



TRACKING EYE MOVEMENT BY CHARACTERIZING A SEQUENCE THROUGH HIERARCHICAL CLUSTERING

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***ABSTRACT:** Eye tracking is an evolving concept in the field of computer science it has emerged to the extent of gaze-based mouse usage to the system that may be implemented in the upcoming era. This concept can also be applied for the security purpose. An algorithm was developed to characterize, compare, and analyze eye movement sequences that occur during visual tracking of multiple moving targets. The most notable gaze features in the face image are the iris centre and eye corner. The eyeball moves in the eye socket when looking at different positions on the screen. The developed algorithm characterizes a sequence by hierarchically clustering the targets that an individual interrogated through an unordered transition matrix created from the frequencies of eye fixation transitions among the targets. Then, the resulting sets of clustered targets, which we define as multilevel visual groupings (VGs), can be compared with analyze performance. The algorithm was applied to an aircraft conflict detection task. The algorithm supported identifying different eye movement characteristics between experts and novices. Scans of the experts had multilevel VGs around the conflict pairs, whereas those of the novices included different aircraft. Our Existing method, though insensitive to light conditions, achieves only average accuracy results show promise for using the compact representation of eye movements for performance analysis.*

***Keyword:** Visual tracking, Clustered targets, Eye movement.*

I. INTRODUCTION

Face is the index of mind and eyes are the window to the soul. Eye movements provide a rich and informative window into a person's thought and intentions. Thus the study of eye movement may determine what people are thinking based on where they are looking. Eye tracking is the measurement of eye movement/activity and gaze (point of regard) tracking is the analysis of eye tracking data with respect to the head/visual scene. Researches of this field often use the terms eye-tracking, gaze-tracking or eye-gaze tracking interchangeably. Eye tracking is mostly used in the applications like drowsiness detection [Picot et al. (2010)], diagnosis of various clinical conditions or even iris recognition [Xu et al. (2006)]. But gaze tracking methods can be used in all the ways that we use our eyes, to name a few, eye typing for physically disabled, Cognitive and behavioural therapy, visual search, marketing/advertising, neuroscience, Psychology and Human Computer Interaction (HCI). Usually the integration of eye and head position is used to compute the location of the gaze in the visual scene. Simple eye trackers report only the direction of the gaze relative to the head (with head-mounted system, electrodes, scleral coils) or for a fixed position of the eyeball (systems which require a head fixation). Such eye tracking systems are referred as intrusive or invasive systems because some special contacting devices are attached to the skin or eye to catch the user's gaze. The systems which do not have any physical contact with the user and the eye tracker apparatus are referred as non-intrusive systems or remote systems.

Several recent studies have shown that manipulating the gaze direction of face stimuli could influence their later recognition. Authors have reported that faces seen with a direct gaze (i.e., the gaze directed to the observer) are more likely to be recognised at a subsequent recognition task compared to faces seen with a laterally deviated gaze. In a surprise recognition task, the participants' performance was better for targets presented with a direct gaze during the initial classification task.

II. LITERATURE SURVEY

A variety of eye-gaze (eye-movement) tracking techniques have been reported in the literature [1]. A brief list of them includes Electra-Oculography [2], Limbus, Pupil and Eyelid Tracking, Contact Lens Method, Cornea1 and Pupil Reflection Relationship, Purkinje Image Tracking, Artificial Neural Networks and Head Movement Measurement. Computer vision is intrinsically non-intrusive, and does not require any overly expensive equipment. Nonobtrusive sensing technology - such as video cameras and microphones - has received special attention in this regard. This paper draws a model for gaze tracking has been

constructed using a web camera in a desktop environment. An MTAHC(Maximum Transaction based agglomerative hierarchical clustering algorithm) algorithm was developed to characterize, compare, and analyze eye movement sequences that occur during visual tracking of multiple moving targets.

The concept of this paper is organized as follows: Section II describes related study. The details of the proposed gaze tracking method are presented in Section III, which includes Existing System, Problem Definition, Proposed System, Advantages. In Section IV, we study the architecture diagram. Section V explain proposed algorithm. Section VI is the conclusion.

III. RELATED WORK

Nowadays most eye-tracking systems work on video-based pupil detection and a reflection of an infrared LED. Video cameras became cheap over the last years and the price for a LED is negligible. Many computer devices come already with built-in cameras, such as mobile phones, laptops, and displays. Processor power still increases steadily and standard processors are powerful enough to process the video stream necessary to do eye tracking, at least on desktop and laptop computers. Head-tracking systems, which are necessary to give the users the freedom to move in front of their display, are also video-based. Such systems can be implemented unobtrusively with a second camera. If produced for the mass market, a future standard eye tracker should not cost much more than an optical mouse or a webcam today. Some people interact with the computer all day long, for their work and in their leisure time. As most interaction is done with keyboard and mouse, both using the hands, some people suffer from overstressing particular parts of their hands, typically causing a carpal tunnel syndrome. With a vision of ubiquitous computing, the amount of interaction with computers will increase and we are in need of interaction techniques which do not cause physical problems. The eyes are a good candidate because they move anyway when interacting with computers. Using the information lying in the eye movements could save some interaction, in particular hand-based interaction.

Eye Gaze is defined as the line of sight of a person. It represents a person's focus of attention. Eye gaze tracking has been an active research topic for many decades because of its potential usages in various applications such as Human Computer Interaction, Eye Disease Diagnosis, Human Behavior Study, etc. Earlier eye gaze trackers were fairly intrusive in that they require physical contacts with the user, such as placing a reflective white dot directly onto the eye or attaching a number of electrodes around the eye. Except the intrusive

properties, most of these technologies also require the viewer's head to be motionless during eye tracking.

With the rapid technological advancements in both video cameras and microcomputers, eye gaze tracking technology based on the digital video analysis of eye movements has been widely explored. Since it does not require anything attached to the user, the video technology opens the most promising direction to build a non-intrusive eye gaze tracker. Based on the eye images captured by the video cameras, various techniques have been proposed to do the eye gaze estimation. Yet most of them suffer from two problems, the need of calibration per user session and the large restriction on head motion.

Among them, the PCCR technique is the most commonly used approach to perform the video-based eye gaze tracking. The angle of the visual axis (or the location of the fixation point on the display surface) is calculated by tracking the relative position of the pupil center and a speck of light reflected from the cornea, technically known as "glint".

A. EXISTING SYSTEM

In existing system, infrared imaging and visible imaging approaches are commonly used. As infrared-imaging techniques utilize invisible infrared light sources to obtain the controlled light and a better contrast image. 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. In visible imaging methods there is no need of any specific infrared devices and infrared light sources. But ambient light is uncontrolled, so iris centre detection will become more difficult.

B. PROBLEM DEFINITION

- Infrared-imaging-based gaze tracking system is quite expensive
- An infrared-imaging system will not be reliable
- Not all users produce the bright-dark effect
- The reflection of infrared light sources on glasses is still an issue.
- Ambient light is uncontrolled
- Lower contrast images
- The iris center detection will become more difficult

C. PROPOSED SYSTEM

In proposed system, the implemented technique is an MTAHC algorithm which characterizes a sequence by hierarchically clustering the targets that an individual interrogates through an unordered transition matrix created from the frequencies of eye fixation transitions among the targets. The resulting sets of clustered targets, which is defined as multilevel visual groupings (VGs), can be compared with analyze performance. The algorithm supported identifying different eye movement characteristics between experts and novices. The results show promise for using the compact representation of eye movements for performance analysis.

D. ADVANTAGES

- Low cost
- Improved accuracy
- Achieve robustness for the gaze estimation
- Gaze tracking has been constructed using a web camera in a desktop environment.
- Locate the iris centre and Utilizing the piecewise eye corner detector to detect the eye corner.

IV. SYSTEM ARCHITECTURE

System architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviours of the system.

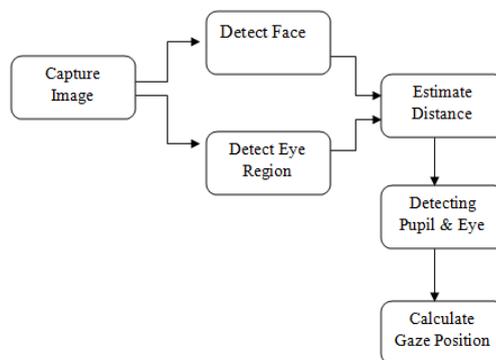


Fig 1: System Architecture

V. MTAHC ALGORITHM

A proof of concept experiment was conducted in part to find out whether the MTAHC algorithm can be used to analyze performance by characterizing scanpaths with multilevel VGs, and to characterize the possible differences in the cognitive processes among groups of individuals with different expertise for a conflict detection task. The MTAHC algorithm was applied to a task of interrogating multiple aircraft on a radar screen in order to detect conflicts that would occur in the near future. Multilevel VGs were evaluated based on the expertise (experts and novices) and the difficulty of the task (easy, moderate, and hard). Oculomotor statistics were calculated. Conflict detection rates for the novices were investigated for relationships to their multilevel VGs.

Step 1: Obtain an unordered transition matrix from a scanpath.

Step 2: Iteratively cluster the targets using the single linkage Function

$$T(C_i, C_j) = \max_{x \in C_i, y \in C_j} t(x, y)$$

Where C_i and C_j are clusters and $t(x, y)$ is the number of transitions between the targets in the clusters.

Step 3: Assign levels based on the size of the clusters (multilevel VG sets).

Step 4: (For comparing between groups) Compare proportions of obtained VG sets from the total obtained VG sets at each level of VG.

VI. CONCLUSION

A model for gaze tracking has been constructed using a web camera in a desktop environment. We proposed MTAHC algorithm is introduced to create multilevel visual groupings (VGs), defined as sets of targets that have higher number transitions between or among them compared with other targets. The algorithm supported identifying different eye movement characteristics between experts and novices. Scans of the experts had multilevel VGs around the conflict pairs, whereas those of the novices included different aircraft. The results show promise for using the compact representation of eye movements for performance analysis.

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