Eye Gaze Tracking With a Web Camera in a Desktop Environment

Mr. K.Raju

Ms. P.Haripriya

ABSTRACT:

This paper addresses the eye gaze tracking problem using a lowcost andmore convenient web camera in a desktop environment, as opposed to gaze tracking techniques requiring specific hardware, e.g., infrared high-resolution camera and infrared light sources, as well as a cumbersome calibration process. In the proposed method, we first track the human face in a real-time video sequence to extract the eye regions. Then, we combine intensity energy and edge strength to obtain the iris center and utilize the piecewise eye corner detector to detect the eye corner. We adopt a sinusoidal head model to simulate the 3-D head shape, and propose an adaptive weighted facial features embedded in the pose from the orthography and scaling with iterations algorithm, whereby the head pose can be estimated. Finally, the eye gaze tracking is accomplished by integration of the eye vector and the head movement information. Experiments are performed to estimate the eye movement and head pose on the BioID dataset and pose dataset, respectively. In addition, experiments for gaze tracking are performed in real-time video sequences under a desktop environment. The proposed method is not sensitive to the light conditions. Experimental results show that ourmethod achieves an average accuracy of around $1.28°$ without head movement and $2.27°$ with minor movement of the head.

INTRODUCTION

EYE gaze tracking has many potential attractive applications including human–computer interaction, virtual reality, and eye disease diagnosis. For example, it can help the disabled to control the computer effectively [1]. In addition, it can support controlling the mouse pointer with one's eyes so that the user can speed up the selection of the focus point.Moreover, the integration of user's gaze and face information can improve the security of the existing access control systems. Eye gaze has been used to study human cognition [2], memory [3] and multielement target tracking task [4]. Along this line, eye gaze tracking is closely related with the detection of visual saliency, which reveals a person's

focus of attention. The video-based gaze approaches commonly use two types of imaging techniques: *infrared imaging* and *visible imaging*. The former needs infrared cameras and infrared light sources to capture the infrared images,while the latter usually utilizes highresolution cameras for images (see Fig. 1). 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) [9]–[12]. As a result, an infrared imaging-based method is capable of performing eye gaze tracking. Most of video-based approaches belong to this class. Unfortunately, an infrared-imaging-based gaze tracking system can be quite expensive. Other shortcomings include: 1) An infrared-imaging system will not be reliable under the disturbance of other infrared d 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 Compared with the infrared-imaging approaches, visibleimaging methods circumvent the

aforementioned 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. The iris center detection will become more difficult than the pupil center detection because the iris is usually partially occluded by the upper eyelid.

In this paper, we concentrate on visible-imaging and present an approach to the eye gaze tracking using a web camera in a desktop environment. First, we track the human face in a realtime video sequence to extract the eye region. Then, we combine intensity energy and edge strength to locate the iris center and utilize the piecewise eye corner detector to detect the eye corner.

To compensate for head movement causing gaze error, we adopt a sinusoidal head model (SHM) to simulate the 3-D head shape, and propose an *adaptive-weighted facial features embedded in the POSIT algorithm* (AWPOSIT),

EXISTING SYSTEM:

- ❖ The video-based gaze approaches commonly use two types of imaging

techniques: *infrared imaging* and *visible imaging*. The former needs infrared cameras and infrared light sources to capture the infrared images,while the latter usually utilizes high resolution cameras for images.

❖ Compared with the infrared-imaging approaches, visible imaging methods circumvent the aforementioned 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.

❖ Sugano *et al.* have presented an online learning algorithm within the incremental learning framework for gaze estimation, which utilized the user's operations (i.e., mouse click) on the PC monitor.

❖ Nguyen first utilized a new training model to detect and track the eye, and then employed the cropped image of the eye to train Gaussian process functions for gaze

estimation. In their applications, a user has to stabilize the position of his/her head in front of the camera after the training procedure.

❖ Williams *et al.* proposed a sparse and semi-supervised Gaussian process model to infer the gaze, which simplified the process of collecting training data.

DISADVANTAGES OF EXISTING SYSTEM:

❖ The iris center detection will become more difficult than the pupil center detection because the iris is usually partially occluded by the upper eyelid.

❖ The construction of the classifier needs a large number of training samples, which consist of the eye images from subjects looking at different positions on the screen under the different conditions.

❖ They are sensitive to head motion and light changes, as well as the number of training samples.

❖ They are not tolerant to head movement

PROPOSED SYSTEM:

❖ In this paper, we concentrate on visible-imaging and present an approach to the eye gaze tracking using a web camera in a desktop environment. First, we track the human face in a real time video sequence to extract the eye region. Then, we combine intensity energy and edge strength to locate the iris center and utilize the piecewise eye corner detector to detect the eye corner. Finally, eye gaze tracking is performed by the integration of the eye vector and head movement information.

❖ Our three-phase feature-based eye gaze tracking approach uses eye features and head pose information to enhance the accuracy of the gaze point estimation.

❖ In Phase 1, we extract the eye region that contains the eye movement information. Then, we detect the iris center and eye corner to form the eye vector.

❖ Phase 2 obtains the parameters for the mapping function, which describes the relationship between the eye vector and the gaze point on the screen. In Phases 1 and 2, a calibration process computes the mapping from the eye vector to the coordinates of the monitor screen.

❖ Phase 3 entails the head pose estimation and gaze point mapping. It combines the eye vector and head pose information to obtain the gaze point.

ADVANTAGES OF PROPOSED SYSTEM:

❖ The proposed approach can tolerate illumination changes and robustly extract the eye region, and provides an accurate method for the detection of the iris center and eye corner.

❖ A novel weighted adaptive algorithm for pose estimation is proposed to address pose estimation error; thus, improving the accuracy of gaze tracking.

SYSTEM ARCHITECTURE:
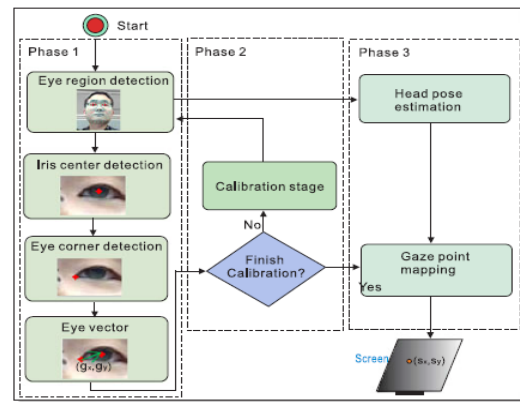
CONCLUSION

A model for gaze tracking has been constructed using a web camera in a desktop environment. 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. Further, we have proposed the AWPOSIT algorithm to improve the estimation of the head pose. Therefore, the combination of the eye vector formed by the eye center, the eye corner,and head movement information can achieve improved accuracy and robustness for the gaze estimation. The experimental results have shown the efficacy of the proposed method.

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Author's Profile

Mr. K.Raju received M.Tech degree from Jayamukhi Institute of Technological Science,Narsampet, Warangal affiliated to JNTUH, Hydearabad. He is currently working as Assistant professor, Department of CSE, in Vinuthna Institute of Technology & Science ,Hasanparthy, Warangal, Telangana, India. Hisinterest includes Data Base Management Systems.

Ms. P.Haripriya received B.Tech Degree fromVinuthna Institute of Technology & Science Hasanparthy, Warangal affiliated to KU, Warangal. She is currently pursuing M.Tech Degree in Software Engineering specialization in Vinuthna Institute of Technology & Science Hasanparthy, Warangal, Telangana, India.