**A SEMINAR REPORT ON**

# HCI For Disabled Using Eye Motion Tracking

**A**
**SEMINAR REPORT**
**SUBMITTED TO**

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

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BY

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# Certificate

This is to certify that the following student of T.E. Computer, Vishwakarma Institute of Information Technology, Pune

"SANIKA KULKARNI"

has successfully completed the Seminar and Technical Communication Report on

"HCI FOR DISABLED USING EYE MOTION TRACKING"

in the partial fulfillment of the requirements for the completion of T.E. in Computer Engineering in

2017 as prescribed by the Savitribai Phule Pune University.

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Date : 29/03/2017

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# Abstract

Human Computer Interaction is a trend-in technology. In this seminar topic a system is developed to provide a solution to the limb disabled people to enable them to interact with computer. Different algorithms are implemented for the same. The first step is to recognize face in each input frame. This is done by face recognition. This can be achieved by using Viola Jones algorithm. The next step includes eye and pupil detection. This is done using Circular Hough transform. Similarly,glint is detected and gaze direction is estimated. With these functions, the user is able to handle input devices of a computer like keyboard and helps to recognize the key to be pressed. The key to be pressed is found out by gaze direction and the key is pressed by blinking. Currently the system is limited to 4-key keypad.It can also let users open various applications. The Implementation is done in MATLAB.

# Acknowledgement

It is matter of great pleasure for me to submit this seminar report on **HCI FOR DISABLED USING EYE MOTION TRACKING**, as a part of curriculum for "Bachelor in Engineering (Computer Engineering)" of University of Pune, I am thankful to my guide Dr.A.K.Barve, Assistant Professor in Computer Engg Department for his constant encouragement and able guidance. I am also thankful to Dr.B.S.Karkare, Principal of VIIT Pune, Dr. S.R. Sakhare Head of Computer Department for their valuable support.

I take this opportunity to express my deep sense of gratitude towards those, who have helped us in various ways, for preparing my seminar. At the last but not least,I am thankful to my parents, who had encouraged and inspired me with their blessings.

Sanika Kulkarni

# Contents

# List of Figures

# List of Tables

# Chapter 1

# Introduction

## 1.1 Background

Today due to advancement in field of image processing and increasing importance of human computer interaction, efforts have been made to. This increases the hardware cost. But this technology requires only video camera and computer.This will help reducing the use of mouse and keyboard and makes human computer interaction user friendly.

## 1.2 Motivation and Social Impact

- This seminar's topic, when implemented, will help the limb disabled to access computer by using just their eye which is not possible normally.
- Accessing computer can make their lives easier. They can communicate using internet and video calls which will help them to stay connected with people across the globe.
- It will also help them get employment which in turn can help them become independent and at the same time enrich the society by their valuable inputs.

## 1.3 Objectives and Outcomes

**OBJECTIVES**

- To create awareness about HCI and its applications.
- To show how HCI can help to solve real life problems like helping the limb disabled in this case.
- To show how computer can be accessed by using just eye movements and how this can help not only the disabled but the whole society and thus make technology "hands free".

**OUTCOMES**

- Eye recognition based computer interaction will be developed.
- Human Computer Interaction will be possible without using hands.
- It will help the disabled to interact with computer and use it to facilitate their growth and overall development of country.
- It will reduce the need of using traditional input devices like keyboard.

## 1.4 Mathematical Model of Problem Solved

- S = s, e, I, o, f, DD, NDD, success, failure
- S = Initial state of system
- I = Input of system
- O = Output of system
- DD = Deterministic Data
- NDD = Non-Deterministic Data
- Success = Desired outcome generated
- Failure = Desired outcome not generated
- Input I = (Image) I1 = .png, .jpg)
- NDD = NULL
- f = imread(),imshow(),imcrop().
- imread()=usetoreadtheimage,imshow()=displaytheimage.,imcrop()=crop image,
- Success=desiredoutput is generated i.e. Image is detected.
- Failure = desired output not generated.

# Chapter 2

# Literature Survey

## 2.1 Existing Techniques

Various techniques have been proposed for Face recognition , eye recognition and eye gaze estimation.The existing techniques are as follows:

### 2.1.1 Eye attached tracking

The first type uses an attachment to the eye, such as a special contact lens with an embedded mirror or magnetic field sensor, and the movement of the attachment is measured with the assumption that it does not slip significantly as the eye rotates.

### 2.1.2 Optical tracking

This uses some non-contact, optical method for measuring eye motion. Light, typically infrared, is reflected from the eye and sensed by a video camera or some other specially designed optical sensor. The information is then analyzed to extract eye rotation from changes in reflections. Video-based eye trackers typically use the corneal reflection and the center of the pupil as features to track over time.

### 2.1.3 Electric potential measurement

This technique uses electric potentials which are measured with electrodes placed around the eyes. The eyes are the origin of a steady electric potential field, which can also be detected in total darkness and if the eyes are closed.

## 2.2 Comparison of Existing Techniques

- The Eye attached tracking requires some instruments to be attached to the eye.
- Expertise is needed when attaching devices to eyes.
- This is not always feasible and many users will not allow it. It affects the human computer interaction.
- Electrical potential measurement involves electrodes placed near eye and usually high cost equipment is needed.
- Expertise is needed in this technique as well.
- Due to all these reasons, Optical technique is most widely used for eye motion tracking.

## 2.3 Comparison and Analysis of Results of other researchers

- Seung-Jin Baek et al. proposed an Eyeball Model-based Iris Center Localization method for Visible Image-based Eye-Gaze Tracking Systems.
- The eyeball is assumed as a sphere to find out iris radius. It is rotated and their elliptical shapes along with their corresponding iris center locations are stored in the database.
- The iris center of obtained video frames are detected by matching them with that database.
- It affects the performance of gaze tracking because of the direct mapping of iris center on the target plane.
- Zhiwei Zhu et al. proposed the novel eye gaze tracking technique.Here, the gaze point is found by intersection of the gaze direction and object which finds angular deviation between the axis of eye and visual axis.
- This method allows natural head movement and calibration required only once, because of the requirement of more no. of cameras and IR illuminators, the set-up becomes complex and also costly.
- There are some other systems but most of the existing techniques involve complex hardware, less accuracy and high cost.
- To overcome these limitations a novel system is implemented in this paper for HCI. This system is implemented by the concatenation of many algorithms mentioned before.

| LITERATURE SURVEY | | | |
|---|---|---|---|
| **PAPER** | Novel Eye Gaze Tracking Techniques Under Natural Head Movement | Eyeball Model-based Iris Center Localization method for Visible Image-based Eye-Gaze Tracking Systems | Estimation of gaze for human computer interaction |
| **ALGORITHMS OR METHODS** | The cornea of the eyeball is modeled as a convex mirror. Via the properties of convex mirror,a simple method is proposed to estimate the 3-D optic axis of the eye. | Iris centre locations are found out by making spherical models of eyeball to form elliptical shape by rotation and stored in a database. | Daugman's algorithm. |
| **CONS** | Because of the requirement of more no. of cameras and IR illuminators, the set-up becomes complex and also costly. | It affects the performance of gaze tracking because of the direct mapping of iris center on the target plane. | More computational time. |

Table 2.1: Survey

## 2.4 Techniques/Algorithms selected

- The technique selected is the **optical eye recognition technique.**
- User interacts with a virtual four key keypad using video camera.
- The input is video which is divided in frames.
- The first step performed on each input frame is the face detection, which is achieved using **Viola-Jones algorithm**.
- **Circular Hough Transform** is used to locate the pupil in eye image.
- Glint (a small and intense dot inside the pupil image) is detected by the **blob analysis method**.
- **Pupil Corneal Reflection (PCR) method** to estimate gaze of user by determining the relationship between pupil center and glint.
- **Template matching method** is used for blink detection.

# Chapter 3

# Implementation

## 3.1 Flow of Work

The implementation flow of work is explained in the following points:

- A real time video is given as an input and it is processed to separate frames.
- Each input frame is further used for face detection using Viola-Jones Algorithm.
- Eye detection is done after detection of face.
- The next step is pupil localization ,that is, to find the position of pupil in the detected eye.
- The next step is to perform glint detection and gaze estimation is done to find out where a person is looking.
- Calibration and blink detection is done later to obtain final output.

## 3.2 Data collection and Data sets

Data is in the form of images which are obtained from the Video camera. These are given as input to various algorithms. The input depends on the step and type of algorithm used. At first stage,the video is the input. The next stages have image frames of the video as inputs. The data sets include templates stored in the database,input video and input image frames of face, eye and pupil.

## 3.3 Results obtained

Table 3.1: Results

| Background | | Lightning Conditions | | Resolution | | Viewing Angle | | Distance | |
|---|---|---|---|---|---|---|---|---|---|
| Complex | Static | Sufficient | Insufficient | Low | High | Center | Corner | Near | Far |
| 80% | 90% | 80%-90% | 65%-70% | 70% | 90% | 90%-95% | 80%-85% | 85%-95% | 65%-70% |

**Face Detection Output**

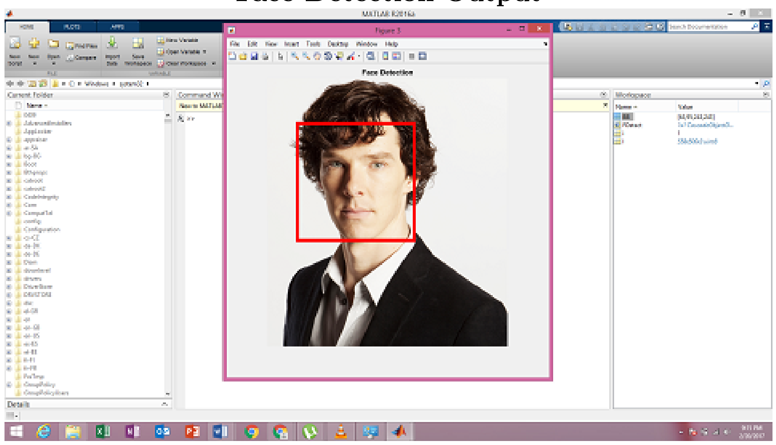

Figure 3.1: Face Detection

**Eye Detection Output 1**

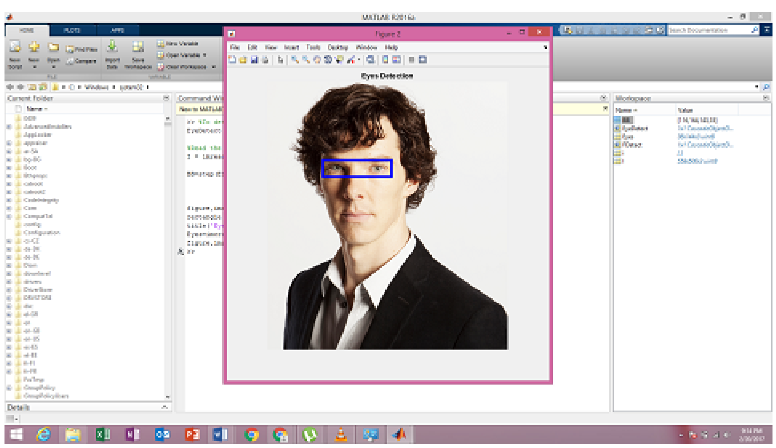

Figure 3.2: Eye Detection

**Eye Detection Output 2**

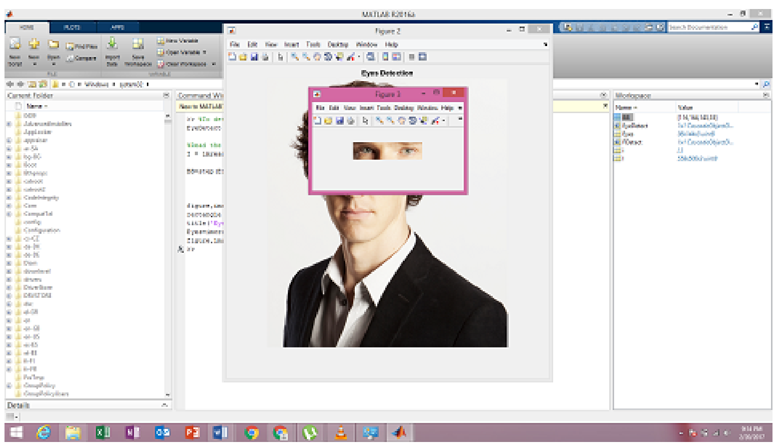

Figure 3.3: Eye Cropping After Detection

# Chapter 4

# Results and Discussion

## 4.1 Discussion on Result Obtained

- The camera used in this application,to access video is Logitech HD 720p webcam (C310) and the software implementation part is done in MATLAB.
- The next necessary step is the camera mounting.
- As we are using the non-touch user interface approach, the camera is located away from user,on the top of computer screen.
- The distance between the computer and user is maintained approximately 16 to 30 inches so that the clear face image can be obtained.
- In order to create a prominent blob of glint for gaze estimation an LED or IR source with supply of 5 to 12 Volts can be used.
- The system is tested under various environmental conditions, giving the appreciable results and speed.
- Once the setup is ready, the video input device takes the continuous images of user and are processed in MATLAB.
- The processing speed of the system is 5 frames/sec.
- This speed depends on the complexity of algorithm.
- Performance evaluation of the system is carried out under various conditions which is shown in table above to check the robustness of system.
- The system gives appreciable results and speed with an accuracy of 90

## 4.2 Comparison of Results (with other researchers)

- In the method of 3D optic axis estimation, the requirement of more number of cameras and IR illuminators is needed.
- This makes the method set up complex and costly.
- The Eye ball based model for Iris Centre Localization affects performance of gaze tracking because of the direct mapping of iris center on the target plane.
- The third technique is Daugman's algorithm which takes more computational time.

# Chapter 5

# Conclusion and Future Work

There are many techniques available for tracking eye gaze but this technique is a cost effective one. It is easier to implement as no costly equipment are needed. These can have many applications like helping the disabled to use computers or to improve accessibility of the computer for any user. It is the first step towards making technology hands free. This will enable people to access computer from a distance and the physical presence won't be necessary.

In future, the system can be made to include more than 4 keys. Binocular vision can be a future improvement. If this technology can be made available as a mobile phone app, it will reach out to masses and be of a tremendous help to society.

# Appendix A

# Code

## A.1 Source Code

**Code For Face Detection**

```
faceDetector = vision.CascadeObjectDetector;
I = imread('faces.jpg');
bboxes = step(faceDetector, I);
IFaces = insertObjectAnnotation(I, 'rectangle', bboxes, 'Face');
figure, imshow(IFaces), title('Detected faces');
```

**Code For Eye Detection**

```
EyeDetect = vision.CascadeObjectDetector('EyePairBig');
I = imread('eye.jpg');
BB=step(EyeDetect,I);
figure,imshow(I);
rectangle('Position',BB,'LineWidth',4,'LineStyle','-','EdgeColor','b');
title('Eyes Detection');
Eyes=imcrop(I,BB);
figure,imshow(Eyes);
```

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