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SURVEY ON "AUTOMATIC CURSOR MOVEMENT WITH EYE GAZE TRACKING

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***Abstract*— The eye has a lot of communicative power. Eye tracking is a process for measuring eye position and movement, and gaze tracking is used to estimate a user's point of regard. This techniques have been widely used in human–computer interaction. Eye tracking system is a communication and control system for people with physical disabilities. It is a technique that acquires and analyzes the eye movements and use it to determine where user's attention is focused through his eyes which can be used to manipulate the cursor position relative to the position of the user's eye on the screen. Eye movement tracking is used in navigating the computer screen without the need for mouse or keyboard input. In this paper, provide an introduction to eye tracking technology and gaze estimation approaches. We also discuss and key features of different eye tracking systems to find the best system for each task.**

Keywords— Eye Gaze Tracking, Point of Gaze, PCCR

INTRODUCTION

Definition of Eye Tracking:

The term *eye tracking* as it is used here means the estimation of direction of the user's gaze. In most cases the estimation of the gaze direction means the identification of the object upon which the gaze falls.

With a growing number of computer devices around us, and the increasing time we spend for interacting with such devices, we are strongly interested in finding new interaction methods which ease the use of computers or increase interaction efficiency.

Some people interact with the computer all day long, for their work. As most interaction is done with keyboard and mouse, both using the hands. Some people suffer from overstressing particular parts of their hands which may cause some muscle problems. The eyes are a good candidate for solving this problem because they move anyway when interacting with computers. Using the information lying in the eye movements could save some interaction.

For that purpose developing a cheaper and more convenient solution for people with special needs who need to interact with computers. Many computer devices come already with built-in cameras, such as mobile phones, laptops, and displays. Also, standard processors are powerful enough to process the video stream necessary to do eye tracking, at least on desktop and laptop computers. Those computer whose have not built-in camera then this system made by using web camera.

Eye gaze tracking is the procedure of determining the point of-gaze on the monitor, or the visual axis of the eye in 3D space. Gaze tracking systems are primarily used in the Human Computer Interaction (HCI), cognitive studies and computer usability studies and in the analysis of visual scanning patterns. In HCI, the eye gaze can serve as an advanced computer input to replace traditional input devices such as a mouse pointer. Moreover, the graphic display on the screen can be controlled by the eye gaze interactively [4]. The gaze tracking system cannot only be used as an efficient pointing device but also provide the users' points of interest. Since visual scanning patterns are closely related to the attentional focus, cognitive scientists use the gaze tracking system to study human's cognitive processes [1]. Therefore, gaze tracking continues to be an important research topic for various fields.

Earlier, intrusive devices such as contact lenses and electrodes have been used. However, these methods require physical contact with the users and hence it has created discomfort to users. Later, less intrusive devices such as headgear have been used, which remains practically challenging [2].

In contrast, video-based gaze tracking techniques that could provide an effective nonintrusive solution are more appropriate for daily usage. The video based gaze estimation can be categorized into appearance based approaches and feature-based approaches. Appearance-based approaches are relatively simple to implement. However, it cannot effectively address head movements, despite much effort in this area [6]. The feature-based gaze estimation approach can be further classified into two groups: 2D mapping based gaze estimation methods and 3D model-based gaze estimation methods. However, these methods highly rely on the environmental effects such lighting, devices, etc [1]. Earlier, intrusive devices such as contact lenses and electrodes have been used. However, these methods require physical contact with the users and hence it has created discomfort to users. Later, less intrusive devices such as headgear have been used, which remains practically challenging [2].

I] RELATED WORK:

The first qualitative descriptions of eye movements in the 18th century (Porterfield 1737). At the end of that century Wells (Wells 1792) used afterimages, also called ghost images, which appear in the visual perception after staring some time on the same spot, to describe the movement of the eyes. In the 19th century Javal (1879) and Lamare (1892) observed the eye movements during reading and introduced the French originated word *saccade* for the abrupt movements of the eye. They used a mechanical coupling of the eyes and the ears using a rubber band to make the eye movements audible. Dodge and Cline made the first unobtrusive measurements in 1901. They used a photo-graphic method and light reflections from the eye, recording eye movements in horizontal direction only.[9]

In the 1980s, mini computers became powerful enough to do real-time eye tracking and this gave the possibility using video-based eye trackers for human computer interaction. Bolt presented such a vision in 1981[8]. It was also the time of the first eye trackers to assist disabled users [7].

From the 1990s up to now, there has been a steady increase in the use of eye trackers. Falling prices for the tracking systems caused wider use typically for marketing research or usability studies. Scientists started to research the possibilities of eye trackers for human computer interaction.

Eye tracking refers to the process of tracking eye movements or the absolute point of gaze (POG) referring to the point the user's gaze is focused at in the visual scene. Eye tracking is useful in a broad range of application areas, from psychological research and medical diagnostic to usability studies and interactive, gaze-controlled applications.

Numerous researchers have contributed in the literature for developing a potential eye gaze tracking system. Few traditional methods include 2D mapping approaches, 3D model based approaches and appearance based approaches. However, these methods are sensitive to head pose and they require human intervention at few instances [1]. In 2015, Jixu Chen and Qiang Ji [1] have proposed a probabilistic eye gaze tracking system without explicit personal calibration. Unlike the conventional eye gaze tracking methods, which estimate the eye parameter deterministically using known gaze points, their approach estimates the probability distributions of the eye parameter and eye gaze. Using an incremental learning framework, the subject does not need personal calibration before using the system. His/her eye parameter estimation and gaze estimation can be improved gradually when he/she is naturally interacting with the system. The experimental results have shown that their system could achieve <3° accuracy for different people without explicit personal calibration.

II] SURVEY OF EYE TRACKING TECHNIQUES:

There is no universal technique to track the movement of the eyes. In any study, the selection of the technique rests with the actual demands of the application. During the analysis, some major techniques were reviewed. Every technique has its own robust points and disadvantages.

1. Electro-oculography:

Electro-oculography is based on electrodes attached to the human skin. Due to the higher metabolic rate at the retina compared to the cornea, the eye maintains a constant voltage with respect to the retina. This can be approximately aligned with the optical axis. Voltage rotates with the direction of gaze and can be measured by surface electrodes placed on the skin around the eyes. This technique is easily mounted elsewhere other than directly in front of the person as compared to other techniques. Electrical skin potential tracking is often used in medicine and practice to diagnose certain conditions. For example, EOG is employed to diagnose sixth nerve palsy. From their analysis it can be seen that while a clinical orthotic examination is still the best technique of diagnosis. Electro-oculography provides a suitable replacement within the follow-up stage of treatment programs. While these uses are beneficial, the utilization of electrodes makes this technique of gaze tracking unsuitable for use in everyday applications.

2. "Dark Pupil/Light Pupil" technique :

"Dark Pupil/Light Pupil" technique using infrared. Under infrared illumination, the pupil becomes very white, almost the exact opposite of its visual-spectrum appearance. By capturing both the dark and light pupil images, the high contrast (which is mostly localized to the pupil) can be used via image subtraction to evaluate the pupil location with very high accuracy.

3. Visible-light cameras and Computer-vision techniques:

This method uses plain visible-light cameras and computer-vision techniques to extract details about the position of various interesting features. The growth of the computer vision field in the last ten to fifteen years has led to a multitude of techniques that are capable of performing such analysis. For examples, see the USB Webcam Blink Detector by Chau and Betke, the Starburst Algorithm by Li and Parkhurst, and Savas' Track Eye software[10]. One benefit of this method is that it doesn't rely on characteristics that are extremely specific to the eye (e.g. retinal charge gradients or infrared pupil reflection), and can be tailored to other features of more complex interactions.

III] SURVEY OF VARIOUS APPROACHES TO EYE GAZE TRACKING

The video-based gaze approaches commonly use two types of imaging techniques:
1. Infrared imaging
2. Visible imaging

1. Infrared imaging:

As infrared-imaging techniques utilize invisible infrared light sources to obtain the controlled light and a better contrast image, it can reduce the effects of light conditions, and produce a sharp contrast between the iris and pupil (i.e., bright-dark eye effect), as well as the reflective properties of the pupil and the cornea (PCCR) [5].As a result, an infrared imaging-based method is capable of performing eye gaze tracking. Unfortunately, an infrared-imaging-based gaze tracking system can be quite expensive.

Other things including in Infrared imaging system are:
1) An infrared-imaging system will not be reliable under the disturbance of other infrared sources;
2) Not all users produce the bright-dark effect, which can make the gaze tracker fail; and
3) The reflection of infrared light sources on glasses is still an issue.

2. Visible imaging:

Compared with the infrared-imaging approaches, visible imaging methods circumvent the mentioned problems without the need for the specific infrared devices and infrared light sources. They are not sensitive to the utilization of glasses and the infrared sources in the environment. Visible-imaging methods should work in a natural environment, where the ambient light is uncontrolled and usually results in lower contrast images. Yiu-ming Cheung [2] concentrated on visible-imaging and presents an approach to the eye gaze tracking using a web camera in a desktop environment.

It includes eye feature detection, calibration, and pose estimation. Its primary novelty is using intensity energy and edge strength to locate the iris center and utilizing the piecewise eye corner detector to detect the eye corner.

IV] SURVEY OF EYE GAZE ESTIMATION APPROACHES:

Video-based eye gaze estimation can be divided into two approaches:

a. Feature-based
b. Appearance-based

Appearance-based approach is relatively simple to implement, it, however, cannot effectively address head movements, despite much effort in this area [4] [6]. This research focuses on feature-based approach.

Feature-Based gaze estimation approach can be further classified into two groups: 2D mapping based gaze estimation methods and 3D model-based gaze estimation methods**.**

2D mapping approaches assume the mapping from 2D features (e.g., contours, eye-corners, pupil center, etc.) to gaze (3D gaze direction or 2D gaze point) a polynomial mapping function.

3D model-based gaze estimation directly computes 3D gaze direction from eye features based on a geometric model of the eye using stereo cameras or a single camera with multiple calibrated light sources [1].

GAZE tracking is the procedure of determining the point of-gaze on the monitor, or the visual axis of the eye in 3D space. Gaze tracking systems are primarily used in the Human Computer Interaction (HCI) and in the analysis of visual scanning patterns.

Most of current gaze estimation systems require a personal calibration procedure for each subject in order to estimate his/her specific eye parameters. This calibration process could significantly limit the practical utility of gaze estimation. To overcome this limitation, Jixu Chen [1] proposed a novel gaze estimation framework without any explicit personal calibration.

Personal Calibration*:*

Personal Calibration means to correct or adjust the graduation of something that measures, in comparison to certain standard.

In the explicit personal calibration, in order to acquire the ground-truth gaze points to estimate κ, the subject has to look at some specific points. This procedure is often inconvenient and unnatural.

PROBABILISTIC GAZE ESTIMATION

A. Proposed Probabilistic Framework
B. Probabilistic Eye Parameter Estimation
C. Probabilistic Gaze Estimation

The probabilistic gaze estimation proposed a new probabilistic gaze estimation framework by combining the gaze prior with the 3D eye gaze model. It allowing combining eye gaze prior with optical axis estimates to simultaneously estimate 3D gaze point and the personal eye parameters in an incremental manner without any cooperation from the user.

V] SURVEY OF HEAD-MOUNTED EYE-TRACKING SYSTEM:

Kentaro Takemura [3] employed a Visual SLAM technique to estimate the head pose and extract environmental information. When the person's head moves, the proposed method obtains a 3-D point-of-regard.

Additionally, a 3-D environment is employed to detect objects of focus and to visualize an attention map. Eye tracking systems support measuring the point-of-regard during movement.

However, the point-of-regard is generally measured as a point on an image captured by a camera that is installed in the eye-tracking system; therefore, the coordinates of the point-of-regard are heavily influenced by head movements. Therefore, it is difficult to analyze the scanpath quantitatively or merge multiple scanpaths in the same coordinate system.

For head mounted eye tracking system proposed a method to estimate the 3-D point-of-regard by considering a real environment in real time. The head pose (position and orientation) is estimated using a camera that is installed in a head-mounted eye-tracking system, and the 3-D point-of-regard is estimated by associating a 2-D point-of-regard with interest points. By considering a real environment, the scanpaths of multiple people can be visualized in the same coordinate frame.

VI] CONCLUSION:

Automatic cursor movement is depend on Eye Gaze Tracking, which ongoing interesting research topic for many years, but still there is a lack in taking real time video sequence with 100% accuracy.

Many researchers have been use many head-mounted eye-tracking system, various approaches to eye gaze tracking, eye gaze estimation approaches. A more efficient method is required for Eye Gaze Tracking.

References

[1] Jixi Chen; Qiang Ji, "A Probabilistic Approach to Online Eye Gaze Tracking Without Explicit Personal Calibration," IEEE Transactions on Image Processing, Vol. 24, No. 3, pp. 1076 - 1086, 2015

[2] Cheung, Y.; Peng, Q., "Eye Gaze Tracking With a Web Camera in a Desktop Environment", IEEE Transactions on Human-Machine Systems, Vol. 45, No. 4, pp. 419 - 430, 2015.

[3] Kentaro Takemura, Kenji Takahashi, Jun Takamatsu, and Tsukasa Ogasawara "Estimating 3-D Point-of-Regard in a Real Environment Using a Head-Mounted Eye-Tracking System", IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS, VOL. 44, NO. 4, AUGUST 2014

[4] F. Lu, T. Okabe, Y. Sugano, and Y. Sato, "A head pose-free approach for appearance-based gaze estimation," in Proc. Brit. Mach. Vis. Conf., 2011, pp. 126.1–126.11.

[5] E. D. Guestrin and E. Eizenman, "General theory of remote gaze estimation using the pupil center and corneal reflections," IEEE Trans. Biomed. Eng., vol. 53, no. 6, pp. 1124–1133, Jun. 2006.

[6] K.-H. Tan, D. Kriegman, and H. Ahuja, "Appearance-based eye gaze estimation," in Proc. 16th IEEE Workshop Appl. Comput. Vis., Dec. 2002, pp. 191–195.

[7] Majaranta, P., and Räihä, K. Twenty Years of Eye Typing: Systems and Design Issues. In Proceedings of the 2002 Symposium on Eye Tracking Research & Applications. ETRA '02. ACM Press (2002), 15 – 22

[8] Bolt, R.A. Gaze-orchestrated Dynamic Windows. In Proceedings of the 8th Annual Conference on Computer Graphics and interactive Techniques, SIGGRAPH '81. ACM Press (1981), 109 – 119.

[9] Dodge, R. and Cline, T. S. The angle velocity of eye movements. Psychological Review (1901), 8, 145 – 157

[10] Z. Savas, "Track Eye: Realtime tracking of human eyes using a webcam.