Eye Control System Based on Hough Transform Algorithm

Submitted in partial fulfillment of the requirements
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Bachelor of Engineering

in

Computer Science

by

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CERTIFICATE

This is to certify that the project Synopsis entitled ***"Eye Control System Based on Hough Transform Algorithm"*** is a bonafide work of ***"Anindita Chowdhury (15102067), Anamika Sonavane (15102018), Vibha Gaikwad (16202014)"*** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of ***Bachelor of Engineering*** in ***Computer Science.***

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Abstract

These days the lifestyle and living of the world has changed a lot, Technology plays a very important part in ones life. Thus,this paper proposes an eye control system employing eye gaze tracking techniques that might be helpful for those limb disabled people with healthy eyes. We design a motion function as well as an efficiently blink detection function. With these functions, users can select any button, link or can move the mouse anywhere on the screen, with their eyes only, through a conventional camera mounted on top of the computer or laptop. Digital Image Processing here will be used to process the image, with the help of hough transform algorithm, which will initially help us capture the image of eye, process the images into templates and creating a database which will be further used to compare with the real time images.

Introduction

More than 1 billion people in the world have some form of disability. This corresponds to about 15% of the world's population.Census 2001 has revealed that over 21 million people in India are suffering from one or the other kind of disability. This is equivalent to 2.1% of the population.Now in this population some are limb-disabled. Although this number is very small, but it matters to those who can not enjoy the digital world.

Due to their limb handicap, such vast amount of people cannot enjoy the convenience and entertainment of the ever advancing computer technology.A person's eyes convey a great deal of information with regards to the meaning behind certain facial expressions. Also, the direction in which an individual is looking shows where his or her attention is focused. By tracking the position of the iris, useful interfaces can be developed that allow the user to control and manipulate devices in a more natural manner. So, this paper has purpose of meeting the specific needs of these limb disabled people. By using the eyes as a pointer on a screen, eye tracking facilitates interactions with computers and other devices when the user cannot or does not wish to use their hands as the input form.

Eye trackers are used in research on the visual system, in psychology, in psycholinguistics, marketing, as an input device for human-computer interaction, and in product design. There are a number of methods for measuring eye movement. The most widely used current designs are video-based eye-trackers. A camera focuses on one or both eyes and records eye movement as the viewer looks at some kind of stimulus.

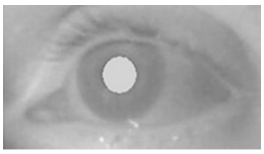

Figure 1: Infrared / near-infrared: bright pupil.

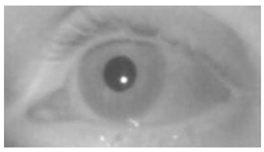

Figure 2: Infrared / near-infrared: dark pupil and corneal reflection.

Most modern eye-trackers use the center of the pupil and infrared / near-infrared non-collimated light to create corneal reflections (CR). The vector between the pupil center and the corneal reflections can be used to compute the point of regard on surface or the gaze direction. A simple calibration procedure of the individual is usually needed before using the eye tracker. Other methods use search coils or are based on the electrooculogram. Eye-trackers measure rotations of the eye in one of several ways, but principally they fall into three categories: (i) measurement of the movement of an object (normally, a special contact lens) attached to the eye; (ii) optical tracking without direct contact to the eye; and (iii) measurement of electric potentials using electrodes placed around the eyes.

Objectives

Objectives of this project are:

- To design a system that controls mouse actions using Eye-Tracking.
- To design an effective system that enables limb-disabled people with healthy eyes to use computer.
- To eliminate use of any external Head-Mounted Eye Tracker and replace it with a normal camera.

Literature Review

Eye-tracking experiments have an early history. One of the earliest eye-trackers was designed by Edmund Huey (Huey, 1908) which just consisted of a contact lens like device with a hole for the pupil.

The lens was connected to an aluminum pointer that moved in response to the movement of the eye. Huey studied and quantified regressions (only a small proportion of saccades are regressions), and he showed that some words in a sentence are not fixated. The first non-intrusive eye-trackers were built by Guy Thomas Buswell in Chicago, using beams of light that were reflected on the eye and then recording them on film. Buswell made systematic studies into reading and picture viewing. In the 1950s, Alfred L. Yarbus did important eye tracking research and his 1967 book is often quoted. He showed that the task given to a subject has a very large influence on the subject's eye movement.

Generally, eye tracking measures the eyeball position and determines gaze direction of a person, and the movements of the eye can be tracked using different technologies. It can be categorized into four categories: infrared-oculography (IROG), scleral search coil method (SSC), electrooculography (EOG), and video-oculography (VOG). Currently, most of the eye tracking researches for HCI are based on VOG, because the VOG technique has minimized the invasiveness to user in some degree.

Eye-Tracking is the process of measuring eye-positions and eye-movements of a subject. The devices used in carrying out such experiments are known as eye-trackers. Eye-trackers can broadly be classified into:

1. Head-mounted eye-trackers
2. Remote eye-trackers

In head-mounted eye-trackers, sensors are embedded into the glasses worn by subjects while in the Remote eye-trackers the screen is embedded with sensors for recording eye-movements.A headmounted eye-tracker by Eye-Tracker manufacturer Tobii is shown in Figure 3. The rate at

Figure 3: A head-mounted Eye-Tracker from Tobii

which the eye-tracker captures eye-movements is known as the Sampling Frequency F . Higher the sampling frequency, higher is the number of gaze points recorded by the device in unit time. In linguistic research, remote eye-trackers are normally used since they are more suitable for reading/writing experiments. Modern eye-tracker manufacturers ship Experiment Design Software through which eye-tracking experiments can be configured, replayed and analyzed. For example, Tobii ships a software called Tobii Studio along with the device. One can also utilize the APIs provided by the manufacturers to develop special purpose eye-tracking applications.

Eye-tracking has found its applications in many projects. Over the past few years, Eye-tracking techniques have been of consider-able interest to the NLP research groups at IIT Bombay.In 2006 a group of Taiwanese engineers developed a "Powered Wheelchair controlled by Eye-Tracking system".They used pupil-tracking goggles linked to a computer in order to translate gaze direction into chair movement. In 2011 an Italian group of engineers published a paper discussing the disadvantages of eye-controlled electric powered wheelchair (EPW) systems. In

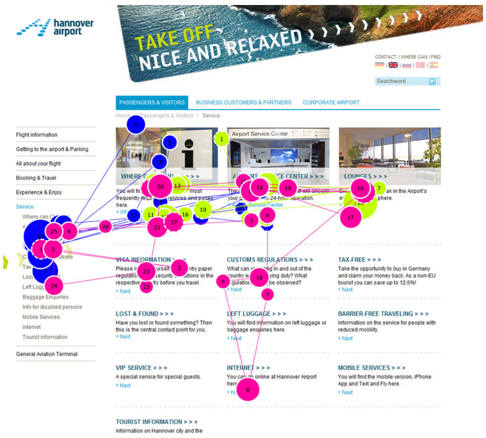

Figure 4: Eye tracking used in market research

2016 conducted a comparative study of user experience in online-social media branding web pages using eye-tracker.It allows market researchers and brand owners to study the process consumers undertake when viewing and selecting a product. It shows them what elements naturally attracted the most attention and what areas were ignored. Unlike surveys or questionnaires, eye tracking details authentic behavior which is useful when designing advertising, branding, packaging and product placement.

Problem Definition

This project uses eye gaze position and eye-state (starring or blinking) for enabling virtual mouse, so as to make it possible for limb-disabled people to experience the digital world. The camera will capture image frames of eye pupil as input. After the eye is detected it will be processed for calibration. Processing should include conversion to gray-scale followed by canny-edge detection , which will be used to detect pupil center using Hough transform algorithm.

The user can gaze any where on the screen and for selecting a link / clicking a button, the user must blink. If the blink duration exceeds 2 seconds, the it will be considered as a click, otherwise not. Instead of using additional head mounted eye-tracker , the laptop camera will be used. If the camera is inefficient, then external camera, connected to the computer via USB cable or Bluetooth should be used.

Design

Hardware Requirements

- Camera : preferably with a resolution of 5MP
- Computer : Processor (CPU) with 2 gigahertz (GHz) frequency or above , Monitor Resolution 1024 X 768 or higher , Processor : 32-bit and above

Software Components

- Hough transform algorithm,
- The Purkinje image detection method,
- The blink detection method, and
- The coordinates transform and calibration method.

Activity Diagram

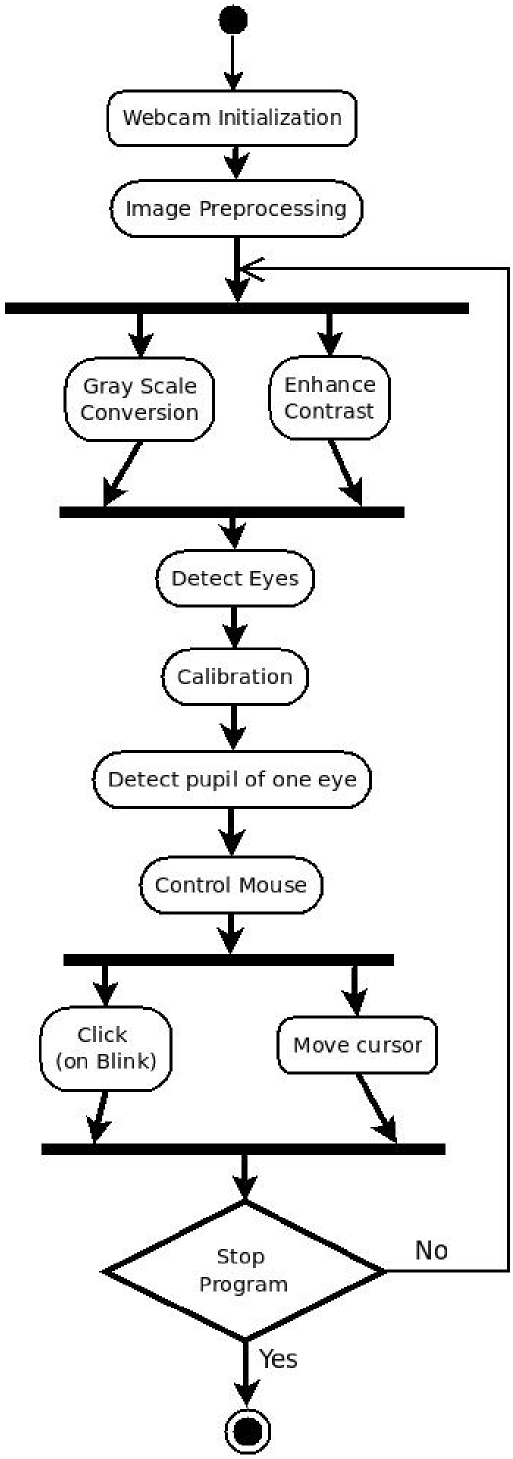

Figure 5: Activity diagram

Technology Stack

Following technologies are used currently used in this project :

- **Windows Operating System, Windows 7 Professional**
- **Visual Studio 2015 Community version :** Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs, as well as websites, web apps, web services and mobile apps and it supports 36 different programming languages, such as C++, Visual Basic .NET, C, Javascript, Python, Node.js and many more.
- **Open CV with C++ :** OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. OpenCV runs on the following desktop operating systems: Windows, Linux, macOS, FreeBSD, NetBSD, OpenBSD. OpenCV runs on the following mobile operating systems: Android, iOS, Maemo, BlackBerry 10.

Use-Case Diagram

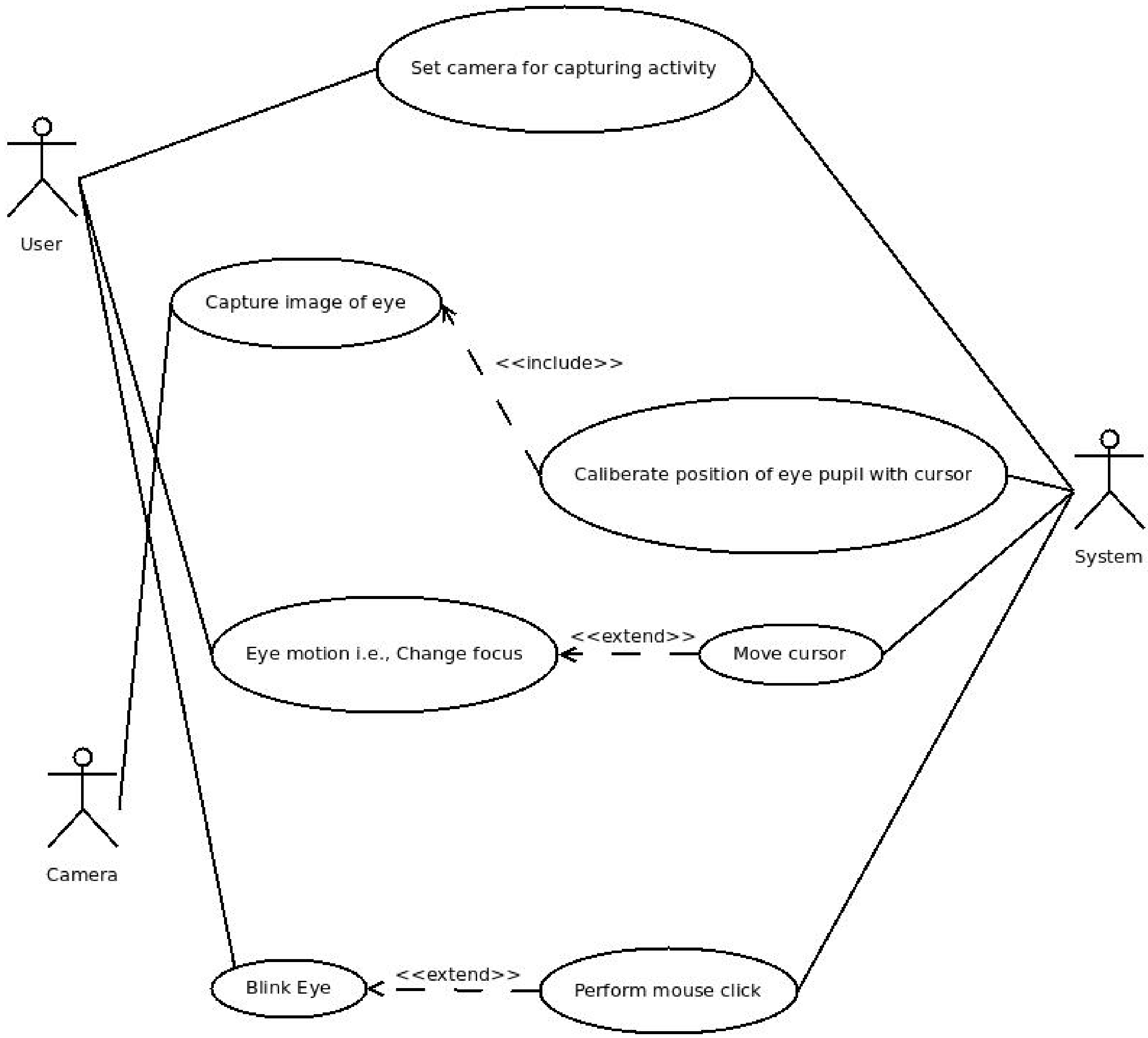

Figure 6: Use case diagram

Class Diagram

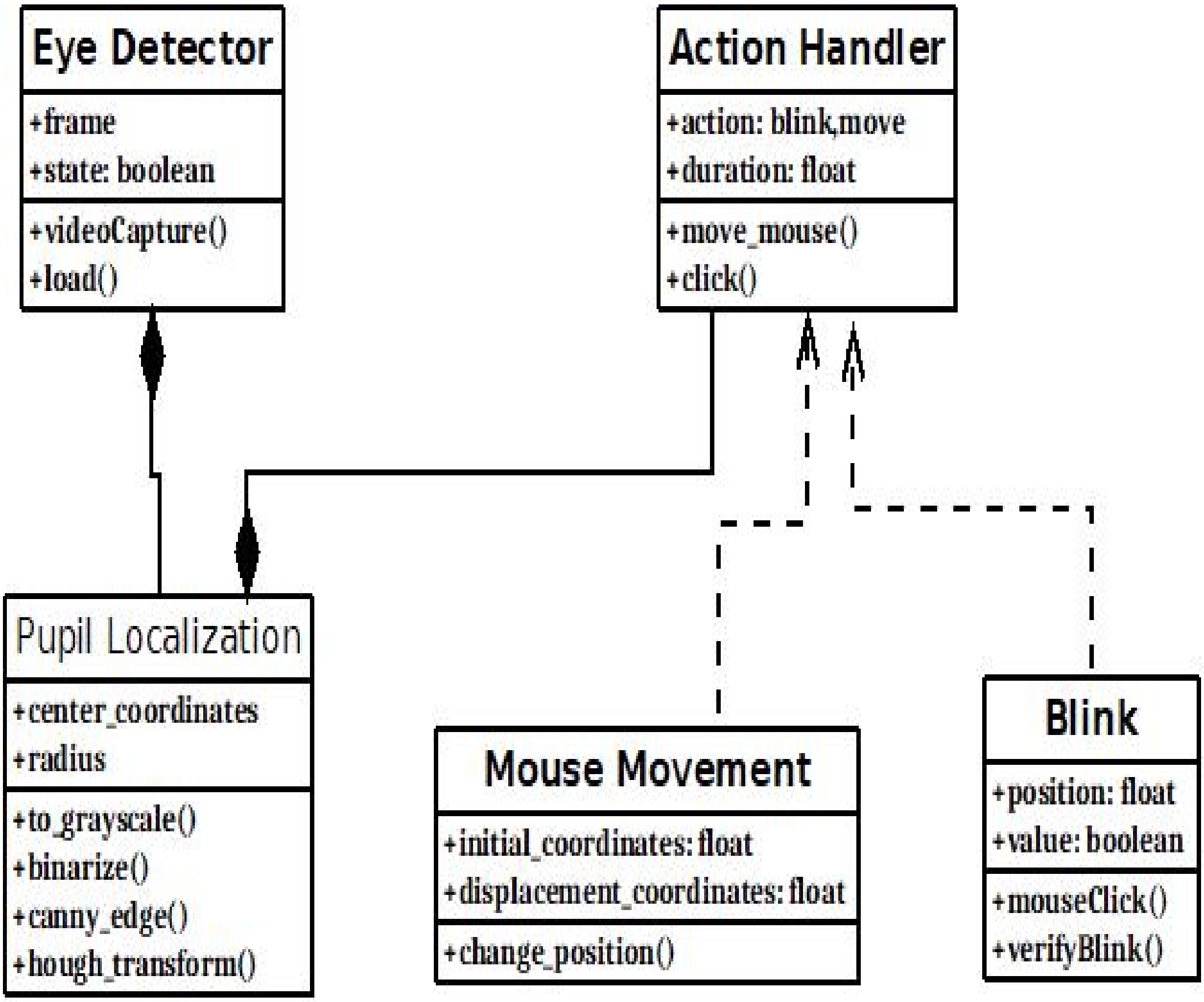

Figure 7: Class diagram

Dependencies

- The distance between the person and the camera should be as less as possible, preferably 30cm to 35 cm. The reason for this is that, the tracking would not be accurate with large and varying distance.

- Camera resolution should be of the best quality, at least 5MP, for higher efficiency of the video captured. It is important in feature extraction that, the image is having a good clarity, since different training frames are compared with the obtained image frame for identification of different components.

References

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Planning

S. No.	Activity	From	To	Number of Days
1	To develop a window containing 4 buttons, where each button corresponds to a particular operation.	10-01-19	19-01-19	10
2	Deciding upon the 4 functionalities and integrating them with the buttons	21-01-19	04-02-19	14
3	To implement blink detection and mouse click	04-02-18	18-02-19	14
4	Testing the obtained proposed system in Laptop	19-02-19	25-02-19	7
5	Transforming the computer application into mobile application with the use of VR gear	26-02-19	12-03-19	15
6	Testing the obtained application	12-03-19	19-03-19	7
7	Implementing the final application	19-03-19	22-03-19	3

Table 1: Planning for next semester