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A Survey on Head Posture and Eye Location Information by Gaze Direction Estimation

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ABSTRACT: Another strategy for head stance and look course estimation is proposed. Firstly, three models of head position are built up and stances are judged in light of triangle trait constituted by eyes and mouth. At that point understudy is found utilizing Hough change as a part of eye range. With the technique for level and vertical projection and eye earlier learning, the typical eye diagram is fitted. At last, look course is evaluated by position of student in ordinary state eye and head stance. The exploratory results exhibit the proposed strategy can precisely recognize head stance and look bearing. For considering head act, the strategy has more exactness in look estimation.

KEYWORDS: gaze estimation; head posture; pupil; Hough transform; gray projection

I. INTRODUCTION

Eyes typically contain more accessible data, in which look heading is one of imperative data. For instance, long time unaltered look course demonstrates that the driver has diverted or been in exhaustion. With the improvement of PC, look heading following has ended up hot. Head position judgment is the reason of look bearing. As of late, the techniques for look bearing research chiefly contain: neural system, highlight extraction, iris reflection flare and mapping capacity, and so on. SeWell [1-3] has proposed neural system which had higher exactness and continuous, yet the technique is all the more effectively influenced by brightening and has poor power. Yamazoe[4-5] has dissected the relationship in the middle of student and eye attachment to gauge bearing, yet he doesn't consider head stance. Iwata[6-9] has utilized Purkinje flare to recognize bearing in the premise of understudy recognition, yet the technique utilizes infrared light source which has a specific intrusive. Nguyen [10-11] has utilized single mapping between facial data and look focuses to gauge heading, yet the technique has lower versatility and exactness. Additionally, the above calculations have a typical deficiency which does not consider head stance [12-13]. At present, the strategies for head stance examination for the most part are isolated into two classes: geometric investigation in light of 2D facial components and appearance strategy. Wu[14] has examined the geometric connections of five facial focuses to gauge head stance, however the calculation needs to find five focuses which is troublesome and defenseless against outward appearances change. Chen [15] has utilized adaboost technique to find eyes and mouth and broke down head stance with the trademark triangle, yet he has just viewed as two straightforward stances. Lu [16] has proposed nonlinear atomic change which has overcome conventional straight estimation inadequacies, however the calculation needs a substantial number of preparing tests.
We propose another strategy for head stance and look bearing estimation. Firstly, head stance is judged in light of triangle characteristic constituted by eyes and mouth. At that point student is found utilizing Hough change as a part of eye range. With the strategy for level and vertical projection and eye earlier learning, the ordinary eye diagram is fitted. At last, look course is evaluated by position of understudy in ordinary state eye and head stance.

II. HEAD POSTURE ANALYSIS

In videos, the relative position of eyes and mouth will change when head posture changes and the change has some geometric features. Therefore, we can analyze head posture based on the geometric features. Research shows that any

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head posture can be divided into three basic postures(turn, nod, swing), as Figure 1 indicates .*X*, *z* axis is shown in picture and *y* axis is perpendicular to the *x*-*z* plane.

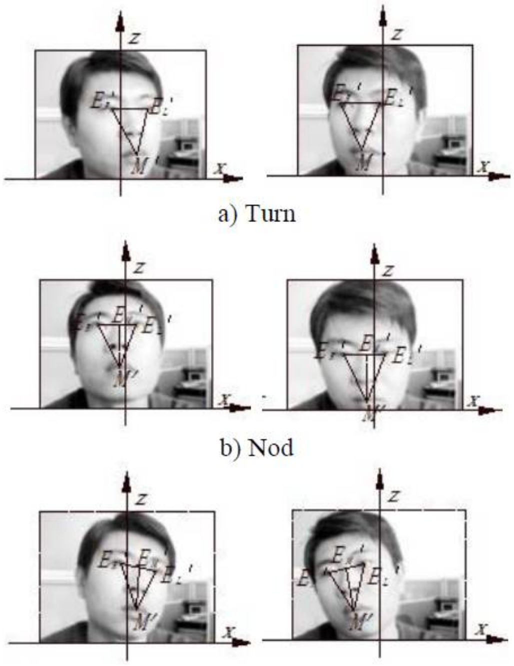

Figure 1. Head Posture

EL,ER,M individually speaks to the focal point of eyes and mouth. As per facial geometric connections, when head confronts camera, ELERM is an isosceles triangle; when head position changes, triangle qualities will change. In this way, we can break down head stance with triangle traits. For example, turn, when head pivots □ around z hub, ELERM changes into EL'ER'M'. For comfort of estimation, two triangles are anticipated into x-y plane, as appeared in Figure 2(a).

According to geometric relationships, we can deduce:

$$\alpha = \arccos(\frac{L_{EE}'}{L_{EE}}) \qquad (1)$$

Among them, LEE is the separation of two eyes in positive head picture; LEE is the separation of two eyes in pivoting head picture. At the point when Mx > 0, is sure.

For example, gesture, which head pivots β around z hub, ELERM changes into EL'ER'M'.

The triangle qualities and separation between two eyes stay unaltered. Stitch changes into HEM. Sew speaks to the separation in the middle of mouth and two eyes connection. Two triangles are anticipated into y-z plane, as appeared in Figure 2 (b).

As per geometric connections, we can find:

$$\beta = \arccos(\frac{H_{EM}'}{H_{EM}}) \qquad (2)$$

When $M_z < M_z'$, β is positive.

Such as swing, which head rotates γ around ***y*** axis, the only change is that triangular high has a certain angle with **z** axis. Two triangles are projected into **x-z** plane, as shown in Figure 2 (c).

According to geometric relationships, we can deduce:

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$$\gamma = \arccos(\frac{W_{EE}}{L_{EE}}) \quad (3)$$

W_{EE} represents horizontal distance of two eyes in image. When $E_{LZ} < E_{RZ}$, γ is positive.

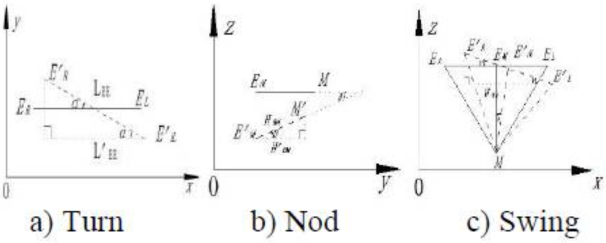

Figure 2. Projection Drawing

III. PUPIL DETECTION

Because of the impact of taxicab light changing, the sign to-clamor and difference of gathered driver video picture are lower and they influence location results. Brightening remuneration is essential and the outcome is appeared in Figure 3.

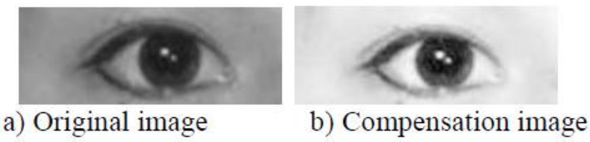

Figure 3. Illumination Compensation

A. EDGE DETECTION

Since student's dim extension is distinctive with other eye part, we utilize "watchful" administrator to identify edge in twofold picture. Resultis appeared in Figure 4.

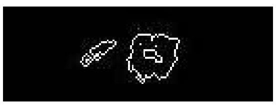

Figure 4. Image Binarization

B. HOUGH TRANSFORM

Hough change is a PC vision calculation which can identify any item with known shape. The standard layout of Hough change can be characterized as:

$$H(\Omega) = \sum_{j=1}^{N} p(X_i, \Omega) \quad (4)$$

Among them,

$$p(X,\Omega) = \begin{cases} 1, \forall (X,\Omega) : \{\Lambda : f(X,\Lambda) = 0 \cap C_\Omega \neq \Phi\} \\ 0, \text{otherwise} \end{cases}$$

, $\{X_1, X_2, \cdots, X_N\}$ represents the

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highlight point in picture space. □ C speaks to collectors unit in parameters space which focus is □ . H(□) speaks to the estimation of Hough change in □ . f (X,□) □ 0 speaks to parametric limitation mathematical statements. The key of Hough change is to locate a sensible parametric expression and suitable discrete space. As pupil is round, the analytical expression is:

$$(x-a)^2 + (y-b)^2 = r^2 \quad (5)$$

(a, b) is focus and r is span. So collectors' information structure must be 3D. In spite of the fact that Hough change can identify any bend with known shape, aggregators' information structure presents exponential development alongside the development of bend parameters. There will be bigger measure of count. On the off chance that we utilize the priori data of edge heading, we can essentially lessen the measure of estimation. Since the student size is altered, the quantity of unit collectors incredibly diminish in parameter space. Student identification is appeared in Figure 5.

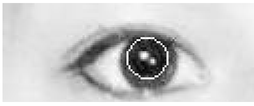

Figure 5. Pupil Detection

IV. EYECONTOUR EXTRACTION

The framework of typical eyes is constitutes by two parabolas which are comparing to the eyelids. Two explanatory crossing points are comparing to the can in this manner. Two explanatory focuses are comparing as far as possible purpose of eyelid. In this manner, the key of eye form extraction is finding the can in this manner and eyelid focuses. We utilize the calculation of vital projection to decide the positions. In flat essential projection, crests are the vertical directions of eyelid; troughs are vertical directions of can in this way. In vertical indispensable projection, crests are the level directions of eyelid; troughs are flat arranges of can in this manner. Finding result is appeared in Figure 6.Themethod is not delicate to head position and does not require high determination pictures.

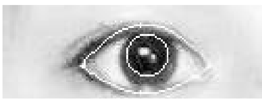

Figure 6. Eye Contour Extraction

V. GAZE DIRECTION ESTIMATION

We detect eye gaze direction according to different pupil positions. Generally, gaze directions can be divided into nine directions, as shown in Table 1.

Table 1. Eye Gaze Direction

Upper left	Upper middle	Upper right
Middle left	Middle	Middle right
Lower left	Lower middle	Lower right

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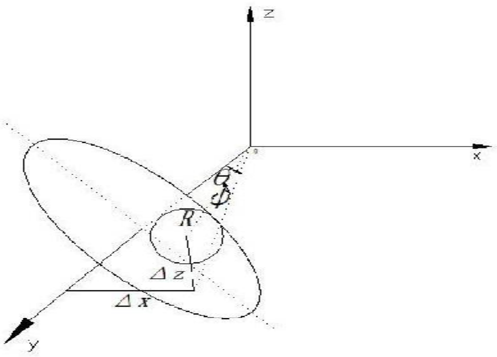

Figure 7. Direction Estimation

When we don't consider head position, the position of pupil relative toeye contour is shown in Figure 7. $\Psi$is up or down angle; $\theta$is right or left angle. So, we can deduce:

$$\psi = \arcsin\left(\frac{\Delta z}{R}\right) \qquad (6)$$

$$\theta = \arcsin\left(\frac{\Delta x}{R\cos\psi}\right) \qquad (7)$$

Among them, $R$is eyeball radius; Δx and Δz respectively is the distance between pupil and eye contour center.
When we consider head position, eye gaze direction formula can be expressed as:

$$\psi' = \arcsin\left(\frac{\Delta z\cos\gamma}{R}\right) + \beta \qquad (8)$$

$$\theta' = \arcsin\left(\frac{\Delta x\cos\gamma}{R\cos\psi}\right) + \alpha \qquad (9)$$

VI. ALGORITHM PROCESS

The algorithm flow chart is shown in Figure 8.

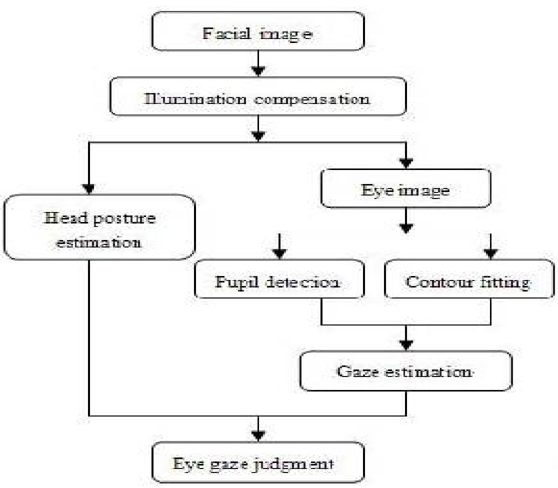

Figure 8. Algorithm Flow Chart

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VII. EXPERIMENTSAND DISCUSSIONS

The analysis depends on face database which we have manufactured. Some portion of exploratory results is demonstrated as follows. Pictures in Figure 9 are from any head position. In investigation, the separation in the middle of face and camera is 40cm. In picture, when head stance is typical, the separation between two eyes is 4.9cm and the separation in the middle of mouth and two eyes connection is 5.7cm. Head stance recognition results are appeared in Table 2and we can see that any head position can be depicted by three essential stances.

Figure 9. Head Posture Estimation

Table 2. Results of Head Posture Estimation

Image	Parameters					
	L'_{EE}	H'_{EE}	W_{EE}	α	β	γ
a	3.3	3.8	3.1	47.6	-48.2	50.7
b	4.9	5.7	4.9	0	0	0
c	4.2	4.8	3.9	31.0	-35.6	-37.3
d	4.4	5.1	4.2	26.1	26.5	-31.0
e	3.5	4.6	4.4	-44.4	-36.2	-26.1
f	3.4	5.5	4.3	-46.1	-15.2	-28.6

After head posture calculation, results of eye gaze estimation are shown in Table 3 according to formula (8, 9).We can deduce that considering head posture is very necessary for gaze estimation.

Table 3. Results of Gaze Estimation

Image	ψ/(°)	θ/(°)	ψ'/(°)	θ'/(°)	Result
a	11	4	-37.2	51.6	Upper left
b	0	0	0	0	Middle
c	12	5	-23.6	36.0	Upper left
d	-14	-21	12.5	4.1	Lower right
e	2	-42	-34.2	-86.4	Upper right
f	15	46	0	0	Middle

Two types that the proposed algorithm can't estimate gaze direction correctly is shown in Figure 10.Onetype is that head rotation angle is too big; the other is that eye open is smaller or there is much pixels noise.

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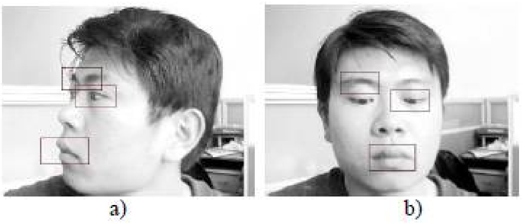

Figure 10. Failure Image Estimation

VIII.CONCLUSION

We propose another strategy for head stance and look course estimation. Three models of head stance are set up and head stance is judged in light of triangle trait constituted by eyes and mouth. At that point student is found utilizing Hough change as a part of eye territory. With the strategy for level and vertical projection and eye earlier information, the typical eye diagram is fitted. At long last, look bearing is evaluated by position of understudy in typical state eye and head stance. The exploratory results show the proposed technique can precisely recognize head stance and look bearing.

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