the mouse control [4]. Gaze positions can provide important cues for natural computer interfaces. In

this method, a new gaze estimation method based on a three dimensional analysis of the human eye which can be used in head-mounted display (HMD) environments. There are already several commercial products which use gaze detection technology. In this method, a new way of estimating gaze points is presented in which the user is only required to gaze at one point for the purposes of calibration [5].

This method aims to present an application that is able of replacing the traditional mouse with the human face as a new way to interact with the computer. Facial features (nose tip and eyes) are detected and tracked in real-time to use their actions as mouse events. It can be applied to a wide range of face scales. Our basic strategy for detection is fast extraction of face candidates with a Six-Segmented Rectangular (SSR) filter and face verification by a support vector machine. The left/right eye blinks fire left/right mouse click events to implement scale-adaptive face detection and tracking system using JAVA (J2ME) for face candidate detection [6].

Camera mouse has been widely used for handicap person to interact with computer. The utmost important of the use of camera mouse is must be able to replace all roles of typical mouse and keyboard. It must be able to provide all mouse click events and keyboard functions (include all shortcut keys) when used by handicap person. In this method, the camera mouse system with timer as left click event and blinking as right click event. Also, we modify original screen keyboard layout by add two additional buttons and change behavior of CTRL, ALT, SHIFT, and CAPS LOCK keys in order to provide shortcut keys of keyboard [7]. Eye detection and gaze estimation play an important role in many applications, e.g., the eye-controlled mouse in the assisting system for disabled persons. In this method, we propose a real-time eye-gaze estimation system. In this method, the methodologies of eye detection and gaze tracking based on a general low-resolution webcam, which detect eyes and track gaze accurately in real time without expensive and specific equipment [8].

III. Outline of the Work

A. *Face Detection*

Face detection is a computer technology that determines the locations and sizes of human faces in digital images. It detects facial features and ignores anything else, such as buildings, trees and bodies. A simple face tracking system will be developed.

The Viola–Jones object detection framework is the first object detection framework to provide competitive object detection rates in real-time. The cascade object detector uses the Viola-Jones detection algorithm and a trained classification model for detection. By default, the detector is configured to detect faces.

B. *Eye Region Detection*

The position of the eyes in the face image is found on the basis of certain geometrical dependencies. The image of the extracted eye region is further preprocessed for performing eye-movement detection. The located eye region is extracted and further eye tracking by means of template matching. The extraction of the eye region is performed only at the initialization of the system.

Template-Matching is a well-known method for object detection. In our template matching method, a standard eye pattern is created manually and given an input image, the correlation values with the standard patterns are computed for the eyes. The existence of an eye is determined based on the correlation values. This approach has the advantage of being simple to implement. However, it may sometimes be inadequate for eye detection since it cannot effectively deal with variation in scale, pose and shape.

C. *Feature Extraction*

Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed.

Haar-like features are digital image features used in object recognition. It is then used to detect objects in other images. Initially, the algorithm needs a lot of positive images (images of eye) and negative images (images without eye) to train the classifier. Then we need to extract features from it. For this, Haar features are shown in Fig 1. They are just like our convolution kernel. Each feature is a single value obtained by subtracting sum of pixels under white rectangle from sum of pixels under black rectangle.

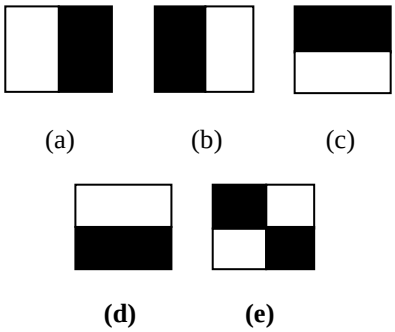

Fig 1: Haar Features

D. *Eye Movement Classification*

The different eye-movements are classified by using the support vector machine classifier. The eye-movements are eye open, eye close, eyeball left and eyeball right.

SVM can be used for classifying the obtained data. SVM are a set of related supervised learning methods used for classification and regression. In SVM, the multi class training file is used.

Table 1: Multi class training file

n (d+1)	
a11 a12 ... a1d	0.0
a21 a22 ... a2d	0.0
b31 b32 ... b3d	1.0
b41 b42 ... b4d	1.0
c51 c52 ... c5d	2.0
c61 c62 ... c6d	2.0
d71 d72 ... d7d	3.0
dn1 dn2 ... dnd	3.0

E. Eye Movement Interaction

The algorithm for automatic detection of voluntary eye movements was employed in the development of a user interface.

The Hough transform is a feature extraction technique used in image analysis, computer vision, and digital image processing. The purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure. The transform was popularized in the computer vision community. If the control movement is detected by the system, the action assigned to the highlighted button is executed.

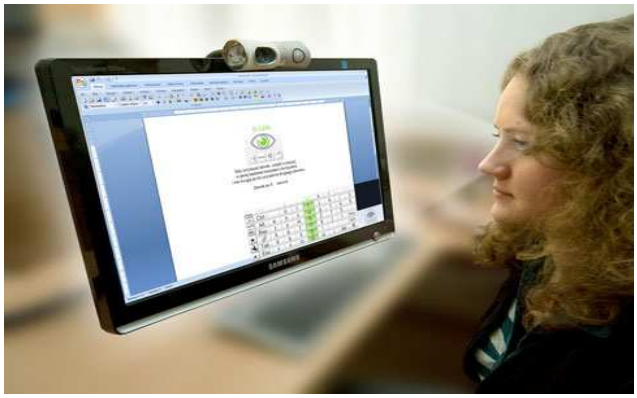

Fig 2: System set-up for user interface

IV. Experimental Setup

In this proposed system, to provide the different eye movements for control the cursor movements. This method is very easily used to activate the cursor movements. The experimental setup includes several steps as shown in Fig 3.

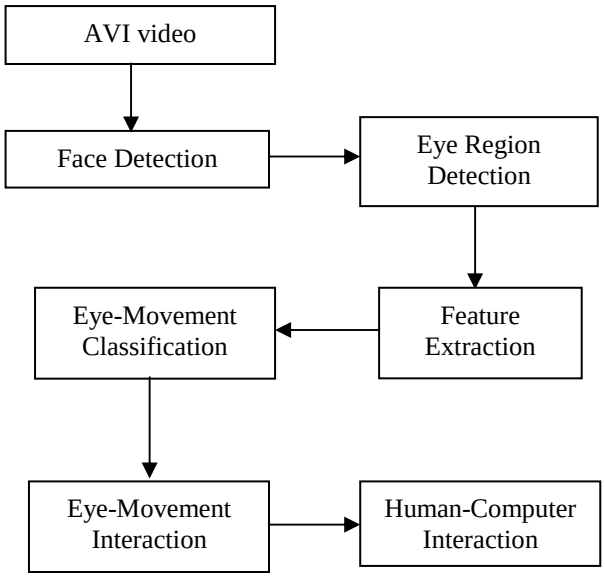

Fig 3: Block Diagram of Eye-Movement Interaction

In this method, the face detection and eye extraction are important steps in human-computer interaction. Sample of the face detection and eye extraction is shown in Fig 4.

Fig 4: Sample for Face detection and Eye extraction

Haar like Feature is applied to the eye region that is used to extract the features. In this paper, there are four classifications in eye movement that are presented in the following Figures.

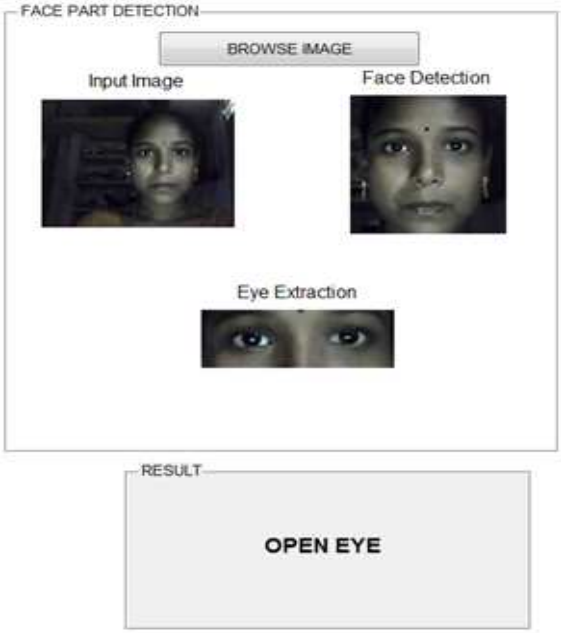

Fig 5: Sample for Eye Open Movement

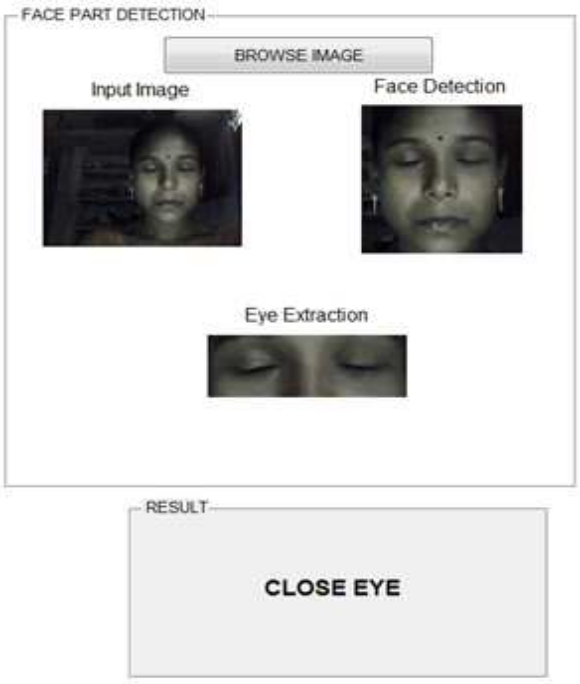

Fig 6: Sample for Eye Close Movement

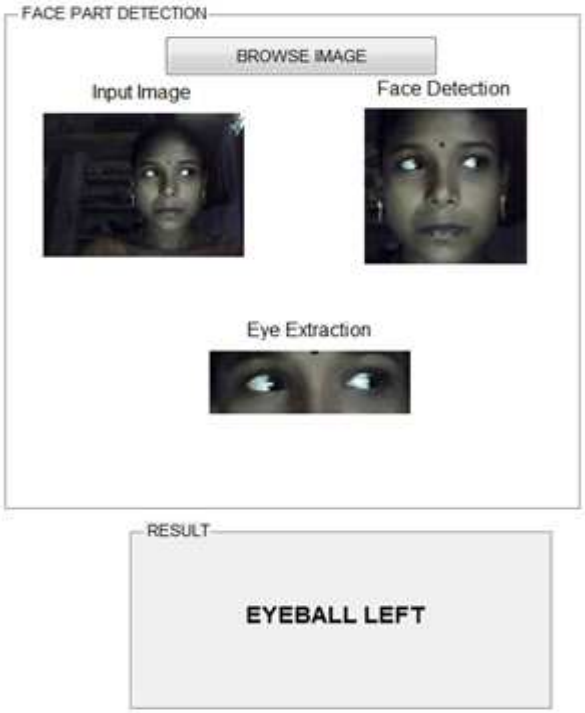

Fig 7: Sample for Eyeball Left Movement

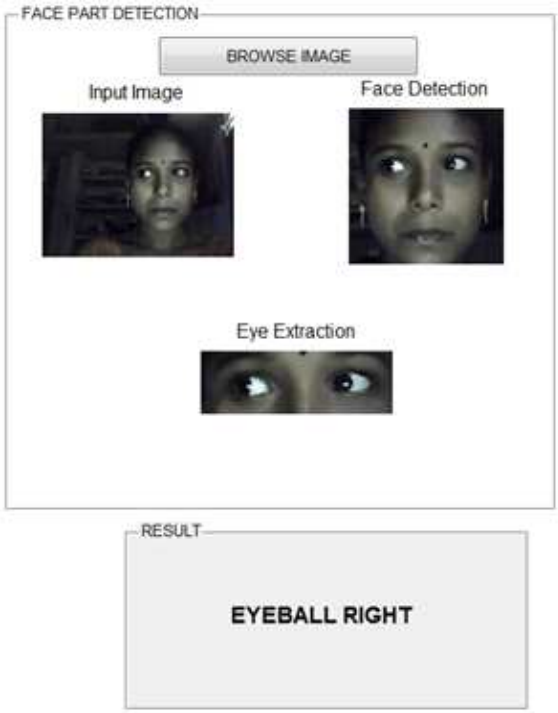

Fig 8: Sample for Eyeball Right Movement

A. Performance Evaluation

In this section, we present the detailed implementations and evaluations of the system, both on eye images and on without eye images. The cursor control system is comprised \of five main steps as shown in Fig 3. Step one is detect the face from the video, second is eye extraction, then third is feature extraction which includes the selection of a set of Haar features which are computed for all of the training data, training and testing of the data is classified using SVM classifier and finally to interact the cursor movements by the proposed system. Performance of the eye movements is shown in the Table 2.

Table-2
PERFORMANCE MEASURE

Eye Movements	Eye Open	Eye Close	Eyeball Left	Eyeball Right
Eye Open	95%	2%	1%	2%
Eye Close	3%	88%	5%	4%
Eyeball Left	5%	3%	90%	2%
Eyeball Right	2%	1%	2%	95%

V. CONCLUSION AND FUTURE WORK

In this paper the algorithm allows for accurate detection of eye movements and also classification like eye open, eye close, eyeball left and eyeball right from the different person images. Finally Hough transform is used to control the cursor movements based on eye movements. The recognition accuracy of eye movements based cursor movements ranged from 80% to 95%. The Eye open and Eyeball Right movement is detected higher than the other movements.

Further research will endeavor to produce efficient movements to perform the click events, and also cover the total mouse functions of the system.

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