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Eye Gaze Communication and Tracking system

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Abstract:

Non-verbal communication in a team meeting is imperative to understand the essence of the conversation. One significant factor of non-verbal communication is that people are often looking at artifacts on the common work space or at the other person when collaborating with each other Among other gestures, eye gaze shows the focus of interest on a work area and can also be used for an interpersonal synchronization. If this non-verbal information is missing and or cannot be perceived by visually impaired and blind people (BVIP), they would be deficient in important information to get fully immersed in the meeting and may feel estranged in the course of the discussion.

Our proposed system is an automatic system to track where a sighted person is gazing at. Eye gaze provides information on emotional state, text entry or concentration for an object given by the user, to infer visualization tasks and a user's cognitive abilities to enhance interaction to have communication via eye gaze patterns etc. However, such information cannot be accessed by visually impaired and blind people (BVIP) as they cannot see where the other person in the meeting room is looking at. Eye gaze tracking technology is sort out into two categories as head -mounted systems and remote systems where head-mounted eye trackers are mobile and remote systems are stationary trackers.

Keywords — BVIP, Eye Gaze, Remote systems.

I. INTRODUCTION

One considerable factor of non-verbal communication is that people are often looking at artifacts on the common work space or at the other person when collaborating with each other. Eye gaze provides information on emotional state, text entry, or concentration for an object given by the user, to infer visualization tasks and a user's cognitive abilities to enhance interaction, to have communication via eye gaze patterns, etc. However, such information cannot be accessed by blind and visually impaired people (BVIP) as they cannot see where the other person in the meeting room is looking at. Therefore, it is important to track eye gaze in the meeting environment to make available the relevant information to them.

Eye gaze tracking is locating the point where a person is looking at. This precise spatial position is known as the point of gaze. It has been employed for research in scan patterns and attention in human-computer interaction, as well as in psychological analysis. Eye gaze tracking technology is categorized into 2 categories, i.e., head-mounted systems and remote systems where head- mounted eye trackers are mobile and remote systems are stationary trackers.

Early eye tracking systems were based on metal contact lenses while today's eye trackers exploit an infrared camera and a bright or dark pupil technique. These techniques locate the pupil's center. The tracker can then locate the target's position on the screen where the person is gazing at using the relative position of the corneal reflection and the pupil center. Other eye trackers which are based on high speed video cameras are more expensive than the infrared based eye trackers, but are also more accurate than web-cam based eye trackers. In such eye trackers, the measurement is done based on deep learning and computer vision applications.

Based on the possibility to improve the accessibility of non-verbal communication for BVIP, our work will use eye gaze tracking to detect where people are looking at. Based on the availability and known ad-vantages of the systems, the Open Face and SMI RED250 were chosen to be included in the analysis. Open-Face is open-source software for real-time face embedding visualization and feature extraction that works with webcams. The commercialized SMI RED250 remote eye tracker comes with the iView software to process the data.

II. RELATED WORK

Eye gaze trackers are devices used to track eye gaze arrangements. Before digital computers, they were prepared by metal contact lenses. With progression of computing technology, recent eye gaze trackers make use of computer vision algorithms to detect eye ball movement from digital image in real time and use that to forecast points of fixation and saccadic gaze movement. Accessible commercial eye gaze trackers mostly used infrared camera and bright or dark pupil technique.

The bright pupil technique allows image processor to locate center of pupil. The eye gaze tracker can then locate where the person is looking on the screen based on the relative positions of the pupil center and corneal reflection within the video image of the eye. The existing system proposed and compared two different webcam-based gaze trackers for a set of users with severe speech and motor impairment (SSMI) for an online quiz.

Webcam-based gaze tracking is not a new concept although deploying such a system for users with severe speech and motor impairment was not widely reported. Most webcam-based systems initially detect face using standard OpenCV library and then based on the relative position of pupil within the standard geometry of eyes estimate gaze position.

A. Landmark Detection

To detect face from the webcam image. After that, we take out the eye regions from the facial image for further processing. From the face region, the eyes were extracted. Once we extracted the eye region, we scaled it down to smaller size to increase computation speed. For every video frame, the eye landmarks were detected and subsequently used to measure the eye aspect ratio (EAR) between the height and width of the eye.

It is noted that EAR remains constant irrespective of the distance between the user and the camera module. We predicted the nine directions of the gaze (top left, top middle, top right, left, center, right, bottom left, bottom middle and bottom right). To perceive the pupil position, initially applied a threshold value on the image matrix representing the eye region based on the maximum value, and confiscate all the remaining values that are connected to the image borders and then find out the maximum value from the remaining set of values and the selected pupil center having the highest summation value of their neighboring pixels. A linear transformation function has been used to map the EAR and the disarticulation value of the iris form the center to screen coordinates. The eye gaze was predictable by calculating mode from a number of EAR values measured in continuous frames.

B. Using Webgazer.Js

In this process used an eye tracking library written entirely in JavaScript, i.e.webgazer.js, that uses common webcams to infer the eye gaze locations of users on a web page in real time. Web - Gazer is an online eye tracker that exploit regular webcams already present in laptops to infer the eye gaze locations of Web visitors on a page in real time. The eye tracking model self-calibrates by watching users interacts with web page and trains a mapping between features of the eye and positions on the screen. It has 2 key components, a pupil detector that can be collective with any eye detection library, and a gaze estimator using regression analysis informed by user interactions.

Web Gazer technology is companionable with 3 open-source eye detection libraries for locating the bounding box of user’s eye. The eye detectors that are evaluated in Web Gazer are clmtracker.js- object detect and tracking.js. It can also be generalized to include others. There are 2 gaze estimation methods in WebGazer, one which detects the pupil and make use of its location to linearly estimate a gaze coordinate on the screen, and a second one which treats the eye as a multi-dimensional feature vector and uses regularized linear regression combined with user interactions. As the number of gaze locations. We were getting in a particular time period through webgazer.js was high, so we had taken the mean of last 8 points from webgazer.js for better target prediction and accuracy of system. Using the mean value of gaze location for last eight points, we have designed the following algorithm to select 5 screen locations on a web page through the webcamand webgazer.js.

C. Controlling Pointer with Inaccurate Eye Gaze Tracker

Both of the projected eye gaze trackers were not as accurate as compared to commercial eye trackers. We have developed an algorithm to control a graphical user interface through inaccurate eye tracker. Box 1 shows the algorithm to activate one of 5 elements in a screen using eye gaze. In the following algorithm, w and h correspond to the inner width and inner height of a window of a browser.

We have taken five points on the screen by initializing appropriate values for dx and dy. The algorithm tracks the adjoining screen element from the current gaze position. If the nearest screen element remains identical for a particular time interval (dwell time), that element is selected. The interval of dwell time was configurable and set to 1.5 s by default.

The webcam-based gaze tracker is useful for the children with severe speech and oral motor impairment due to cerebral palsy.

The disadvantages are process computation takes much time and accuracy is low

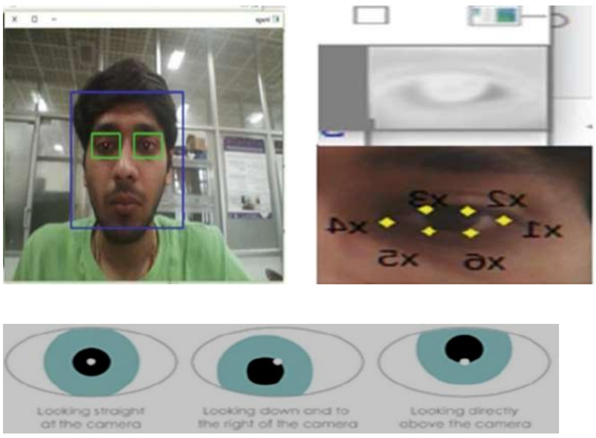

Fig 1 Detecting Eye Gaze from web cam

Fig 1 gives the complete information about detection of eye gazed from webcam.

III PROPSED SYTEM

The proposed system is an automatic system to track where a sighted person is gazing at. We use the opensource software 'Open Face' and develop it as an eye tracker by using a support vector regression. Eye gaze tracking is locating the location where a person is looking at. This precise spatial position is known as the point of gaze. It has been employed for research in scan patterns attention in human-computer interaction, as well as in psychological analysis. Eye gaze tracking technology is categorized into 2 categories, i.e., head-mounted systems and remote systems.

The main motivation is

(1) To develop an overall low-cost eye tracker which uses a webcam and the Open-Face softwaretogether with support vector machines to improve accuracy

(2) To design an eye tracking system to be used in real-time in meeting environments

(3) To perform a user study with users to evaluate the performance of this new eye gaze trackingapproach.

Open-Face is open-source software which can be used in real-time for analyzing facial features. The software has various features: facial landmark detection, facial landmark and head pose tracking, eye gaze tracking, facial action unit detection, behavior analysis. The Eye Tracker SMI RED 250 comes with the modular design which can be integrated into numerous configurations ranging from a small desktop screen to big television screens or projectors. It exploits head movement and eye tracking along with the pupil and gaze data to achieve accurate results. iView software is provided by SMI along with the eye tracker for the data output and processing. Support vector machines (SVMs) were developed as a binary classification algorithm to increase the gap between different categories or classes from the training set.

The setup used for the test with the desktop screen is shown in Figure 2. The user had to look at different regions on the desktop screen while his eye gaze was measured by the commercial eye gaze tracker (using iView) as well as by the webcam (using Open Face without any correction algorithm). The experiments with this setup showed that the screen coordinates from Open Face are accumulated at a sub-region of the whole screen.

Because of the accumulation of points, we used an SVM algorithm to convert those coordinates into a similar form as the output coordinates from the iView software. Figure 6 shows the scatter plot for iView and Open-Face coordinates after using the SVM algorithm for correction. We used 70% of the data for training and 30% of the data for testing.

Figure 2: Setup for small Desktop Screen

Figure 3: 2×3 matrix for the comparison of Open Face and iView after applying thecorrection with the SVM.

Experimental Setup for User Study

The setup consists of a demo environment where a sighted person is looking at a screen. We are aiming to provide the useful information to the BVIP about the location of the sub-region of the screen where a person in the meeting is looking at. We used 1 ×5 boxes in the matrix shown to the user at the time during the user study. In our application, we are concerned about the region of interest of the person gazing at the screen, but not in the particular location. Accordingly, we assume that the screen is divided into5 sub-parts and aim to provide high accuracy for predicting the sub-part of interest of the user. The experimental setup is shown in **Figure 4**

Figure 4: Experimental Setup for user study

The user was asked to look at a numbered region for few seconds and then the next region number was given. The sequence of region numbers a user had to look at was the same for every user to keep the uniformity. The SMI RED 250 eye-tracker with iView and Open Face were used to take measurements simultaneously. The data was refined and processed for the sample values which had the same time stamp.

The results are as shown below Figure 5

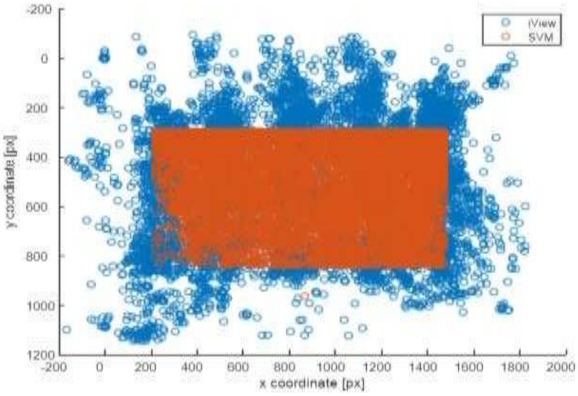

Figure 5: Scatter plots showing the output data from iView and Open Face

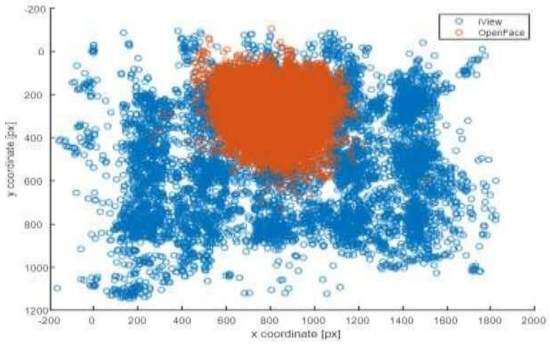

Figure 6: SVM to regress the data

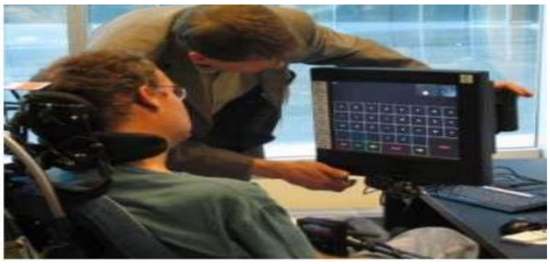

Figure 7: Portable Eye gaze System Mounted on Wheelchair

A wide variety of disciplines use eye tracking techniques, including cognitive science, psychology (notably psycholinguistics, the visual world paradigm), human-computer interaction (HCI), marketing research and medical research (neurological diagnosis).

IV. CONCLUSIONS

The eye-gaze based user interfaces becoming attractive, eye-gaze can express the interests of the user, it is a potential porthole into the current cognitive processes. Communication through the direction of the eyes is faster than any other mode of human communication. It is argued that eye gaze tracking data is best used in multi-model interfaces where the user interacts with the data instead of the interface is so called non command user interfaces.

Care must be taken, though, that eye-gaze tracking data is used in a reasonable way, since the nature of human eye-movements is a combination of several voluntary and involuntary cognitive processes. Built a prototype of an automatic eye gaze tracking system which can be available at low cost using an open source software 'Open Face'. Geometrically converted the eye gaze vectors and eye position coordinates to screen coordinates and manipulated those coordinates using an SVM regression algorithm to work in a similar manner to the commercially available SMI 250 RED Eye Tracker.

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