A Real Time Cursor Movement Control Implementation Based on Eye Gaze Tracking

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Abstract— The field of Human-pc interaction (HCI) has witnessed a superb growth among the past decade. The introduction of pill computers and cell telephones permitting contact-based completely management has been hailed warmly. The researchers during this field have additionally explored the flexibility of 'eye-gaze' as a probable approach of interaction. Some industrial answers have already been discharged, but they are heretofore high priced and provide restrained usability. This paper strives to gift an occasional price actual time system for eye- gaze based human-pc interaction.

Key words: Point of Gaze, Human Computer Interaction, Eye gaze Tracking

I. INTRODUCTION

Progressive and economical methods of HCI are being evolved unexpectedly. it is a full of life studies field of the many professionals. This paper concentrates on a person's portable computer interaction utility based mostly entirely on eye-gaze observation. Human eyes carry associate degree awful heap facts which can be extracted and might be used in several programs i.e. pc interaction. Eye gaze reflects a person's purpose of interest. Eye gaze observation is aimed to carry tune of human eye-gaze. "Eye actions is also captured and used as manipulate indicators to modify people in general to interact with interfaces forthwith while not the wish for mouse or keyboard enter" [1]. this might be dispensed by means of exploitation laptop vision and image process algorithms.

Method outlined inside the paper is non-invasive and user friendly, because it will not need a sophisticated hardware or wires. Moreover, it will not have any physical interaction with the patron. A reasonably-priced resolution is stocked with for gaze-monitoring. A integrated internet-cam in pc is employed as a capturing device. A software package based mostly entirely answer is projected for dominant mouse pointer exploitation 'eye gaze'. It's miles a seasoning and economical means of interaction with the pc. Normally the techniques of interaction to be had are sophisticated and cumbersome. The usage of this technique, for dominant mouse pointer can increase the interaction potency and reduces quality. This technique may be a distinctive boon for disabled humans, consisting of funiculars harmed or unfit sufferers. these patients are completely counting on help. Presently, disabled humans unremarkably kind at the pc keyboard with long sticks that they detain their mouth [2], but the strategy being conferred may be a benefaction for handicaps to help them be freelance of their lives. Giving them a danger to figure, socialize, and entertain of their lives.

The remainder of this paper is predicated as follows. connected studies paintings ar provided in section II. phase III provides a high level read of projected gizmo. projected Eye Gaze following set of rules is outlined in phase IV. Section V includes experimental outcomes. part VI provides conclusion of this analysis work and future studies directions.

II. RELATED RESEARCH

A number of eye-gaze observance techniques are already to be had. Some researchers applied eye gaze chase mistreatment the Electro-Oculographic observance methodology. It takes gain of the very fact that associate electricity field exists round the eyes that changes with eye ball motion and these little variations is also recorded with facilitate of electrodes placed at the pores and skin around eye. the utilization of electrodes makes this approach tough and not properly-perfect for normal use, associate utility is also found in [3]. Associate comprehensive analysis of ElectroOculography observance approach is conferred in [4].

Diverse strategies are evolved based on observance bit lenses. These systems perform completely, but they will be invasive, uncomfortable, and sometimes need a anesthetic. "Matin and Pearce (1964) developed a albuginea lenses machine that uses a try of no planar four-mm-diameter mirrors embedded within the ground of the lens on opposite sides of the scholar, their system includes a call of zero.00028 inside a range of ten for all 3 dimensions" [5]. A laser-based eyetracking machine is planned in [5], it falls at a lower place the category of head-set up eye chase structures that is not favorable for normal use. Different instance of head put in trackers are [6], [7].

Video-based altogether structures have in addition been aforementioned in literature. In beyond, low process power of computing gadgets restrained the usage of video-based altogether techniques for Eye Gaze chase as computing gadgets failed to had the potential to supply actual time eye gaze chase operation. In previous few a few years, high process strength computing gadgets had been created to be had that excited the researchers to develop video primarily based answers for Eye Gaze chase. Various video-based device techniques were declared in literature, a number of them are membrane Reflection [2], Jan Evangelista Purkinje exposure chase [8]. This paper in addition offers a video-primarily primarily based eye gaze observance appliance and makes an attempt to require good thing about integrated internet-cam in portable computer for eye gaze observance. It provides a solution the utilization of portable computer inventive and discerning and exposure process algorithms. This is often an endeavor to file a coffee price eye gaze chase machine for Human laptop interaction.

III. SYSTEM DESCRIPTION

An instance of setup for Gaze Pointer is bestowed in determines one. The device consists of a computer

integrated net-cam that takes keep image frames and Gaze Pointer computer code techniques the frames to extract user's issue of Gaze (PoG).

Proposed contraption performance was analyzed in specific eventualities and a few boundaries were defined, which may be as follows. client head need to air the equal altitude as a result of the net-cam. Distance among person's eyes and web-cam got to be within the vary of 20-75 cm. This contraption can't be used with glasses on, lights things need to be precise and head moves aren't any longer allowed. Presently device is handiest tested for frontal faces.

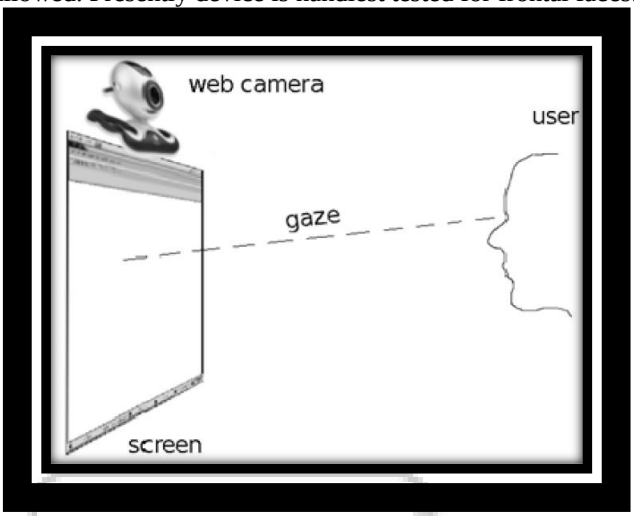

Fig. 1: Setup for Eye Gaze Tracking

IV. EYE GAZE TRACKING ALGORITHM

Overview of Eye gaze chase algorithmic rule is equipped in figure a pair of. It consists of 3 major modules: (i) facial expression extraction; (ii) Eyes functions detection and (iii) issue of Gaze calculation.

Set of rules offered during this paper plays operations on grayscale pics. Dig cam captures BGR or YCbCr shade space pictures, relying upon default settings. As a first step BGR! Grayscale color space conversion is completed. Straightforward image pre-processing methods square measure achieved at each level of set of rules. bar chart deed is applied on grayscale pictures to normalize distinction in received photograph. It tries to equalize the photograph bar chart by suggests that of adjusting constituent intensities in accordance with bar chart [10]. For face detection, a tool learning based mostly technique is employed, item detection algorithmic rule planned in [11]. This methodology employs a Haar-features based mostly technique for item detection, that makes the quick and proper item detection possible. Eye patch extraction can also be accomplished mistreatment same item detection set of rules outlined in [11]. For student detection, extracted eye patch have to be compelled to be ironed to avoid pretend detections. Scholar detection approach getting used is Hough Circle make over (HCT) [12]. For photograph binarization, facet detection methodology is employed. Eye location obtaining wont to trace the take a look at neck of the woods is to be detected, for this reason a simple activity technique is meant, that is outlined later during this section. When functions detection, a simple issue of Gaze calculation set of rules is meant that consistently interrelates the detected feature factors to lead to a particular PoG calculation

A. Facial Features Extraction

This paper intends to relinquish a watch gaze following algorithmic rule and facial capabilities detection i.e. faces and eyes extraction is a vital challenge during this regard.

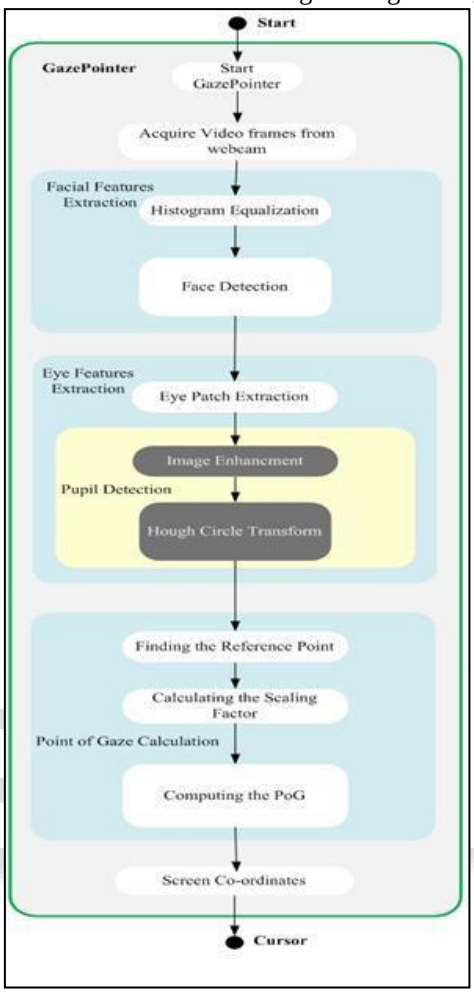

Fig. 2: Overview of Gaze Pointer algorithm

1) Histogram Equalization

Histogram effort may be a approach for assessment social control by victimization adjusting photograph intensities in accordance with photograph bar chart [10]. it's a comparison sweetening procedure that takes benefit of bar chart records and makes an attempt to equalize the bar chart. For showing facial capabilities detection, bar chart effort provides benefit of upper performance in phrases of accuracy.

2) Face and Eye Patch Extraction

Face detection may be a classification bother i.e. classify received photograph into face and non-face areas. a quick and sturdy item detection set of rule is utilized to hold out face and eyes extraction, propose in [11]. It follows a tool learning primarily based technique. Haar feature primarily based classifiers is trained for varied objects detection i.e. face, eyes. Those classifiers ar trained for faux tremendous and pretend poor samples as properly. a tough and quick of easy functions ar received from schooling records. Haar-options ar calculated via the excellence among dark-vicinity and lightweight region element values. A threshold price is fixed at mastering degree i.e. perform is alleged to be gift if distinction worth comes dead set be further than the fee

fixed as threshold. Face and eyes detection may be a advanced technique, need plenty computations to remedy this classification trouble. For this reason, obtained snap shots ar down-sampled, face is detected and face co-ordinates ar mapped to authentic picture the utilization of easy calculations. Identical apply is exercised for eye patch extraction to reduce the computation time; this approach has tried to be effective so as to attain data processing of the frame.

B. Eye Features Detection

Eye gaze following may be a sophisticated problem; it needs to assemble variety of facial and eye options to reason issue of Gaze (PoG). During this regard, first bother is to find important And spare eyes functions that would lead to an correct PoG calculation. vital eye options necessary to reason PoG had been identifies, which could be (i) scholar and (ii) Eye Corners. This section provides the ways applied for this eye capabilities extraction.

1) Pupil Detection

Pupil is that the important and focusing component of eye, positioned at center of iris. Gentle enters into eye through pupil, and finding the position of student is foremost purpose of interest in planned methodology. Eye gaze projection is based upon the relative displacement of pupil from middle of eye. Student wishes to be detected to challenge person's eye gaze within the 'check area'. The first tread on this regard, is to return across the iris from the frames captured with internet-cam, then student is also discovered, as it' miles set at center of iris. Iris may be a spherical space and may be detected the usage of the terribly generally used Hough circle rework technique [12]. Hough Circle remodel takes a binary image as associate enter and detects circle in it. the superb of the image wishes to be correct to extract each viable reality from it. First, the input image is improved for wonderful nice once that "Hough circular remodel" is applied on that.

To decorate image, smoothing is dispensed that in-impact reduces noise. For this reason, grayscale image is surpassed through Gaussian blurring filter. the strategy used for iris detection is 'Hough Circle transform'. cagey edge detection filter [10] is dispensed on additional fascinating grayscale exposure to figure binary photograph. HCT is then enforced on binaries exposure to figure pupil points in each eyes.

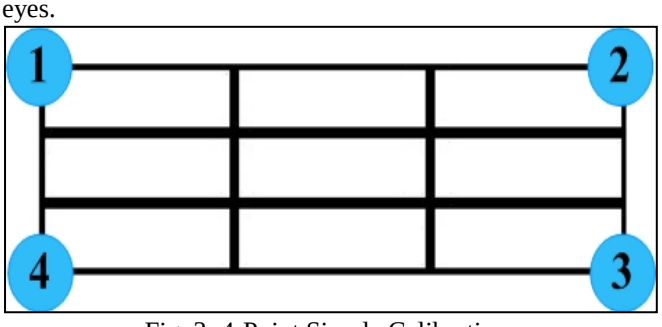

Fig. 3: 4-Point Simple Calibration

2) Eye Corners Extraction

Eye corners area unit such AN important eye feature that variety of facts or so eyes could also be extracted the usage of eye nook places. as before long as eye corner places area unit regarded, they'll be accustomed estimate eye dimension, eye height and most importantly this statistics could also be accustomed find center of eye.

Some other truth is attached via varied experiments that eye corners extraction is not acceptable, to induce to grasp or so movable place for iris in eye to hint the 'check area'. For this purpose, once analysis it changed into ended that laptop computer isn't that clever to find those boundary factors in eye, user ought to feed some statistics at begin and a few processes ought to be distributed to use this statistics in intelligent manner to extract capabilities i.e. movable space for iris, center of eye and plenty of others. T satisfy this demand, a simple four-factor activity technique is intended.

A four-factor activity rule is intended for this widget, evidenced in recognize 3. plan behind coming up with such activity set of rules is, it should be helpful to calculate eye location which might be accustomed scan the 'test location'. this easy rule permits the person to review all corner points in free mode. Here 'unfastened mode' indicates that user is allowed to remain at a nook purpose for AN discretionary period of time. this idea helps the device to reduce mistakes occurred thanks to inaccurate scholar detections for the period of activity.

C. Point of Gaze Calculation Algorithm

Point of gaze are often spoken because the purpose of interest of user in 'Test Area'. User's purpose of interest i.e. PoG can be calculated by extracting eye patch and a few vital eye features. Vital eye options sufficient to calculate PoG has been identifies and mentioned in earlier sections.

It is the foremost vital and significant stage of algorithmic program because it involves mistreatment already found feature points to calculate PoG. This stage should effort to compensate the errors occurred at detection stage.

1) Finding the Reference Point

it's completely in-feasible to perform PoG calculations while not a point of reference. It will be needed to translate pupil movements in eyes into pointer movements on screen. 'Center of Eye' will act as a desired candidate for point of reference. Eye's movable region has already been computed throughout activity stage, a straightforward averaging of x and y co-ordinates may result in Center of Eye calculation. This concept is illustrated in Equation one and Equation a pair of.

$$COE_x = \frac{Top\ Right\ Corner_x + Top\ Left\ Corner_x}{2} \quad (1)$$

$$COE_y = \frac{Top\ Right\ Corner_y + Top\ Left\ Corner_y}{2} \quad (2)$$

Where, COE_x and COE_Y denote x and y coordinates of center purpose of eye's movable region severally. Top Right Corner, Top Left Corner, Bottom Right Corner and Bottom Left Corner construct an oblong region that Represent eye's movable region.

2) Shrewd the Scaling Factor

During this step the indicator movements and pupil movements were reticulating i.e. it was to be found that what number pixels a indicator can traverse for a single picture element movement of the pupil. For this calculation, width and height of eyes were related to the breadth and height of th screen. Screen breadth and height is constant, but eye's movable region breadth and height is subject to vary in different situations. Eye's movable region breadth and height can be computed mistreatment Equation 3 and Equation 4.

$$w_{eye} = Top\ Left\ Corner_x - Top\ Right\ Corner_x \quad (3)$$

$$h_{eye} = Top\ Right\ Corner_y - Botom\ Right\ Corner_y \quad (4)$$

Where, w_{eye} and h_{eye} represent breadth and height of eye's movable region severally. Currently scaling issue is to be computed for x and y coordinates with facilitate of Equation 5 and Equation 6.

$$R_x = \frac{w_{screen}}{w_{eye}} \quad (5)$$

$$R_x = \frac{h_{screen}}{h_{eye}} \quad (6)$$

Where, w_{sreen} and h_{screen} screen denote breadth and height of 'Test Area'. R_x *and* R_y Represent scaling issue for x and y coordinates.

3) Computing the PoG

This is often the final step of PoG calculation also as Gaze Pointer rule. This stage can realize the significance of indicator. It interprets the pupil movements in eyes into pointer movements in 'Test Area'. Taking assumption that indicator in eye corresponds to center purpose in 'Test Area', pupil movements are often merely translated into pointer movements victimization Equation 7 and Equation 8.

$$PoG_x = \frac{w_{screen}}{2} + R_x \times r_x \ (7)$$

$$PoG_x = \frac{h_{screen}}{2} + R_y \times r_y \ (8)$$

Where, PoG_x and PoG_y represent r_X and r_y coordinates of Point of Gaze severally and r denotes pupil distance in x direction from point of reference and r denotes pupil distance in y direction from point of reference and that they will be computed by victimization Equation 9 and Equation 10.

$$r_x = COI_x - COE_x \quad (9)$$

$$r_y = COI_y - COE_y \quad (10)$$

Where, COI represents pupil location. Figure 4 illustrates this procedure.

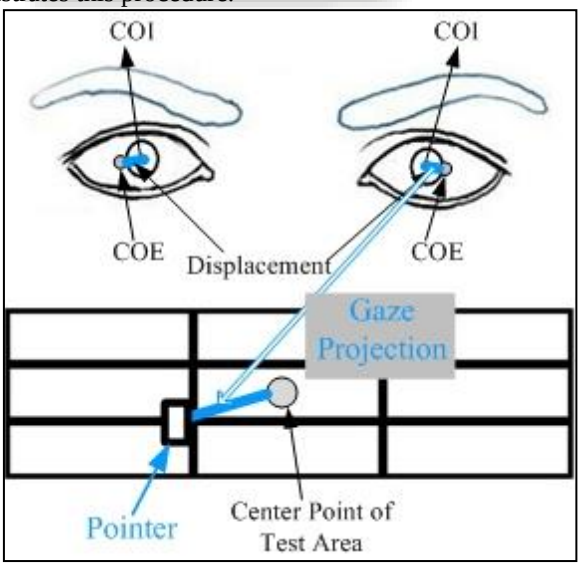

Fig. 4: Computing Point of Gaze using Reference Point

Extracted Features Accuracy	Face Detection 100%
Eye Patch Extraction 100%	Pupil Detection 87%
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Eye Patch Extraction 100%	Pupil Detection 87%

Table I: Experiment 1 Accuracy Results

V. Experiment Result

Two experiment setups were designed to test the developed system.

A. Experiment 1: Gaze Pointer Gui A

'Graphical User Interface' is meant to demonstrate the results. 1st space shows the extracted eye-patch from the captured frames and second space indicates HCT results. The portion under that represents the 'Test Area' for movement o mouse pointer. Alittle Gaze Pointer is shown within the Figure 4 which shows the projection of eye movements.

1) Experiment a pair of Results

Accuracy results of experiment a pair of are given in Table III. Overall accuracy of 100 percent is being reported for experiment a pair of. Some results from experiment a pair of are shown in Figure nine. Time efficiency results of experiment 2 area unit shown in Table IV. Overall time interval of thirteen Ms per frame is being reported for experiment a pair of.

2) Experiment one Results Discussion

Face detection provided satisfactory results. Accuracy failed to drop with ever-changing lighting conditions, backgrounds, and distance. This implementation detects frontal faces solely. Its accuracy remained 100% when tested on a limited dataset of 223 frames. A few

Extracted Features	Processing Time (Ms)
Face Detection	13-15
Eye patch Extraction	10-15
Pupil Detection	6-10
PoG Computation	2-3

Table 2: Experiment 1 Accuracy Results

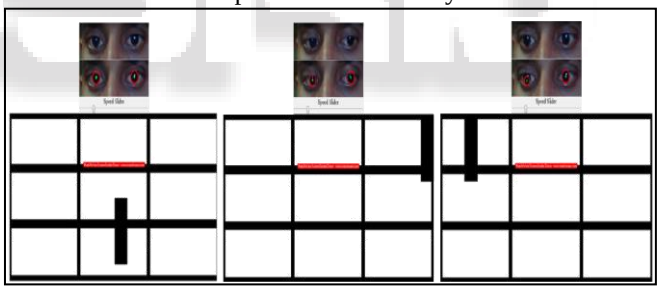

Fig. 5: PoG calculation results in different frames.

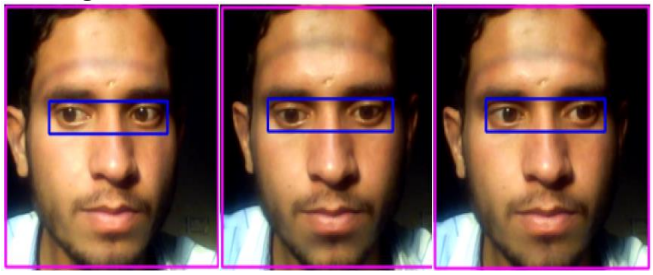

Fig. 6: Face and Eyes Detection Results

Fig. 7: Extracted Eye Patch in different frames

Samples of face detection results square measure bestowed in Figure 6. Gaze Pointer is assumed to be a system operating with real time constraints. Captured frames were down sampled five times to reduce the computation time. Before re-sizing, it took 500600 mS per frame and it reduced to solely 13-15 mS per frame.

Eyes detection implementation was done accurately in nearly every case once face was detected. This implementation was conjointly tested on a restricted dataset of 223 frames and it resulted in 100% accuracy. Eyes detection results square measure given in Figure 7. This implementation resulted in an exceedingly giant computation time. The computation time was reduced by limiting the region of interest to detected face solely. Then this face region was down sampled a pair of times. Computation time was reduced to 10-15 mS per frame when modifying the implementation.

HCT implementation resulted in an exceedingly few mS process time. Initial algorithmic program resulted in various false detections. It resulted in accuracy of eightieth once tested on a restricted dataset of 223 frames. Pupil detection results square measure given in Figure 8. the speed of false detections was shriveled by applying a threshold between previous frame pupil location and gift frame pupi location. Thus, accuracy improved to eighty seven. Point of Gaze Calculation resulted in satisfactory results once tested on a restricted dataset PoG calculation results square measure bestowed in Figure 5. Projections followed user's eye-gaze. False detections Were concerned as a result of pupil detection results weren't 100% accurate.

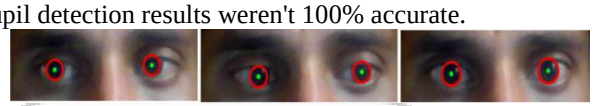

Fig. 8: Pupil detection in different frames

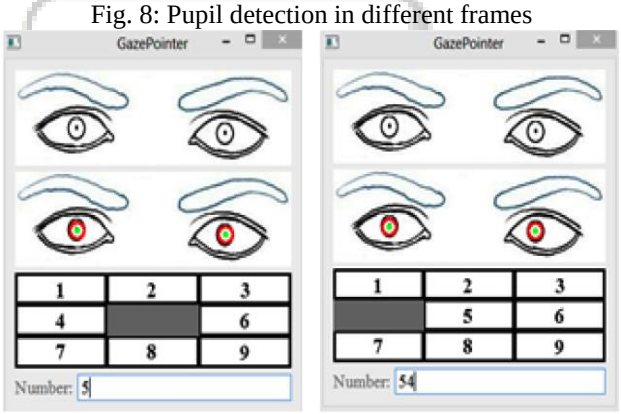

Fig. 9. Experiment 2 Results in different frames

Extracted Features	Accuracy
Pupil Detection	100%
PoG Computation	100%

Table 3: Experiment 2 Accuracy Results

B. Experiment 2: Test Bench

A simple take a look at Bench model was designed to check the accuracy of this technique. Artificial eyes rather than human eyes were used. Application prompts user to input variety. Iris moves in accordance with the quantity entered. Algorithm processes these iris movements and comes the attention gaze in 'Test Area'.

1) Experiment two Results

Accuracy results of experiment two are bestowed in Table III. Overall accuracy of 100% is being reported for experiment two. some results from experiment two are shown in Figure nine. Time efficiency results of experiment 2 are shown in Table IV. Overall time interval of thirteen Ms per frame is being rumored for experiment 2.

VI. CONCLUSION

In this paper a pc vision algorithms primarily based resolution is implemented. a trial has been created towards development of low value, period resolution for eye gaze following. There are several applications of eye gaze following, for example in HCI, appliances management, usability studies and in advertising.

Extracted Features	Processing Time (mS)
Pupil Detection	6-10
PoG Computation	2-3

Table 3: Experiment 2 Efficiency Results

Effectiveness. Accuracy for options extraction algorithms depends upon image quality and lighting conditions. Algorithm performance drops down in poor lighting surroundings. Computer Vision algorithms area unit utilized for options detection and they don't perform well in unhealthy lighting. PoG is accurately calculated provided detections area unit correct. Pointer size is giant due to low web-cam resolution and little 'Test Area' size.

To improve the projection results, image quality should be increased. Higher image quality would improve accuracy of laptop vision algorithms. Refined Pre-Processing algorithms ought to be introduced to compensate lighting variation and web-cam resolution ought to even be hyperbolic to decrease the pointer size. A feature describing head-posture must even be introduced; it'll enable the user to move freely while interacting with system. Introducing the idea of gaze estimation at the side of gaze projection is beneficial because it'll improve gaze projections drastically. The idea of gaze estimation guarantees to find out from usage statistic and infer gaze projections. Particle Filters will be wont to implement gaze estimation as a result of they're quite easy and has a likeness with drawback of gaze estimation.

REFERENCES

[1] Alex Poole and Linden J. Ball, "Eye Tracking in Human-Computer Interaction and Usability Research: Current Status and Future Prospects, "in Encyclopedia of Human Computer Interaction (30 December 2005 Key: citeulike: 3431568, 2006, pp. 21 219.

[2] D. H. Yoo, J. H. Kim, B. R. Lee, and M. J. Chung, "Non-contact Eye Gaze Tracking System by Mapping of Corneal Reflection," in Fifth IEEE International Conference on Automatic Face and Gesture Recognition (FGR02), 2002, pp. 94-99.

[3] Rafael Barea, Luciano Boquete, Manuel Mazo, and Elena Lpez, "Syste for assisted mobility using eye movements based on ElectroOculography, IEEE TRANSACTIONS ON NEURAL SYSTEMS AND REHABILITATION ENGINEERING, vol. 10, no. 4, pp. 209-217, DECEMBE 2002.

[4] H. Singh and J. Singh, "A Review on ElectroOculography," International Journal of Advanced Engineering Technology, vol. III, no. IV, 2012.

[5] K. Irie, B. A. Wilson, and R. D. Jones, "A laser-based eye-track in system," Behavior Research Methods, Instruments, & Computers, vol 34, no. 4, pp. 561-572, 2002.

[6] P Ballard and George C. Stockman, "Computer operation via fac orientation," in Pattern Recognition, 1992. Vol.I. Conference A: Computer Vision and Applications, Proceedings., 11th IAPR International Conference on, 1992, pp. 407-410.
[7] T. Horprasert, Y. Yacoob, and L.S. Davis, "Computing 3-D head orientation from a monocular image sequence," in Second International Conference on Automatic Face and Gesture Recognition, 1996, pp. 242247.
[8] K. Arai and M. Yamaura, "Computer Input with Human Eyes-Only Using Two Purkinje Images Which Works in a Real-Time Basis without Calibration," CSC Journals, vol. 1, no. 3, pp. 71-82, 2010.
[9] D. Back, "Neural Network Gaze Tracking using Web Camera.," Linkping University, MS Thesis 2005.
[10] R. Gonzalez and R. Woods, Digital Image Processing, 3rd ed.: Pearson Education, 2009.
[11] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," in COMPUTER VISION AND PATTERN RECOGNITION, 2001. 159
[12] C. Kimme, D. Ballard, and J. Sklansky, "Finding circles by an array of accumulators," in Communications of the Association for Computing Machinery, 1975, pp. 120122.
[13] H. Hula, P. Krishnaswamy, and J. P. Rolland, "Video-based eyetracking methods and algorithms in head-mounted displays," Optics Express, vol. 1, no. 10, pp. 4328-4350, 2006.

