Eye-Gaze Estimation Systems for Multi-Applications: An Implementation of Approach Based on Laptop Webcam

Jumana Waleed[1], Taha Mohammed Hasan[2] and Qutaiba Kadhim Abed[3]

Department of Computer Science - College of Science - University of Diyala – Iraq

[1]jumanawaleed@sciences.uodiyala.edu.iq

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Abstract

Eye-gaze is the mirror of speech, the language of nonverbal communication. The research investigations in eye-gaze estimation systems may reveal what persons think about on the basis of where they are looking. Nowadays, the eye-gaze estimation systems represent a combination of appropriate hardware and related software for estimating the eye-gaze directions to provide new domains of applications. The purpose of this paper is to provide an inclusive expansion in the recently existing applications based on the eye-gaze estimation systems by considering different applications; driver assistance systems, Smartphone as an input mechanism, controlling smart homes/TV, virtual space and entertainment, medicine, human robot interaction, sports, security, and authentication. Additionally, an implementation of an accurate, reliable and a low cost eye-gaze estimation approach based on Laptop Webcam is presented. This paper contains the main preliminaries, up-to-date advantages, and disadvantages, in addition to the necessity of future expansion in the domain.

Key words: Eye-gaze estimation systems, Multi-applications, Laptop Webcam.

نظم تخمين نظرة العين في تطبيقات متعددة: تطبيق طريقة تعتمد على استخدام كاميرا الحاسوب المحمول

جمانة وليد، طه محمد حسن و قتيبة كاظم عبد

قسم علوم الحاسوب - كلية العلوم - جامعة ديالى - العراق

الخلاصة

نظرة العين هي مرآة الكلام، لغة التواصل غير اللفظي. وقد تكشف التحقيقات البحثية في نظم تخمين نظرة العين عن ما يفكر به الأشخاص على أساس المكان الذي يبحثون عنه. في الوقت الحاضر،تمثل نظم تخمين نظرة العين مزيج من الاجهزة المناسبة والبرامج ذات الصلة لتقدير اتجاهات نظرة العين لتوفير مجالات جديدة من التطبيقات. الغرض من هذا البحث هو تقديم توسع شامل عن التطبيقات الحالية القائمة على أساس أنظمة تخمين نظرة العين من خلال اعتماد تطبيقات مختلفة؛ أنظمة مساعدة السائق، الهاتف الذكي كآلية للمدخلات، السيطرة على المنازل الذكية / التلفزيون، الفضاء الافتراضي والترفيه، الطب، تفاعل الإنسان مع الروبوت، الرياضة، الأمن والموثوقية. بالإضافة إلى ذلك، يتم تقديم تطبيق دقيق وموثوق ومنخفض التكلفة لطريقة تخمين نظرة العين التي تعتمد على استخدام الكاميرا الموجودة في الحاسوب المحمول. ويتضمن هذا البحث تمهيدات مهمة، والمزايا والعيوب المحدثة، بالإضافة إلى ضرورة التوسع المستقبلي في هذا المجال.

الكلمات المفتاحية: نظم تخمين نظرة العين، تطبيقات متعددة، كاميرا الحاسوب المحمول.

Introduction

Eye-gaze movement provides an informative and essential interface into a people's thinking and objectives. A noteworthy view from the scope of psychology is the capability of studying the interior working of the brains by calculating how different eye muscles are contracted [1]. Figure 1 shows the eye muscles which are provide the eye-gaze movement.

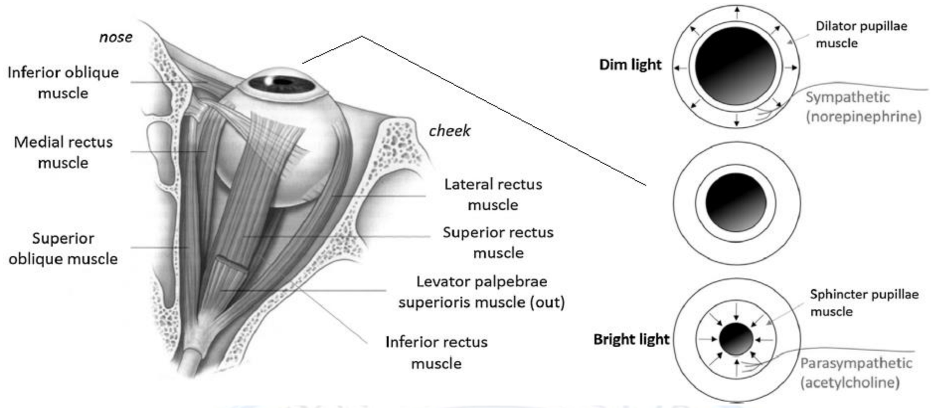


Figure 1: Excellent sight for the eye [1].

The researchers in eye-gaze estimation systems may reveal what individuals think about on the basis of where they are looking. Consequently, the eye-gaze estimation has been drawing a great consideration over the world and provides various applications for different purposes such as offering new attributes to the e-readers, helping the handicapped individuals to run the automated appliances, alerting the drivers when their eye-gaze moves away from the path, controlling the instruments by the surgeons, allowing to control the smart home appliances like smart TV, controlling the video games, assisting the marketers to detect which a product the persons view at most, detecting the eye-gaze movement for the simulation of pilots in flight, non intrusive controlling for drones and monitoring the unusual eye-gaze movement in divers which may refer to narcosis nitrogen or deprivation of oxygen.

There are a number of various types of eye-gaze estimation systems that can be classified along various ranges. Firstly, there are two distinct types of the eye-gaze estimation systems, which are the systems based-wearable devices (head mounted systems) and based-unwearable devices (remote systems). In head mounted systems, the people need to put cameras on the helmets or the glasses frames. Helmets offer good results for eye-gaze estimation; nonetheless, their heaviness makes them unpractical for expanding utilization. Spectacles have been achieving a good popularity because they are accurate and not heavy. With remote systems, there is no need to wear any sensor or camera to the human's body, and this may lead to increase the user's convenience, essentially in long term utilization. But, this type of systems provides a low accurate as well as it is unsuitable for the applications that needed mobility [2]. As compared with various systems based-wearable devices [3], [4], [5], [6], the systems based-unwearable devices are extensively utilized [7], [8], [9], [10], [11], thankfulness to its ease of use and convenience. Secondly, they can be classified into active and passive systems. In Active systems, the estimators require the use of cameras, infrared illuminants (IR) and A light emitting diode (LED) to add lighting to get a preferable look for the eye. These systems have a lower efficiency at big distances and in the daytime. The passive systems are working in visual light. These systems are very natural; however, they are more sensitive to lighting cases [12]. The most existing eye-gaze estimation systems require to some extent a high cost and utilization of near IR and LED technologies [13] in which the user's eyes may sense uncomfortable. In spite of the use of invisible IR illumination, it is still possible for the IR illuminator to affects the users' eyes and this affects the applicability. For these reasons, a design of a low cost based a software eye-gaze estimation system is very necessary [14]. With this context, some researchers use a low cost single camera [15], [16], and others use low cost devices like high definition (HD) web camera and Kinect [17].

Another significant classification is between feature-based and appearance-based systems. Feature-based systems are developed to be the highest popularity for the eye-gaze estimation that detects the local attributes from the images of the eye, like eye corners, reflections, and contours. In appearance-based systems, the eye-gaze estimation does not obviously detect the attributes; but it utilizes the contents of the image as an input and maps them directly to screen coordinates. The major disadvantages of this type of systems are; firstly, it has a low-accuracy typically between 2º and 3º with a fixed head movement, on the contrary, the feature-based system has a higher accuracy (less than 2º); secondly, it is difficult to merge the information of head pose with an appearance in a strong manner when involving the head movements [2]. Anyone can turn the eye-gaze to a proper location after moving the head. Therefore, head pose estimation systems must be integrated with the eye-gaze estimation systems. There are many researches for head pose estimation such as [18] [19] that can be utilized for eye-gaze estimation systems [20]. Therefore, a lot of systems have been developed for robustly combining the head pose estimation with the eye-gaze estimation [15], [17], [21], [22], [23], [24].

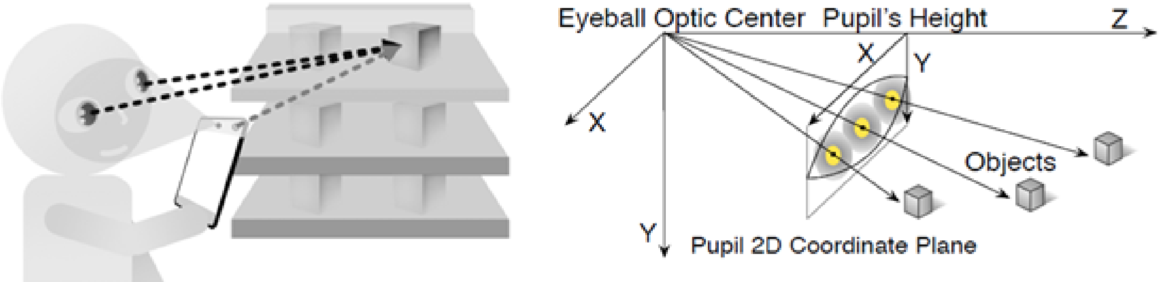
This paper provides a comprehensive presentation of the recently existing applications in the eye-gaze estimation systems. Also, it presents an implementation of a low cost feature-based eye-gaze estimation approach based on Laptop Webcam. The remainder of this paper is formed as follows: the next section provides a summarization about the highest representative applications for the eye-gaze estimation systems. After that, the proposed approach and the performance analysis are presented; the conclusions are given in the last section.

Eye-Gaze Estimation Systems for Multi-Applications

Recently, the term of eye-gaze estimation systems in unlimited cases has become a modern research field in which various types of programs and related devices are improved over the multidisciplinary researches. In spite of the considerable achievements by the researchers in this domain, the ability to use eye-gaze movements in various application fields is still negligible in reliability and accuracy criteria [25]. Currently, the use of trained neural network can determine the eye-gaze estimation with high reliability and accuracy as in the works [20], [26]. Also, the utilization of optimization techniques like particle swarm optimization can improve the performance of eye-gaze estimation systems [27]. And to optimize the performance of the whole system, [28] presents an optimized combination of neural network and particle swarm optimization. This section presents a summarized study about the highest representative works in eye-gaze estimation systems. Therefore, different applications have been considered.

Eye-Gaze Estimation as Input Mechanism with Smartphone

With the fast development of techniques, Smartphone is developed to be a ubiquitous device used by a large number of users. It is vastly utilized to control an extremely domain of commercial applications in daily lives because it is supplied perfectly with various equipment such as a high resolution camera, wireless connection, a considerable processing, large storage and etc. In order to deal with Smartphone without using the hand, eye-gaze estimation systems have been developed as an alternative input mechanism to allow the user to do many jobs at the same time. Different researchers utilize a Smartphone based eye-gaze estimation to determine the visual attention of the users. [29] Proposes a low cost visual attention detection system based on a Smartphone which is able to compute the eye-gaze direction and the range toward the object (see figure 2). This system achieved high accuracy with low response time. A driver's visual attention system based on a Smartphone utilizing computer vision techniques is presented in [30], as a solution for driver monitoring with high convenience and low cost. Smartphone represents a dynamic platform in which the cases for fixed eye-gaze estimation are extremely challenged owing to changeable locations to the users with respect to Smartphone, the unusual hand movement and variable lighting [25].



(a) (b)

Figure 2: Explanation for the visual attention detection system based on a Smartphone. (a) Getting information about objects through an eye-gaze. (b) The computation of eye-gaze directions [29].

Eye-Gaze Estimation for Controlling Smart Homes/TV

Fundamental developments have been built in smart home appliances to support the disabled and regular persons in their daily life. The suitable design for the smart homes provides unconventional free life for these persons to stay in their usual surroundings for a long time. Nowadays, Smartphones are utilized for a low cost and flexible home control and monitoring system. But, with daily workloads, the users are not in a situation to take out the Smartphone to control their home devices. Several methods have been proposed in the design of such systems for estimating the user emotions by analyzing eye-gaze, nose and lips [36]. Eye-gaze estimation based smart homes are a new domain of human environment interaction which provides a perfect life for the old and disabled people. Recently, the Smart TV has been widely used by offering a smart interaction between system and user for controlling TV menus based on a remote controller, user's gestures and etc. With the appearing of different functions for the smart TV, it is difficult for a remote control to do these large functionalities. In addition to, the viewers need convenient input devices without moving their hands. Therefore, the eye-gaze estimation can be used for detecting the location where the users are looking at on television screen, and thus represents a substantial use in the situation of choosing a special television menu or monitoring if the user is watching television or not. [21] Proposes an eye-gaze estimation system based on head pose estimation in smart TV, and this work requires reducing the impact of lighting in the process of detecting the face contours. [37] Presents a wearable system based on internet protocol TV environment. This system still needs to improve its throughput to get a high reliability and convenience.

Eye-Gaze Estimation in Driver Assistance Systems

According to the government data issued by the Central Bureau of Statistics of the Ministry of Planning, Iraq witnessed after 2003 a significant increase in the number of cars, reaching 5.8 million cars distributed between the provinces. Over the past ten years, Iraq has witnessed more than 66,000 traffic accidents resulting in the death of 22,952 people and the injury of 79545 people. The reasons for increasing the traffic accidents besides the increase in the number of cars, are the high speed of some drivers, the lack of compliance with traffic laws and the loss of driver concentration in driving, and may the driver did not perform maintenance and periodic inspection of his vehicle. Specifically, with regard to the utilization of mobile phones while driving, as well as bad weather and road congestion affecting the vision for the driver. The Traffic Accidents Report issued by the Central Bureau of Statistics showed that collisions recorded the highest percentage during the year 2015, with (4,213) incidents by (48%) of the total accidents, followed by run-ins (3,405) accidents by (38.5%), Car crashes (1,000) accidents by (11%), while other accidents (218) by (2.5%). One of the causes of the accidents was due to the driver as it recorded (6,393) accidents by (72%) and represents the highest percentage, the accidents caused by the car amounted to (998) accidents by (11%), because of the road (738) accidents by (8.4%), and the rest of the causes amounted to (707) accidents (1%) of the total number of accidents (8,836). After examining these percentages and numbers, we find that there are great challenges and responsibilities to the state, because the roads cannot accommodate this number of cars, causing traffic jams and accidental accidents on a continuous basis. Traffic accidents have become very dangerous similar to terrorist operations. Those traffic accidents are becoming a worry for all individuals in society, in addition to draining the material resources. The resulting of social difficulties and losses in human energies that affects the components of life, which is the human element, and must find proposals and solutions for reducing these incidents or at least identify the causes and reduce the negative effects and address the most significant elements that share and cause the occurrence of traffic accidents, which are the driver, road, vehicle and others. These problems require developing robust safety systems, which can reduce the road accidents via alerting the drivers under different bad driving conditions. Eye-gaze estimation systems are one of the essential techniques for the future of driving assistance systems. A lot of researchers recorded the driver assistance systems based eye-gaze estimation in which the eye-gaze movements for the drivers are estimated as a point of their attention [31], [32]. The ability to use this kind of applications include difficulties in eye-gaze estimation owing to unstable lighting, the blurred area of the eye due to shade or wearing glasses, fake warning, and the ability to operate in real time. [33] Presented a low cost system capable of detecting the direction of the eye-gaze when it is out of the road along the day under different conditions such as age or wearing glasses. In addition to eye-gaze estimation, this feature-based assistance system contains a robust facial feature and head pose estimations for detecting the eye-gaze out of the road, see figure 3. Another system is proposed to detect the driver distraction by using the eye-gaze estimation [34]. But, this system requires handling head movement and detecting the facial directions. The navigation systems in cars can supply the drivers with information about the traffic in the complex roads or strange regions. [35] Explores eye-gaze behavior for providing a vision about the performance of drivers through the use of mobile navigation systems in a civilized region. Eventually, most existing driving assistance systems require special devices which restrict their ability to access.

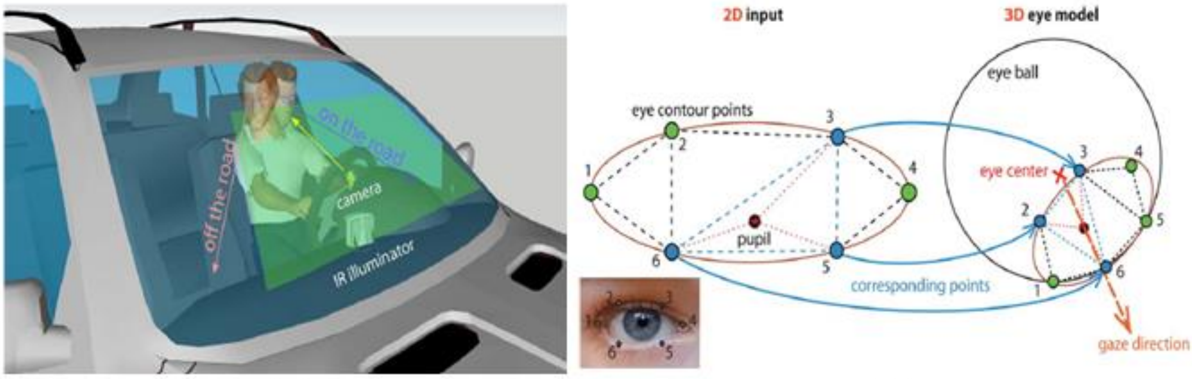


Figure 3: (a) Illustration for detecting the direction of the driver's eye-gaze when it is out of the road. (b) The computation of 3D eye-gaze estimation [33].

Eye-Gaze Estimation in Virtual Space and Entertainment

In the past few years, the virtual reality systems have been utilized in different applications and research domains by using conventional devices such as joysticks for an interacting user with the system. Even though these means are able to control the video games, they are still unnatural interfaces. Playing the virtual reality game with unnatural interfaces hinders the users from fully immersive experiences. It is necessary to develop natural interfaces for controlling the virtual space and environment based on eye-gaze estimation systems. [38] Presents a natural interaction system through an improved gaming experience, and the user can be interacting with this system based on eye-gaze movement. Increasing the utilization of stereoscopic 3D technologies in virtual space, video game, and entertainment put attention for developing interaction based on eye-gaze. Researches in eye-gaze estimation systems and virtual space have shown up the necessity for a suitable valuation system that can be applied in stereoscopic 3D environments. The computer graphic technologies have made it possible to improve a valuation system for 3D eye-gaze estimator [39], [40], [41].

The main challenge in above systems depends on accuracy when estimating the eye-gaze movements, since the inaccuracies in eye-gaze estimation may lead to wrong selections.

Eye-Gaze Estimation in Medicine

The benefit of using eye-gaze estimation systems in medical applications has been presented by various researches. Most of the existing researches are used for multi purposes such as exploring different kinds of diseases, improving medical education and therapy and etc. Moreover, the eye-gaze estimation systems represent a useful means in medical diagnostics like mental disease diagnostic. Although there is a reasonable number of new researches in this area, there are still unexplored fields which may lead to a diagnostic revolution. Also, the utilization of eye-gaze estimation systems in therapy remains nearly unexplored [42]. [43] Proposed a system for eye cancer therapy that is the critical stage for making the proton treatment of the eye completely noninvasive. Recently, utilizing robots in the operating theater has become very popular. Various interfaces to surgeon robot interactions have been improved for controlling the tools in operating theater like hand controlled and eye-gaze controlled interfaces [44]. With the progress of the diseases, people may suffer from the inability of communicating with their environment. Those disabled may be become incapable of moving their hands or legs, walk or moving the objects, and may be they are incapable of speaking. Nevertheless, in most of these conditions, their cognition capabilities are still robust. Currently, improving tools to aid those people in communicating is the main difficulty which scientific communities are facing. Eye-gaze estimation systems as an assistive tool can help the disabled who can use only their eyes in different fields [13], [45], [46] such as to control the computer effectively [24] and to select objects (home appliances) [47].

Eye-Gaze Estimation for Human Robot Interaction

With nearby future, the Robot will become the best companion. For achieving this aim, still different difficulties required to be removed. One of these difficulties is the ability of robot for perceiving some fundamental communication signals utilized by the users. In the recent years, the significance of communication via eye-gaze has been recognized in the robots, even beyond the limits of social applications. In spite of the chance of utilizing the robot's eyes for communicating has been already implemented in markets, the ability of robots to understand the user’s eye-gaze for anticipating their requirements and objectives has not been exceedingly utilized until now. A lot of researchers are looking forward at utilizing remote eye-gaze estimation systems built in a humanoid robot. The researchers in [12] and [48] provide an effective utilization of eye-gaze information to communicate with the users. And with the context of a low cost Human Robot Interaction, a Tele robotic scheme based on eye-gaze estimation system is proposed in [49], in which the user is capable of controlling the navigation of a Tele-operated portable robot using eye-gaze as input to the scheme. But this scheme contains some difficulties that must be resolved such as the relatively low performance of the eye-gaze interface and the necessity to add the steering control to the robot.

Eye-Gaze Estimation for Sports

Currently, there is a possibility to utilize the eye-gaze estimation systems in various applications of the sport. So, to apply this possibility in the real world, it is needful to remove a series of difficulties related to manufacturing of sports. The head mounted devices and non active lighting based on eye-gaze estimation which adapts with the user's movements are desired for many domains in sports applications. [50] Present a system by expanding of a visible spectrum eye-gaze estimator in the literature to deal with the substantial movement distortions. Particularly, this system utilizes a suitable model to estimate the eyes corners of users and combines the obtained information for iris estimation process. This proposed system is very fast in computations and capable of handling big alterations in eyes position.

Eye-Gaze Estimation for Security and Authentication

The biometrics is one of the sciences that establish the identities of individuals depending on chemical and physical characteristics of the persons. The major objective of the biometrics is to develop a secure and reliable system with high level of accessibility by an authorized user. The conventional systems of distinguishing the identities of persons contain; knowledge-based mechanisms such as a password and token-based mechanism such as ID card. But these mechanisms can easily be missing, shared and stolen, and this lead to lose the required security [51]. In spite of lack inefficiency, the password remains the more popular e-authentication system to protect everything starting from a bank account, computer, email, information concerning health down to social media accounts. Almost the entire human's body parts will be utilized as an indication sight for biometric based identification, like the schemes dependent on fingerprint, facial characteristics, iris, eye-retina, eye-gaze and more. These biometrics based identification allow an extra reliability with a strong performance better than a conventional password. Nevertheless, these biometric security and authentication systems are still not common owing to different causes like privacy and costs. The main idea to use the eye-gaze based biometrics is that every person has its own model of eye-gaze movement. Comparing with the other solutions, eye-gaze movements provide high unrefined biometrics, because it is dependent on invisible and non physiological information embedded deeply inside the persons, and it is very difficult for disproving. Recently, eye-gaze based biometrics has confirmed to be a wonderful substitution technique for authentication, monitoring and etc. An emerging application of eye-gaze based biometrics is in the forensic domain [52]. The manner of exposing the fooling digital information is to improve systems that are able to check the defective areas of digitalized copies. These systems are named forensic systems which are utilized for authentication purposes [53].

The Proposed Approach Based on laptop Webcam

The proposed feature-based approach is able to estimate the eye-gaze directions with good accuracy and reliability. It is a low cost and more comfortable since it is utilizing laptop Webcam. This approach consists of several steps as shown in figure 4:

1. Detect the face of the user in the real time, and find the region of the eye which involves information about the eye-gaze directions, by selecting the features of the facial shape of the gray image that each one represented as (vi, wi), and expressing these features as a line-vector v = $(v_1, \ldots, v_n, w_1, \ldots, w_n)^F$ which represented a group of landmarks. These landmarks must be analyzed and synthesized as new facial shape features in the training group. In order to generate an acceptable facial shape, the principal component analysis (PCA) technique has been used. Figure 5 shows the detection for the region of the eye.
2. Extract the most distinguished eye-gaze features which are the inner corner for the eye and the iris center to generate eye line-vector. To estimate accurate eye-gaze directions, the inner corner of the eye must be detected, and this process is done by using a detector based

curvature and matching scheme. A canny detector is utilized for generating the map edges to detect the contours. The simplification of curvature to the point p is denoted as:

$$C(p) = \frac{\Delta v_p \, \Delta^2 w_p - \Delta^2 v_p \Delta w_p}{\left[(\Delta v_p)^2 + (\Delta w_p)^2\right]^{1.5}} \quad (1)$$

Where $\Delta v_p = (v_{p+s} - v_{p-s})/2$, $\Delta w_p = (w_{p+s} - w_{p-s})/2$,
$\Delta^2 v_p = (\Delta v_{p+s} - \Delta v_{p-s})/2$, $\Delta^2 w_p = (\Delta w_{p+s} - \Delta w_{p-s})/2$, s is a small step.

To estimate the iris center; firstly, find the radius, and then use an informative integration of edge factor and intensity energy.

3. Find the eye line-vector when looking at distinct positions on the screen. This step is done by using the inner corner $E_{\_corner}$ for the eye and the iris center $E_{\_iris}$ ($E_{\_corner}$ - $E_{\_iris}$) for calculating information about the gaze points. There is a calibration process which provides nine target points to which user is looking at the screen, while the corresponding eye line-vectors are kept.
4. Estimate the final eye-gaze direction based on the mapping function which determines the relation between the coordinates on the screen and the eye line-vector. The estimated eye-gaze directions are illustrated in figure 5.

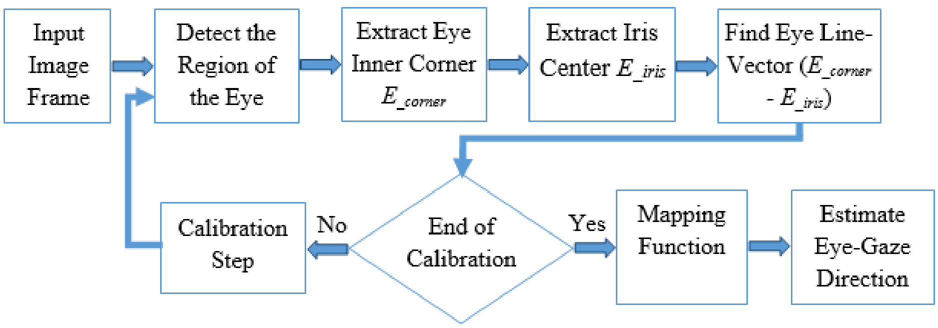


Figure 4: The steps of the proposed approach

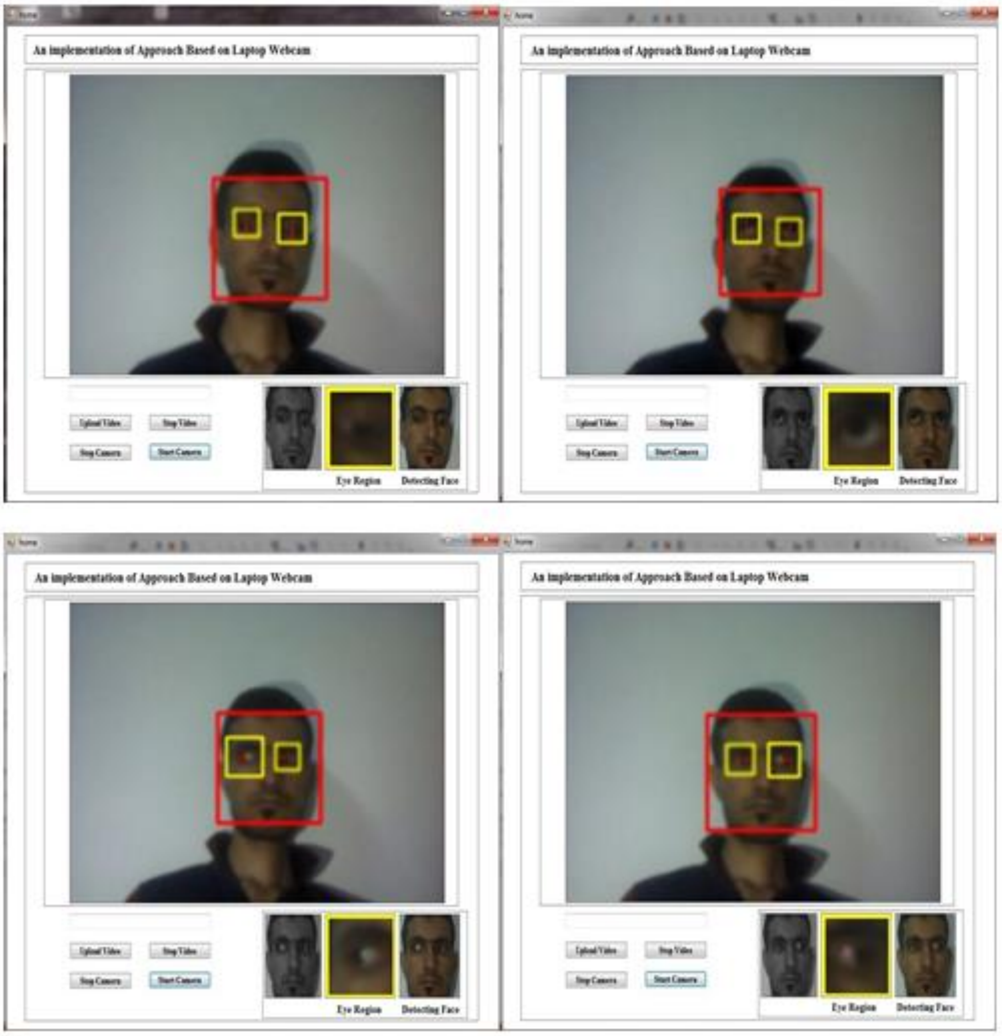


Figure 5: The implementation of estimating eye-gaze directions

Performance Analysis

The term of accuracy has been used to evaluate the performance of the proposed eye-gaze estimation approach without head movements. The degree of angular (*Da*) is a common measurement to find the accuracy of the system. *Da* can be defined as:

$$Da = arctan\left(\frac{dis_d}{dis_g}\right) \quad (2)$$

Where dis_d represents the distance between the detected position of eye-gaze and the ones in the real; and dis_g represents the distance between the subject and the screen plane. The lower *Da* measurement is, the greater is the accuracy of the eye-gaze detecting. The average of the obtained accuracy of the proposed approach is about 1.3º. The formerly given applications are put in a nutshell in table 1. In this table, a comparison is presented depending on the following standards: application field, wearable/unwearable devices, active/passive systems, feature/appearance-based systems and head pose estimation.

Table 1: Multi-applications systems based eye-gaze estimation.

Author(s), Year	Ref. No.	Application field	Based-wearable	Based-unwearable devices	Active system	Passive system	Feature-based system	Appearance-based system	Head pose
Sheng-Wen Shih et al., 2004	[45]	Medicine		✓	✓		✓		
C. W. Cho et al., 2010	[37]	IPTV controlling	✓		✓		✓		
H. Heo et al., 2011	[47]	Medicine	✓		✓		✓		
C.J. Lim et al., 2012	[39]	Virtual reality	✓		✓		✓		
Dat Tien Nguyen et al., 2013	[21]	Smart TV controlling		✓		✓	✓		✓
B. R. Pires et al., 2013	[50]	Sports	✓			✓	✓		
B. Rouzier et al., 2014	[31]	driver assistance		✓		✓	✓		
O. Stan et al., 2014	[32]	driver assistance		✓		✓	✓		
F. Vicente et al., 2015	[33]	driver assistance		✓	✓		✓		✓
Junghoon Park et al., 2015	[13]	Medicine		✓	✓		✓		
O. Palinko et al., 2015	[48]	Human Robot Interaction		✓		✓	✓		

Z. Jiang et al., 2016	[29]	Object detection based Smartphone		✓		✓		✓	✓
D. Xiao et al., 2016	[30]	driver monitoring based Smartphone		✓		✓	✓		
S. Maralap -panavar et al., 2016	[34]	driver assistance		✓		✓	✓		
R. Zheng et al., 2016	[35]	driver monitoring		✓	✓		✓		
D. Kumar et al., 2016	[38]	Virtual reality game controlling	✓			✓	✓		
H. M. Yip et al., 2016	[44]	Medicine	✓			✓	✓		
S. Wyder et al., 2016	[43]	Medicine		✓	✓		✓		
Stefania Cristina et al., 2016	[24]	Medicine		✓		✓	✓		✓
O. Palinko et al., 2016	[12]	Human Robot Interaction		✓		✓	✓		✓
Virginio Cantoni et al., 2016	[52]	Authentication		✓		✓	✓		
Sunu Wibirama et al., 2017	[40]	Virtual space	✓			✓	✓		
S. Tripathi et al., 2017	[41]	Virtual reality	✓		✓		✓		
A. Khasnbish et al., 2017	[46]	Medicine		✓	✓			✓	
D. Gêgo, C. Carreto et al., 2017	[49]	Human Robot Interaction		✓		✓	✓		
The Proposed Approach	-	Can be implemented in multi- applications		✓		✓	✓		

Conclusion

There are several types of eye-gaze estimation systems; each type of systems has its one or multi-applications and has its own advantages and disadvantages. Regrettably, there is no system that can supply a completely exhaustive ambition. In the previous sections, representative insight for utilizing eye-gaze estimation in different applications is given. The necessities for a useful eye-gaze estimation system involve high accuracy and reliability, robust head pose estimation and robustness to vastly diverse lighting cases. Also, it is fundamental to increase the performance of the system and decrease the cost. Actually, various researches in this domain utilized for emphasizing that a low cost and accurate estimation of the eye-gaze in real time with unlimited use conditions is still a big challenge. In this paper, we present an implementation of a low cost eye-gaze estimation approach based on Laptop Webcam. The proposed approach is a more comfortable since it is based-unwearable devices, so there is no need to wear any sensor or camera to the user's body. This approach provides a suitable average of accuracy about 1.3°. In future; we hope to combine the obtained eye line-vector with robust information of the head pose to improve the accuracy of the proposed approach.

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