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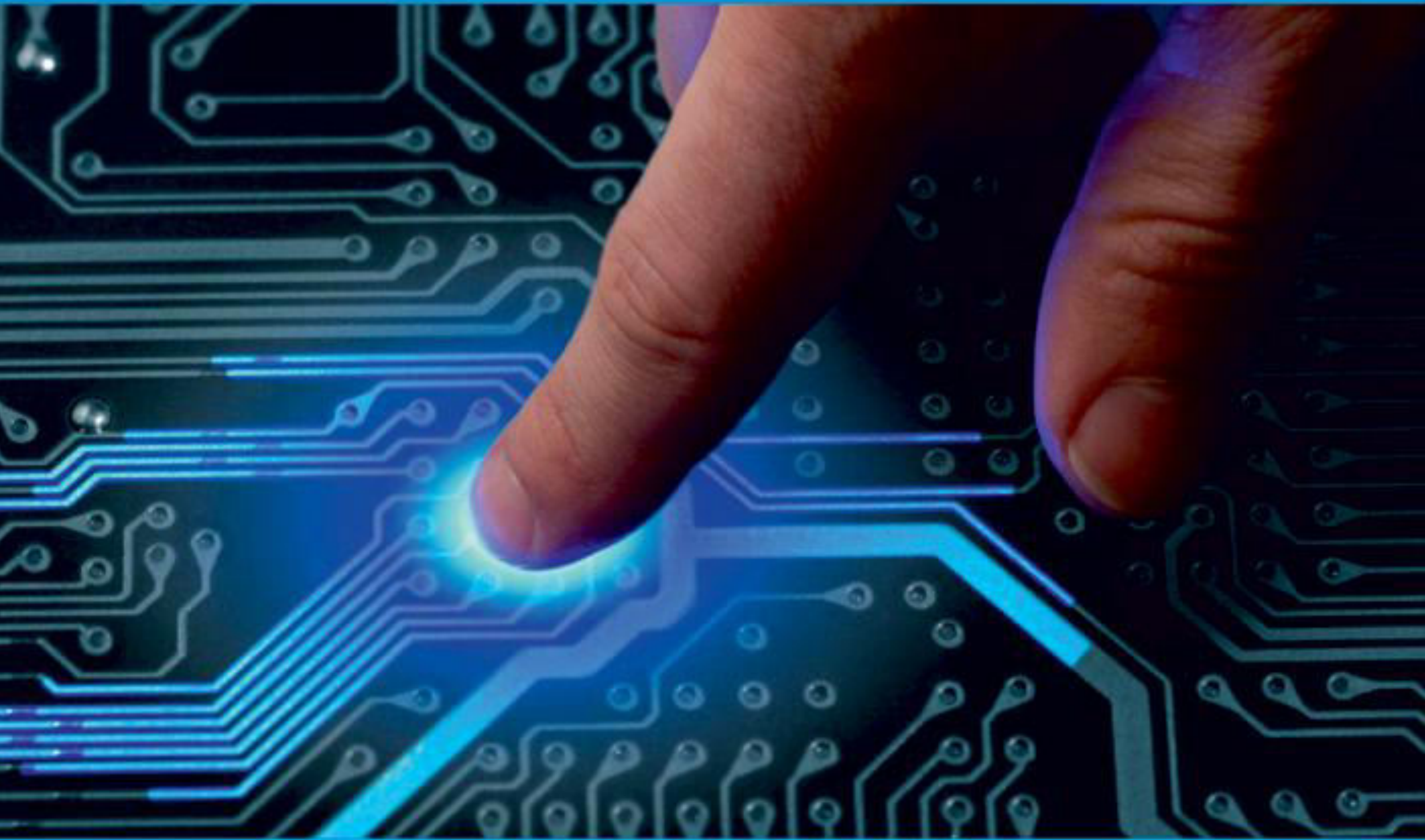

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Joint Eye Tracking and Head Pose Estimation for Gaze Estimation

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ABSTRACT: In-this-paper-we-are-presenting-a-review-on-eye-gaze-techniques-and-head-pose-estimation-which-is-progressed-in-different-ways-in-past-decades.-Previously-head-pose-and-eye-gaze-was-studied-separately-in numerous-of-literature-works.-Previous-research-shows-that-in-constrained-setting-satisfactory-accuracy-can-be-achieved-in-head-pose-and-eye-location-estimation.-Eye-locators-are-not-only-enough-to-accurately-locate-the-centre-of-the-eye.-The-head-pose-can-enhance-the-condition.-So-here-we-use-hybrid-technic-of-using-both-eye-and-head-to-estimate.-To-normalise-the-eye-regions-and-to-turn-in,-the-transformation-matrix-which-is-obtained-from-the-head-pose-is-used.-To-make-corrections-in-the-pose-estimation-procedure,-the-transformation-matrix-generated-by-found-eye-location-is-used.-Our-discussions-will-focus-on-various-methods-of-estimation-and-finally-shows-that-it-is-accurate-and-can-be-implemented-in-cases-where-classical-methods-would-fail-without-using-position-of-head.

I.INTRODUCTION

Head pose estimation is a key step in understanding human behaviour and can have different interpretations depending on the context. From the computer vision point of view, head pose estimation is the task of inferring the direction of head from digital images or range data compared to the imaging sensor coordinate system. Development and advances in various head pose and eye gaze technics have led to promising applications for human-computer interaction. History of gaze tracking began in 1900 with invasive eye tracking technics. Electro-occulography which included electrodes placed around the eyes or the scleral search methods that include coils embedded into a contact lens adhering to the eyes. In 1940s first video based eye tracking was made on pilots. When human interactions are under observation by a static camera in applications, the estimations gives various ideas about the user, especially disabled person, driver who is driving etc. we can say that gaze is the product of important factors such as eye and head pose locations. The estimation of these factors includes using huge data and expensive hardwares so previous works would simplify the project either considering head pose or eye gaze.

II.BACKGROUND

There are many research papers separately for both the factors. When there is variations in head they create problem in eye locating algorithms, so the user have to rest the chin and either use a head-mounted device or to use a high-resolution camera. When low resolution cameras are considered in appearance-based-model they become invasive. According to research by [1],[2],[3],[4] show that appearances-based-model are feasible for eye locators and can be effectively used in various applications. However many head pose or eye location methods have seen progress in gaze estimation, the fundamental assumption of being able to estimate the gaze starting from eye location or head pose only is valid in a limited number of scenarios. For example, if we consider a specific scene such as identifying the objects in the shelf, the eye gaze would alone fail to identify the objects, whereas the head pose alone would fail in identifying. So most of the research prove that combination of both work well to give better results. In the work proposed by [5] represents a real-time eye gaze using IR illumination to detect pupil of eye and get a head pose. But less accuracy makes less attractive when compared to monocular low-resolutions implementations.

After all, there are no research which produced accurate results considering both head pose and eye location factors. Hence, our goal is to implement a system which is capable of analysing the gaze of a person using both the factors in more natural way than traditional methods.

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Our work includes:
1. A unified framework is proposed which gives a deep integration of eye location and head pose tracker methods rather than just a sequential combination.
2. The used eye locators normal working range is extended. The inefficiency of eye locators due too much head poses is satisfied using the feedback from head tracker.
3. The head tracker shows better accuracy and can recover the correct pose according to the directions obtained by the eye location when head tracker is lost.

III.EYE LOCATION AND HEAD POSE ESTIMATION

To describe how we used eye locator and head pose estimator, here, the used eye locator and head pose estimator are discussed.
A. Eye Centre Localization
As we are discussing appearance-based methods here, an overview of the state of the art on the subject is given. The method used in [6] assigns a vector to every pixel in the edge map of the eye area, which points to the closest edge pixel. The length and the slope information of these vectors is consequently used to detect and localize the eyes by matching them with a training set. With respect to the aforementioned methods, the method proposed in [44] achieves the best results for accurate eye centre localization, without heavy constraints on illumination, rotation, and robust to slight pose changes, and will be therefore used in this paper. The method uses isophote (i.e., curves connecting points of equal intensity) properties to obtain the centre of (semi) circular patterns. This idea is based on the observation that the eyes are characterized by radially symmetric brightness patterns; hence, it looks for the centre of the curved isophotes in the image.
B. Head Pose Estimation
Throughout the years, different methods for head pose estimation have been developed. The 3-D-model-based approaches achieve robust performance and can deal with large rotations. However, most of the method reasonably work in restricted domains only, e.g., some systems only work when there is stereo data available [7], [8], when there is no (self-) occlusion, or when the head is rotating not more than a certain degree [9]. Systems that solve most of these problems do not usually work in real time due to the complex face models that they use [10] or require accurate initialization. However, if the face model complexity is reduced to a simpler ellipsoidal or cylindrical shape, this creates a prospect for a real-time system and can be simply initialized starting from eye locations. To achieve good tracking accuracy, a number of assumptions are considered for the simplification of the problem. First of all, camera calibration is assumed to be provided beforehand and a single stationary camera configuration is considered. For perspective projection, a pin hole camera model is studies.

IV.EYE GAZE ESTIMATION ALGORITHMS

2D Regression Method
In regression based methods explained by C.Ma , K.A Choi in “Robust remote gaze estimation method based on multiple geometric transforms”, the , the vector between pupil centre and corneal glint is mapped to corresponding gaze coordinates on the frontal screen using a polynomial transformation function. The 2D regression based methods utilize the features of the human eye, like eye geometry, pupil contours and corneal reflections and can be implemented using a single camera and a few NIR LEDs. However, these techniques are very vulnerable to head movements and require users to hold their head very still using a head rest, chin rest or bite bar.

3D Regression Method
According to Martinez’s “A single camera remote tracker” a geometrical model of the human eye is used to estimate the centre of the cornea, optical and visual axes of the eye and estimate the gaze coordinates as points of intersection where the visual axes meets the scene. 3D model based methods can be categorized on the basis of whether they use single or multiple cameras and type of user calibration required. Single camera systems have simple system geometry, no moving parts and fast re-acquisition capabilities. For 3D gaze estimation in Martinez a single camera and LED are used to achieve an accuracy of 0.5 degrees with user calibration. 3D model based methods have tolerance towards user head movement and most of them allow free head motion. However the hardware requirements for implementing 3D and stereo gaze tracking methods are high as they need several light sources or multiple cameras.

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Appearance based Method

Appearance based representation is based on recording various statistics of the pixel values within the face image. According to Bacivarov's paper "Statistical Models of appearance for eye tracking and eye blink detection and measurement" a statistical model is used to represent shape and texture variations and trained using images of the eye region annotated with landmark points.There are several appearance based algorithms. Appearance model based algorithms are non PCCR methods that use the shape and texture properties of the eyes and the position of the pupils relative to the eye corners to estimate gaze. These methods have low hardware requirements which make them suitable for implementation on platforms without a high resolution camera or additional light sources.

By analysing various research papers and articles we have come to a point to select a method to implement our project. After analysis we felt appearance based method is convenient and efficient method to adopt.

V.PROPOSED METHODOLOGIES

Algorithm: Appearance based representation is based on recording various statistics of the pixel values within the face image. Outline of the algorithm

The Viola-Jones Haar cascade algorithm is used for detecting the face in live video. The eye region is found in the face using Haar cascades available in OpenCV. The eyes are characterised by radially symmetric brightness patterns, hence this method looks for the centre of the curved isophotes in the eye region.

POSSIBLE OUTCOME:

The face detection is done using the Haar cascades available in OpenCV. Eye detection is done using the EyeAPI. Eye detection can be said to be quite robust to rotations of the head. Eye tracking is robust to pitch angles upto about 20 degrees. Eye tracking with a pitch angle of approximately 20 degrees. Similarly it is robust to a yaw angle of about 15 degrees. Eye tracking with a yaw angle of approximately 20 degrees.

PSEUDO CODE

```
Step1:Load Datasets and required libraries.
Step2:Open the web cam or video capture source
Step3:Find the face landmarks in the Frames
Step 4:Get the Blinking ratio and gaze ratio using mathematical equations .
Step 5:If Blinking ratio >5.7 ;
        Then put text "BLINKING" on the Frame.
Step 6:if gaze ratio<=1;
            Then put text " RIGHT" on the Frame
             Elseif gaze ratio<1.7;
             Then put text "CENTER" on the Frame.
              Else
              Put Text "LEFT" on the Frame.
Step 7:End
```

VI.CONCLUSION

We have presented an unconstrained system that estimates the visual gaze of a person looking at a target scene. A non sequential system was used to estimate the head pose and the eye centre locations. This multimodal information was combined in order to project the visual gaze of a person on the target scene. The eye displacements information was used to fine tune the gaze vector obtained by the head pose. Evaluation using the Boston University head pose dataset proves that joint eye and head information results in a better visual gaze estimation, reducing the standard deviation on the target scene of about 61.06% horizontally and 52.23% vertically. The user study proves that the system is able to usefully combine head and eye information to better estimate visual gaze in a more natural manner.

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