OPTIMIZATION OF ERROR IN LOCALIZATION OF IRIS FOR NON-FRONTAL FACES

A Thesis submitted in partial fulfillment of the requirement for the Award of the Degree of

MASTER OF ENGINEERING

In

Electronics and Communication

Submitted by

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AUGUST, 2019

DECLARATION

I, **Ipsita Kumar** hereby declare that the work presented in this Project **"OPTIMIZATION OF ERROR IN LOCALIZATION OF IRIS FOR NON-FRONTAL FACES"** in partial fulfillment of the requirement for the award of degree of **Master of Engineering (Electronics and Communication)** submitted at **Electronics and Communication department,** Thapar Institute of Engineering and Technology (Deemed to be University), Patiala is an authentic record of work carried out under supervision of **Mr. Sukhwinder Kumar (Lecturer, ECED, T.I.E.T, Patiala)** from September 2018 to August 2019.

The matter presented in this seminar has not been submitted either in part or full to any other university or institute for the award of any other degree.

Date: 30/08/2019

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It is certified that the above statement made by the candidate is correct to the best of my knowledge and belief.

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ABSTRACT

Eye Localization and eye tracking has been a vast area of research since a while now. There are a lot of applications that works on the basis of eye tracking and eye localization such as in the case of medical identification, human computer interface, gaming and entertainment and so on. The field of eye tracking consist of an issue till date that is eye tracking at non frontal faces or eye localization at different face positions. In this thesis research we try to improve the accuracy of eye localization at different face positions thus, resolving this issue. The method carried out in this research is on the basis of coordinate projections followed by template matching and skin segmentation. The problem also comes in the case of detection of face specially where it is non frontal. In order to carry out the process of eye localization in a smooth manner, we tend to extract the face using the process of skin segmentation. Further, with the help of template matching eye area is extracted, which leads to the localization of eyeball. The process assures the extraction of face at different positions, making it an advantage of skin segmentation. Later we present the results of each part of the proposed methodology one by one. In the end the results are optimized, the accuracy and losses are determined to show how effectively the method worked. This can enhance a lot in the area of research such as determining the eye in the case of occlusions and reflections at non frontal faces. Another upgradation that can be made in this field is determination of eye ball in the shaking situation. A lot of applications can be further upgraded and a lot of new applications can be accomplished with the help of eye ball localization in non-frontal faces.

Keywords: eye localization, eye tracking, skin segmentation, template matching

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LIST OF ABBREVIATIONS

RGB	Red Green Blue
HSI	Hue Saturation Intensity
HSV	Hue Saturation Value
LED	Light Emitting Diodes
ADHD	Attention Deficit Hyperactivity Disorder
ASD	Autism Spectrum Disorder
OCD	Obsessive Compulsive Disorder
CTA	Call to Action
TP	True Positive
TN	True Negative
FP	False Positive
FN	False Negative
CNN	Convolutional Neural Network
HCI	Human Computer Interaction
IW	Intelligent Wheelchair
mRMR	Minimum Redundancy Maximum Relevance
SVM	Support Vector Machine
EAR	Eye-based Activity Recognition
PC-CR	Pupil Center-Corneal Reflection
CDF	Cumulative Distribution Function
PF	Projection Function
EA	Edge Analysis
PMI	Pixel with Minimum Intensity
GPF	General Projection Function
SRC	Sparse Representation Classifier
USB	Universal Serial Bus
RST	Radial Symmetry Transform
ABF	Adaptive Bilateral Filter
FPGF	Fuzzy Peer Group Filter

SBF	Switching Bilateral Filter
PSNR	Peak Signal to Noise Ratio
EEPGF	Enhanced Fuzzy Peer GroupLogic
IR	Infrared
RAM	Random Access Memory
ROI	Region of Interest

CHAPTER 1

INTRODUCTION

1.1 SKIN SEGMENTATION AND FACE EXTRACTION

Skin division or skin shading location is the procedure of partition among skin and non-skin pixels. Numerous PC vision applications managing the identification and acknowledgment of people and their exercises require the division of skin locales as a pre-handling step. Models for such frameworks can be found in the fields of reconnaissance, human PC collaboration and face acknowledgment. The errand of using of shading data is for the most part testing. The skin shading is had all the earmarks of being subject to various factors, for example, light condition, ethnicity, camera qualities and so on the procedure of skin division can be significantly utilized for the confinement of face. Face localization is the first venture in a few applications, for example, face following, individual identification, appearance acknowledgment and eye following. Face confinement can be performed by division utilizing the shade of the skin. Shading pictures can be spoken to in a few shading models including RGB, HSI, CIELab and YCbCr [7][9].

In different uses of programmed controlling utilizing picture preparing the from the outset the essence of the subject candidate in the picture is found which is named as face localization. For the handling of face confinement versatile edge technique is utilized which portions through the color of the skin. Adjusting to the shade of the skin by the programmed methods is one of the major helpful normal for versatile thresholding strategy. Face recognition is a hard identification issue because of the adjustments in scale, area, direction and posture. Additionally, outward appearance, enlightenment changeability and incomplete impediment change the geometric normal for the face. Face confinement is a simplified face recognition issue. In face restriction, the supposition that will be that there is just one face in the scene. Hence, the strategy attempts to restrict a solitary face. This situation is normal in a few applications, for example, eye following, face verification, and so forth [21].

Skin identification is the procedure of finding skin-shaded pixels and locales in a picture or a video. This procedure is regularly utilized as a preprocessing venture to find areas that possibly have human countenances and appendages in pictures. A few PC vision methodologies have been created for skin discovery. A skin finder commonly changes a given pixel into a proper shading space and after that utilization a skin classifier to mark the pixel whether it is a skin or a non-skin pixel. A skin classifier defines a choice limit of the skin shading class in the shading space dependent on a preparation database of skin-hued pixels. The presence of skin in a picture relies upon the enlightenment conditions, where the picture was caught. In this manner, a significant test in skin discovery is to speak to the shading in a manner that is invariant or possibly unfeeling toward changes in light.

Figure 1.1 Skin segmentation

Skin video segmentation (Color based) is an efficient approach which enables very reliable skin segmentation irrespective of the illumination variation which occurs during tracking. The very basic of face recognition and tracking of gestures involve locating followed by tracking of the skin colored pixels [19]. The very useful aspect of this technique is the orientation and the non-varying size for which it is used in early stage localization of the high level systems. The challenge however is to incorporate variations and later adjust with the variation in the illumination conditions which may or may not occur within the image sequence. The use of luminance invariant color spaces lead to a slight robustness but on the other hand this approach withstands variations undergone by skin color distributions in a narrow condition set. Conditions, for example, different sources with time changing brightening and single or numerous hued sources separated from fluctuating light are conditions to be considered in skin division. To list a real time scenario of varying illumination one can consider the night lamps or street light on a person driving a car which change the appearance of color of the skin. Comparative impacts emerge because of surface entomb reflectance which means a surface mirroring a shading onto the skin of the individual for this situation.

The methodologies for the skin shading division can be sorted as the accompanying:

- Physically based approaches
- Statistical approaches

The statistical approaches can be further subcategorized as:

- Parametric approaches
- Non parametric approaches

The parametric skin color segmentation approach represents the distribution of skin color in parametric form such as the Gaussian model. The statistical approaches for skin color segmentation perform the needful in colored spaces commonly HSV and RGB reducing the effect of varying illumination as these color spaces also offer minimum overlap of background color and skin color distributions [5]. Skin color distribution can often times be multimodal therefore hindering the adequate representation as single

Gaussian model in the color space. People and lighting conditions can be responsible for the variation of parameters of skin color distribution.

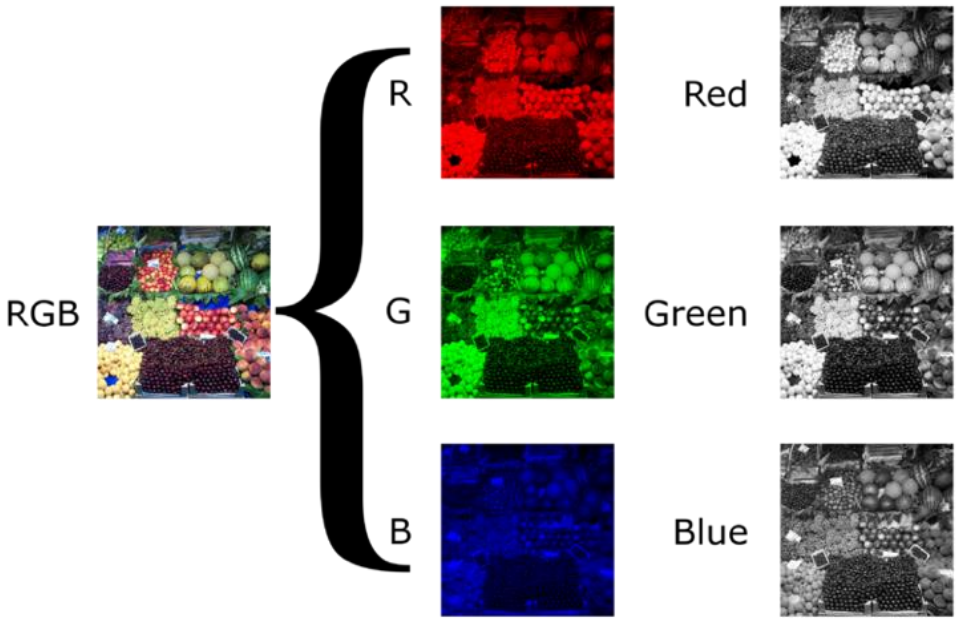


Figure 1.2 RGB color model

1.1.1 Methods of skin detection

- Pixel-Based Methods
  - Classify every pixel as skin or non-skin exclusively, autonomously from its neighbors.
  - Color Based Methods fall in this classification
- Region Based Methods
  - Try to consider the spatial game plan of skin pixels during the identification stage to upgrade the strategies execution.
  - Additional information as far as surface and so forth are required

1.1.2 Advantages of skin color based methods

- This strategy permits quick handling.
- It is strong to geometric varieties of the skin designs.
- It is robust under partial occlusion as well.
- Moreover, this strategy is robust to resolution changes.
- It eliminates the need of cumbersome tracking devices or artificially places color cues.
- Experience suggests that human skin has a characteristic color, which is easily recognized by humans.

Color pictures can be spoken to in a few color models, including RGB, HSI, CIELab and YCbCr. The best execution as far as classification blunder is accomplished by the HSI and YCbCr models. Nonetheless, because of the way that all pictures are caught in the RGB shading model, a change between this model and different models must be performed. The best execution as far as execution time is accomplished by the YCbCr model. A significant accelerate can be accomplished by downscaling the first picture. On account of the HIS model, a downscale factor can accelerate the procedure up to a 28% while a factor of 4 can accelerate the procedure as much as 68%.

1.2 EYE TRACKING AND EYE LOCALIZATION

As we know, face can be extracted through the process of skin segmentation. Once the face is extracted, the other features of face can be easily obtained by various techniques and methods. One of the major feature of face is the eye. Eye is a vital feature that can express thus leading to interaction and communication. Due to the importance of functioning of eye, it's been an important area of research since a while now. Eye tracking or eye localization is now-a-days a leading area of interest for many researchers and authors [17].

Further, followed by skin segmentation or skin color detection comes a process of eye detection or eye localization. Eye detection is the assignment of finding and finding eyes in pictures. It is utilized in an extraordinary number of uses, for example, eye-stare following frameworks, initiating directions, and blends with other pointing gadgets. Different models incorporate ongoing frameworks for face location, face acknowledgment, iris acknowledgment, eye to eye connection redress in video conferencing, autostereoscopic shows, outward appearance acknowledgment, and that's only the tip of the iceberg. Every one of these applications require eye recognition for their work.Eye localization strategies, working under various brightening conditions can be generally separated into the accompanying two primary classes that is Feature based techniques and Appearance based techniques. Highlight based techniques utilize from the earlier information to identify eye focuses from basic appropriate highlights dependent on shape, geometry, shading and evenness. Appearance based strategies utilize an earlier model of the eye all encompassing appearance and encompassing structures and attempt to recognize the area of the eyes by fitting the prepared model.

Since the absolute starting point of the examination in the territory of eye following, it has consistently been an intriguing and significant region of research for quite a while [2]. Eye-stare following places a gigantic effect in the territory of mental research. It has - look following has been a significant and intriguing zone of research for a long while now. In lab tests for mental research, eye-stare following comprises a supportive instrument to test the perceptual or the psychological procedures of the subjects. In everyday applications,

eye-stare following can be utilized as a PC interface for both modern and nonindustrial applications, which require sans hands establishments. It can likewise be utilized to help debilitated individuals to utilize PCs for correspondence and for ecological control [10].

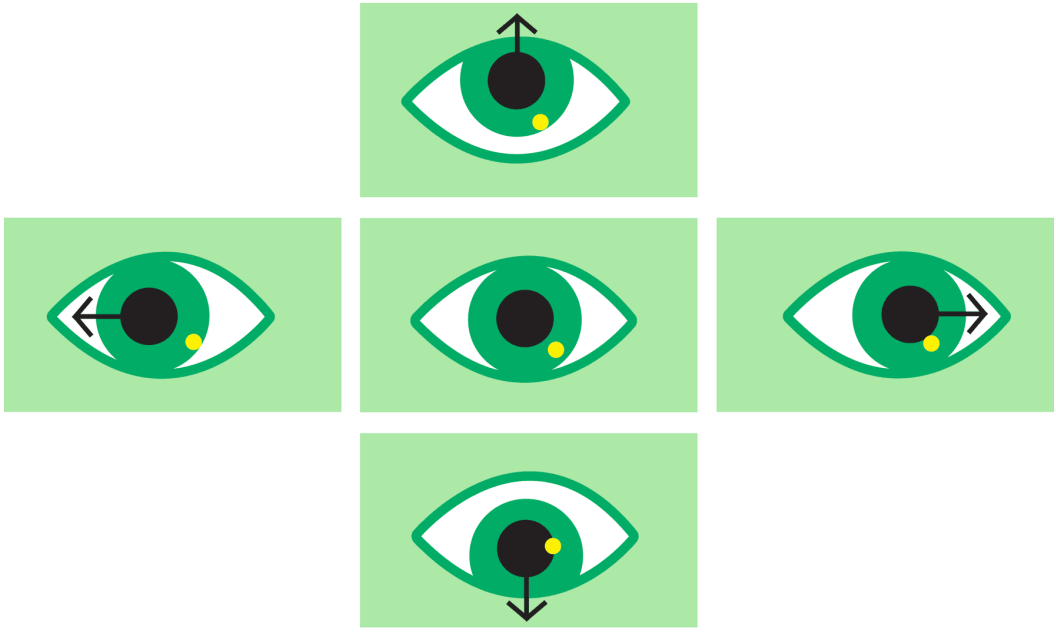


Figure 1.3 Eye tracking

In the case of face analysis and recognition of facial features, eye detection is crucial. Eye detection can be complex due to a number of variations in human faces, size of eyes and artificial occlusions like spectacles etc.

In today's research, eye tracking systems works on the concept of a reflection based infrared LED and video-based pupil detection. Step by step camcorders are getting to be modest and cost of LED is likewise irrelevant. PC gadgets additionally accompanies worked in cameras, for example, cell phones, presentations and PCs. The technology in computer devices is so advanced that eye tracking can easily be accomplished on devices itself with the help of the device's built in camera. With the steady increase in the processor power eye tracking can be easily accomplished with the homely devices and their webcam itself. With the concept of eye tracking human beings can easily interact with the computers with the help of eye movements without causing any physical problems.

Eye tracking tends to record the position of eyes and also the movements that depends upon corneal reflections. Thus, making an analysis of gaze position and eye movements not just in 2D but also 3D

environment. It helps to process the visual information by human processing for communication and diagnostic applications.

Through eye tracking, attention, interests and much more such parameters can easily be signified being a great tool for human actions. Eye tracking can possess a lot of applications, a few of them are listed in the following subchapter.

1.2.1 Applications of eye tracking

1. Academic and Scientific Research

Eye tracking leads to a huge research area not just in image processing but also in neuroscience and psychology. Making it a major topic of concern in the area of research and development.

2. Market area

The value of eye tracking has been rapidly increased in the market area. Many of the top leading brands tend to evaluate, design and also advertise their products and shopping behavior of their products. Eye tracking tends to optimize the overall customer experience.

3. Psychology

In the area of psychology, a person's sense of visualizing can determine a lot about his behavior thus leading to great application of eye tracking. This helps in the recognition of many mental health disorders and problems.

4. Medical field

Eye tracking plays a major role in medical field as just with the information about eyes many diseases can be diagnosed such as ADHD (Attention Deficit Hyperactivity Disorder), ASD) (Autism Spectrum Disorder), OCD (Obsessive Compulsive Disorder) and many more. For example, it can likewise be utilized for the assurance of laziness and tiredness.

5. Usability Research

Eye tracking assumes a noteworthy job in the field of client experience and ease of use. One of the examples that comes under usability research is website testing which includes communication, CTA (Call to Action)

and attention to real estate. A few more application of usability research can be in the form of mobile applications in smartphones and tablets.

6. Packaging

Eye tracking can be greatly used in the field of packaging. Mainly eye tracking is used for the designing of packages which tends to understand the requirements, priorities and preferences of customers. Due to good packaging services the products can gain attention making it stand out from the other products leading to the interests of consumers.

7. PC and Gaming

Eye tracking is a valuable par in the world of gaming and human computer interaction. This helps the getting a better understanding of gaming experience. This tends to get more close to the real world thus making the field more of an interesting place. The possibilities have already arrived that there will be games and other interaction sources that will completely be controlled by eye movements.

8. Human Factors and Simulation

Eye tracking have always taken an important place in the area of automotive research. There is a going on research in automobiles where the vehicles might start responding towards the driver's eye movements and eye gaze. Furthermore, eye tracking can make biometric sensor technology more successful and powerful.

1.3 OUTLINE OF THESIS

The thesis is isolated into five areas. Each segment assumes an imperative part in the satisfaction of the thesis. A brief about each chapter is given in this section.

Chapter 1: In this chapter a brief introduction is given about basics of skin segmentation and face extraction. Various methods and applications of skin segmentation. Followed by this, a brief about extraction of features of face is given. the main focus is on one of the features of face that is eye. In the end a small information about eye tracking and eye localization is provided with the general applications of eye tracking.

Chapter 2: The chapter is provided with a literature survey of various paper on eye tracking. Different methods and algorithms such as template matching, hough transform etc. proposed by researchers is explained with the results in the form of accuracy of the algorithms has been explained. With the help of this chapter further methodology has been proposed.

Chapter 3: In this chapter the criteria of proposed methodology has been explained with the help of a proper flow diagram. The light has been put on each and every step included in the proposed method. The method has been proposed on the basis of eye tracking leading to the comparison of the experimental value to actual value.

Chapter 4: The chapter explains about the results of accuracy of eye tracking obtained by the experimental values and its comparison with the actual values. Thus, finding the error between both the values and further putting them into the form of true positive (TP), true negative (TN), false positive (FP) and false negative (FN).

Chapter 5: This chapter is provided with the conclusions and the future scope of the method proposed on the basis of eye tracking.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

In order to accomplish the work, it is important to be aware about the present research its problem, method and solution. It is also important to understand the area in which the progress and upgradation is going on and what kind of algorithms are being used for its processing. In order to understand and accomplish this a lot of research papers, google documents, books, thesis and dissertation needs to be referred. In order to give a start to this work a lot of such documents and researches about eye tracking, eye localization, and skin segmentation has been studied. It has been noticed that various techniques, methods and algorithms were used for the representation of eye tracking, eye localization and skin segmentation. The study of various techniques and algorithm has also been studied such as template matching, hough transform etc. a literature review has been done in the next part of the thesis for the accomplishment of the work.

Hong LIU et al, in 2002, the creators in their examination proposed a constant and programmed strategy for the location of eye states for example regardless of whether the eye is in open state or shut state [38]. The technique depends on the way that if there should arise an occurrence of open state or when the eye is open the white district of the eye and the iris can be effectively distinguished. The shading pictures are to a greater extent an utilization as they contain more data for iris discovery than the power picture. In the underlying piece of the technique, immersion of the shading is utilized to distinguish the condition of the eye for example regardless of whether the eye is open or shut. While, in the later piece of the technique, the edge guide of the eye is thought about for the location of the iris. Shading data is progressively helpful for the discovery of iris area as opposed to just utilizing edge pictures. The picture grouping taken under test for the entire technique are almost frontal view shading facial picture arrangement. As there can be only two states of the eyes by default they are open and close. In the case of computer controlled system the open state of the eye can be defined as, if the white of the eye or the iris can be seen it is said to be in open state otherwise, it is in closed state. At first, the color information of the image is used for the detection of eye states. The color space here used is HSI (Hue Saturation Intensity), where hue is the perceived color, saturation measures the dilution of the color with the white light and finally the intensity of the color is shown. if more of the white color is blended, smaller is the saturation. As the white part of the eye mixes the most extreme white color, the immersion is consequently littler than some other part of the eye. On the off chance that the light is reflected by the understudy it turns into a high splendor guide driving toward little immersion too. Along these lines the condition of the eye can be distinguished by the proportion of immersion of eye shading picture as the immersion of the skin is higher than any part of the eye. Followed by this edge information was obtained using Canny edge detection method to achieve final result sequence.

As a result, in this research it was observed that the open state of the eyes was properly determined while there was some inaccuracy in the case of closed state. The testing images used were 300*400 facial color images which were operated as 20 images per second on 1700 megahertz PC.

Tirthankar Sengupta et al, in 2003, a study was proposed by the authors that investigated the prospects of eye movements for interaction with user and also user interface design. The experiments were performed such that it included a set of tasks whose interface was command-based with the help of the mouse and simultaneously their eye movements were tracked. Some of the initial results on the basis of study of relativity between eye movements and mouse were provided by the authors. A few findings were obtained through this study for further designing of interfaces and subsequent interaction techniques. It was also observed that the familiarities and regular use can tend to render less focus on the area of commands while more focus on that of work. Further, it was seen that higher eye activities were encountered by the commands that were able to affect the strategy of completion of task. The results can lead to a task situation with the connection between eyes and mouse [37].

Yoshisuke Tateyama et al, in 2004, the authors in the paper say that machines that are needed to assist humans such as personal computers or humanoids make it difficult and complicated for the humans when machines act without detailed orders from humans. The authors had also put an impact on the fact that movement of eyes provide very important information about humans. It has been a great topic of research for researchers to measure accurate fixation points using an eye tracking system. While allowing natural head movement it is not possible to calculate the actual fixation point with limited resources. In the research, the authors separately analyzed the change in direction and change in face positions without detecting the fixation points. Basic three features of eye tracking system has been described i.e. (1) detection of change in face position, (2) wide measurement area for natural head movements and (3) for the detection of saccades, high sampling rate over 20 Hz. The eye tacking system chosen by the authors is based on stereo camera so as to check the ability to detect if the human is concentrating or not. The experimental measurements were made when the subject was involved in various tasks. Finally, the results confirm that there is a huge possibility of detecting a human's state of attention with the help of eye tracking [36].

Samuel Xavier-de-Souza et al, the authors in 2006 in this paper proposed a calculation with the CNN Universal Machine for strong and quick face following [35]. A driving framework was taken in commonsense for the wheel seat, on which the technique proposed in this paper was connected. The calculation incorporated an on-chip usage. A calculation has been presented for example to follow various highlights of a human face, a CNN model was presented. The model is essentially implied for the following of articles. As the proposed technique or the calculation and following of the highlights of face work and close by in a parallel way, the vigor and the speed of the strategy have been exceptionally feasible. The structuring has been done to such an extent that it abuses the particular properties of face highlights and a

high pace of the casing is gotten. A cell vision framework named as Bi-I remain solitary was taken for the usage of the face following technique connected to a wheel seat driving framework. So as to produce chip-explicit vigorous formats, the layout activities were very much prepared. A versatile picture catch system was likewise acquainted all together with improve execution with fluctuating enlightenments in the earth. Because of following by the proposed calculation the pace of the edges turned out to be 92 edges for each second. The outcome was a triumph for the constant driving by and large genuine circumstances.

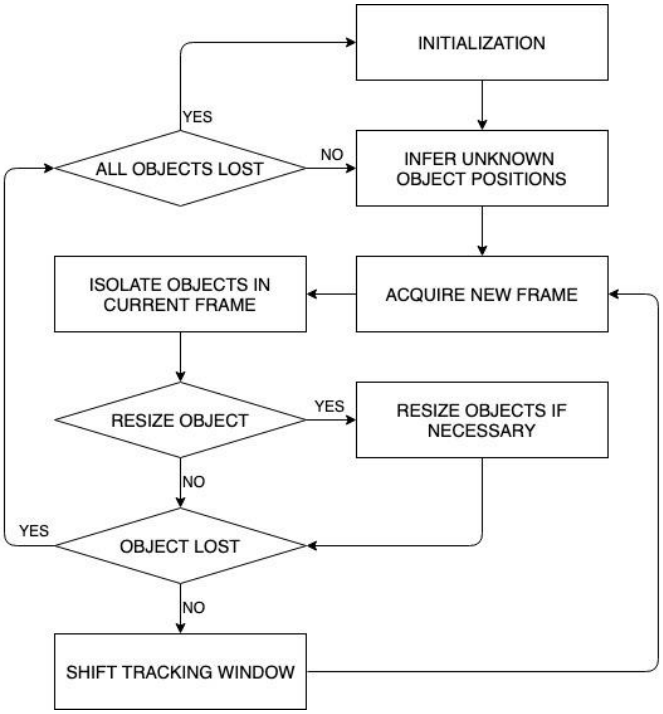


Figure 2.1 Proposed algorithm with CNN universal machine

Ying QI et al, in 2007, the creators in this paper presented a non-contact and minimal effort eye-stare following framework [32][33]. The framework fundamentally satisfies the idea of HCI (human PC cooperation). In the proposes framework the bearings of the look are determined by the estimation of Purkinje Image and the situations in connection. The look is additionally subject to the places of the understudy which takes a shot at the idea of corneal reflect technique. The look headings can be cultivated by the proposed framework progressively. The obsessions can likewise be recognized from other eye developments. The obsession techniques at that point can be utilized for the association with the PC. During the procedure a throughput of roughly 18 look focuses every second was accomplished effectively. The creators will in general say that the best sign of human's goals can be best accomplished by obsession focuses subsequently making the association and correspondence progressively helpful and common. As the outcomes got through the investigation demonstrated an incredible decrement in the pace of mistake of the framework that was utilized in HCI.

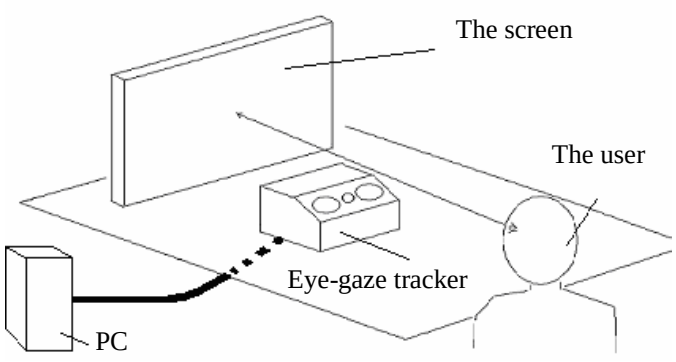


Figure 2.2 Low cost eye gaze tracking system

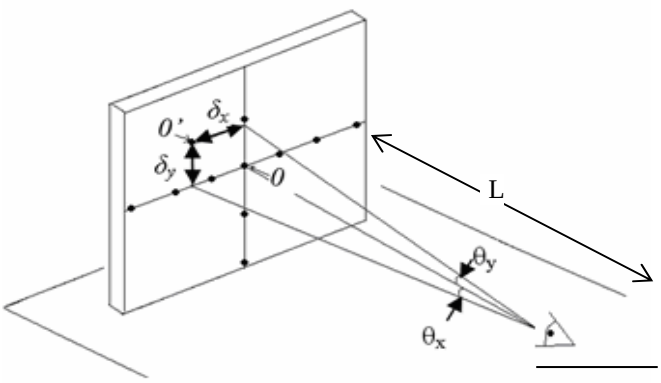


Figure 2.3 Geometric set up for point of regard

Table 2.1 Eye gaze tracking metrics in experiment 1

	G1	G2	G3	G4
ERROR RATE OF GAZE POINTS	12.04%	15.95%	13.06%	12.55%
ERROR RATE OF FIXATION POINTS	7.07%	8.78%	6.24%	7.22%
TIME SPENT IN FIXATION	90.82%	86.33%	92.81%	89.32%
MAX MEAN FIXATION DURATION OF EACH POINT	3.22	3.05	3.38	3.28
AVERAGE MEAN FIXATION DURATION OF EACH POINT	2.63	2.47	2.84	2.78

Table 2.2 Eye gaze tracking metrics in experiment 2

	G1	G2	G3	G4
ERROR RATE OF GAZE POINTS	18.74%	19.53%	21.11%	16.88%
ERROR RATE OF FIXATION POINTS	13.53%	13.11%	10.54%	9.03%
TIME SPENT IN FIXATION	84.74%	86.34%	86.93%	90.51%
MAX MEAN FIXATION DURATION OF EACH POINT	3.21	3.24	3.01	3.50
AVERAGE MEAN FIXATION DURATION OF EACH POINT	2.46	2.63	2.61	2.78

Zhor Ramdane et al, the fundamental thought process of the researchers through their examination was the improvement of a PC framework for the assistance of eye obsession and visual checking during picture investigation. An infrared gadget was utilized for the discovery of vertical and flat eye developments [30]. The primary focal point of the paper is on the continuing it by aligning that can be adequately be used in order to address the non-straight works in the gadget for the eyes of every client independently. In 2008, an execution has been cultivated by the creators by inferring a polynomial model known as versatile adjustment calculation. The proposed methodology is satisfying for the examination of acknowledgment procedures and vision based ramifications as the calculation is fast in nature and furthermore a few tests were proposed to mean this. The alignment characterized in this paper is utilized to beat the bending issue in the recorded information. Here, the strategies for extemporizing are partitioned further for example deliberate mistake remedy and nonsystematic blunder redress. In the main, the fundamental capacity of estimation framework is the reason for twisting which can be distinguished great. Though, on account of nonsystematic mistake amendment, there is no definite data content on the wellspring of mutilation. Without the thought of the reasons for the disfigurements, the amendments are made. The creators utilized an IR light sensor for the improvement of adjustment for the gadget. In this algo, a polynomial transformation of higher request is utilized which encourages the alignment as indicated by the highlights of the client. There are four polynomial changes, the main request polynomial is utilized for the improvement of direct twisting, for example, revolution, interpretation and scaling. The other higher-request polynomial keeps an eye on the improvement in the bigger nonlinear contortions. The utilization of third and fourth-request polynomials demonstrated similar yields on the tried subjects for example 27 of 34 subjects. While, fifth-request polynomial assumed the job for the remainder of the 7. Accordingly this technique can is anything but difficult to be work under sans head movement circumstance and the strategy speaks to extraordinary goals of under 2◦ regardless of whether the beginning mistakes gets past 6◦. The strategy ended up being exact and vigorous in nature [31].

Table 2.3 RMS error statistic calculated by using polynomials of orders two, three, four and five for spatial fit of the calibration data

Statistic	Before fitting	After fitting			
		Order 2	Order 3	Order 4	Order 5
Min	15.719	0.724	0.059	0.058	0.002
Max	27.261	1.394	0.492	0.493	0.062
Mean	21.457	1.011	0.196	0.194	0.011
Std	3.935	0.172	0.107	0.107	0.011
95% CI for the mean	20.145 22.769	0.953 1.068	0.160 0.232	0.158 0.230	0.008 0.015

G Du, the creator proposed a technique for eye limitation in the pictures of human face. The strategy depended on lacunarity, a high-request fractal include and furthermore on evenness investigation. From the start a calculation known as valley field calculation was connected to the picture of face and the eye competitors are recognized. Pursued by this, the balance pivot of the human face has been identified with the utilization of guideline segment examination. After this the entire picture is turned around the evenness pivot once the eye pair applicant are shaped by the gathering of eye up-and-comers. At long last, to precisely depict the neighborhood district of eyes, a novel methodology is proposed to assess the lacunarity esteem. The genuine eye pair applicant is controlled by contrasting the two lacunarity estimations of the two eye areas inside each eye pair competitor. The dependability and viability of this strategy has been exhibited by different numerical examinations.

Noopur Desai et al, the authors of this paper attempts to detect eye in the images of human faces. They proposed an approach which they divided into two phases. In the primary stage they managed the location of countenances in the pictures. After the location of countenances in the pictures, they pursued the second stage that incorporates eye discovery in the face they recently recognized. In the method they used the eye detection was implemented by eye map. The method was simple to apply as it did not include any previous knowledge about eye and also there were no complex calculations. Also, this method was easily compatible with hardware. A good data base of different eye types on different faces and in different lightening conditions was required to accomplish the experiment. The only limitation to the experiment was the lightening conditions. To obtain the proper results specific lightening environment had to be set up. Elsewise, the results came out to be quite accurate.

Jin Sun Ju et al, the authors in 2009 proposed a control framework for human applications. The framework was named as intelligent wheelchair. The framework was made to adapt up to the individuals with incapacities. The framework was made to get smoothen with an enormous number of the capacity of the client. This calculation chips away at the premise of two ideas that is state of the mouth and the tendency of the face. In this the yield to the heading of the wheel seat was acquired by the client's face tendency while the state of the mouth decides if to stop or to continue. The framework includes the wheelchair that deals with power, board for information acquisition, ultrasonic sensors, infrared sensors, a PC camera and an arrangement for vision. For watching the motions of the client, the vision arrangement is separated into three stages: (1) discovery, (2) acknowledgment and (3) transformation. In the initial step, the required locale of the face is gotten utilizing adaboost. At that point, the area of the mouth is acquired based anxious data. The highlights that are separated in the initial step are then moved to the subsequent stage for acknowledgment. The acknowledgment is gotten by the k-implies grouping and insights estimations relying on the state of the mouth and the tendency of the essence of the client. The capacity of the converter is to get the outcomes from recognizer and control the conduct of the wheelchair. The outcomes and points of interest offered by the method are very great. They incorporate with an outrageous less development of the client the expectations of the client are appropriately watched. Not just this, it is likewise strong to the unpredictable and jumbled foundation and the enlightenments. The wheelchair framework configuration was for all intents and purposes tried with 34 individuals both outside and inside so as to watch and record it's focal points. On watching the exactness and the speed of the framework were adequate to demonstrate these points of interest and furthermore the framework has a decent exhibition. The strategy turned out to be helpful, benevolent and invaluable to numerous clients with handicaps. The future plan suggests the need to evade deterrents naturally.

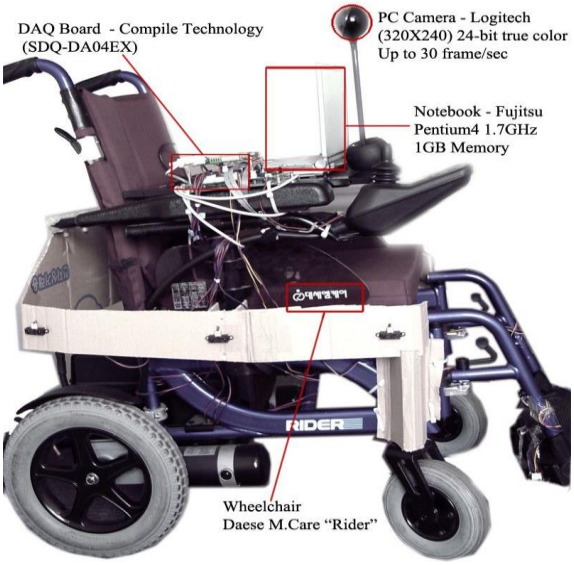


Figure 2.4 Intelligent Wheelchair

Andreas Bulling et al, the authors in 2010 investigated another detecting methodology for action acknowledgment to be eye development examination the chronicle of eye development information was finished utilizing an electrooculography framework [25]. Initially, the calculations for three eye development qualities for example saccades, obsessions and squints were portrayed and assessed from EOG signals. Followed by this, a method was proposed for evaluation of repetitive eye movement patterns. The creators at that point formulated 90 unique highlights based on these qualities and after that utilizing least excess most extreme importance (mRMR) they chose a subset of these attributes. To approve this technique 5 unique exercises that is, duplicating a content, perusing a printed paper, taking manually written notes, viewing a video and perusing the web were thought about by the writers in the workplace condition with the assistance of 8 members. The period with no specific activity was also included. With the help of support vector machine (SVM) classifier and a person-independent training, a 76.1 percent of average precision was obtained, also a recall of 70.5 percent over all classes and participants was obtained. Subsequently, the stir opens up discourse on more extensive materialness of EAR (eye-based action acknowledgment) to the exercises that are troublesome or even incomprehensible, to distinguish utilizing regular detecting modalities. At last, the work shows the guarantee of eye-based action acknowledgment.

Table 2.4 Precision, recall and corresponding number of features selected

	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	MEAN
PRECISION	76.6	88.3	83.0	46.6	59.5	89.2	93.0	72.9	76.1
RECALL	69.4	77.8	72.2	47.9	46.0	86.9	81.9	81.9	70.5
FEATURES	81	46	64	59	50	69	21		50

Kohei Arai et al, the creators in 2011, in their exploration proposed an eye based human PC communication framework utilizing the total determinations of console and mouse [20].The system is performed in a way that can be controlled with human eyes only leading it an advantage to disabled people. In this method gaze estimation process is occurred which utilizes all the pupil information. Unlike eye-mouse, gaze-mouse is not robust with various features such as size, color, and shape of eyes against different users. It is also affected by user's movement, illumination change etc. By using the information about the features, it becomes easy to eliminate the influences. The proposed framework for example eye based HCI framework additionally permits the concurrent utilization of more than three keys, for example, Ctl+Alt+Del for different purposes like left/right click, drag/drop of mouse occasion capacities, starting assignment

supervisor and significantly more. Generally, till then simultaneous function for two keys was provided such as Alt+* whereas this system provided three key input as described above. Such details of mouse occasions and console capacities are given in the proposed HCI system [33]. As results, six different people from different nationalities and so different features were made to participate in the research which showed the effectiveness of using features information which tends to improve the accuracy regarding gaze estimation. The final results showed 96% of total output efficiency with 5% of the improvement using features for gaze estimation.

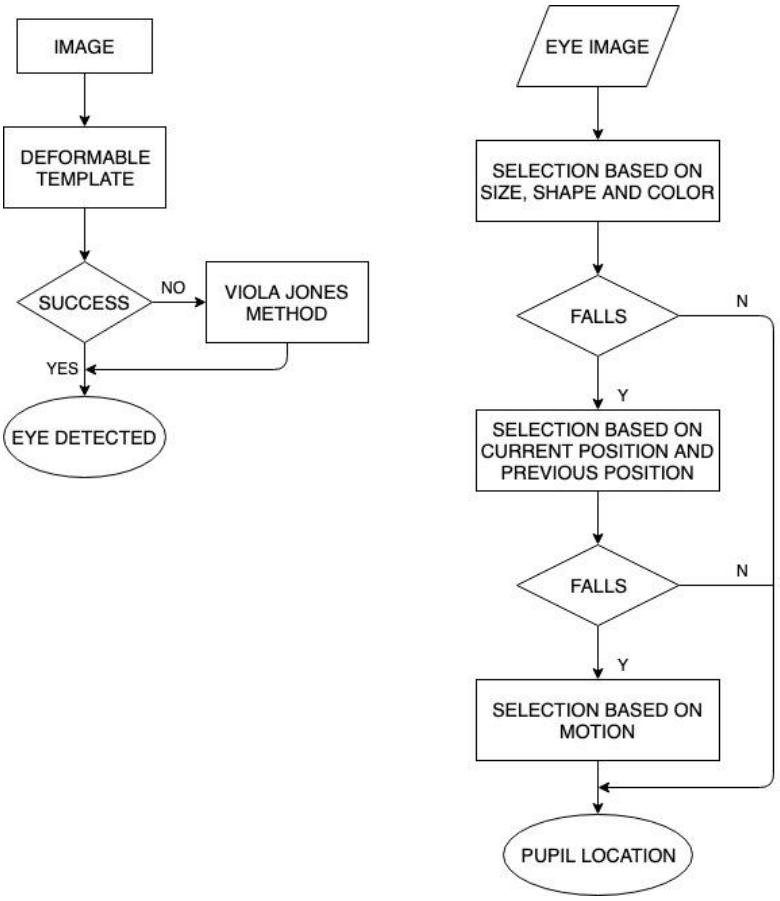


Figure 2.5 Algorithm for eye and pupil detection using viola jones method

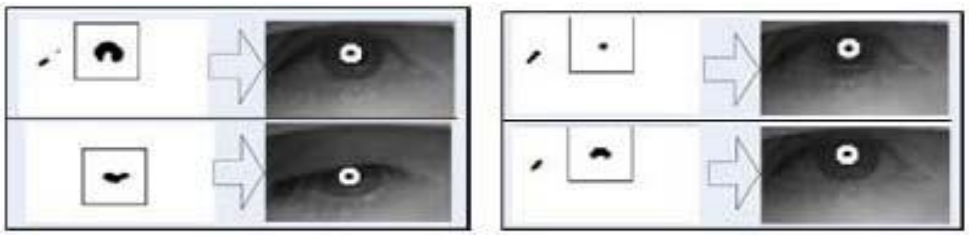


Figure 2.6 Detected eye pupil

Mohammad Ali Azimi Kashani et al, the researchers in 2011 used distinctive features of users eyes to track and detect eye images with cluttered and complex background [14]. They considered the four general advances that partitions the eye following and eye identification into four noteworthy advances. The accompanying advances comprises of (1) recognition of face, (2) identification of the area of eye, (3) discovery of the eye student (4) following of eye. By utilizing the blend of Gaussian they isolated the face area from rest of the picture to discover the situation of the understudy. This helps to make the image background non effective for the further processing. Their major technique was bag of pixels technique, which they used to separate eye and eye brow region from the face region. This will lead to avoid some of the unwanted factors and also decrease the computational complexity. At last, the focuses comprising of most noteworthy force esteems are considered as the up-and-comer's eyes and subsequently the eye locale is appropriately identified among all the power focuses. Another factor is used to remove the irrelevant candidates known as color entropy. The last step performed in the whole process is eye locating and tracking. A number of data sets are taken from various data base, on which, the process is tested and established. The data base or data sets also consisted of various images with complexed or cluttered background. As the results, the experiment shows 94.9% efficiency of the correct detection, which indicates that the method was highly superior and robust.

Table 2.5 Rate of correct and incorrect eye detection

	Two eyes are correctly detected	**one eyes are wrongly detected**	**Two eyes are wrongly detected**
Person 1	92.4%	3.4%	4.2%
Person 2	89.6%	5.4%	5.0%
Person 3	90.8%	3.1%	6.1%
Person 4	94.7%	3.7%	1.6%
Person 5	91.1%	2.3%	6.6%
Person 6	88.6%	4.3%	7.1%
mean	91.2%	3.7%	5.1%

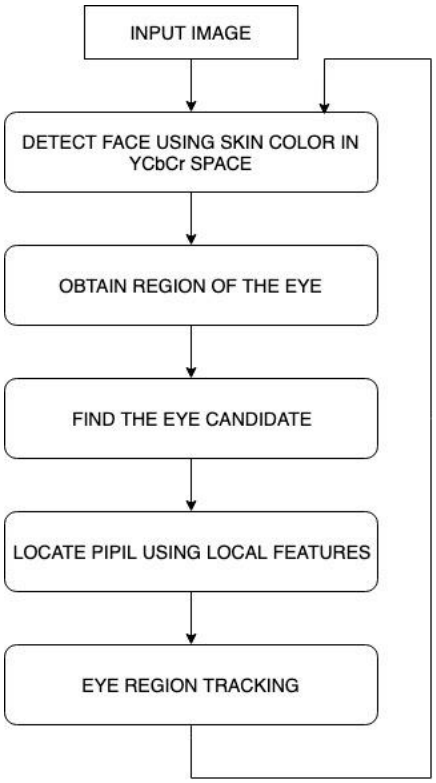


Figure 2.7 Algorithm for eye region detection from cluttered background

Dewi Agushinta R. et al, the researchers in 2011 clarified that the biometric innovation has regularly discovered use in distinguishing and perceiving human segments. The static segments of the human body's exceptional and static body parts, for example, eyes, fingerprints, face, can be related to this innovation. One of the most pervasive employments of biometric innovation is in facial acknowledgment. Recognizable proof and acknowledgment of a human face, requires the preparing and investigation of the face's parts. This strategy involves assurance of the face parts' locale and qualities, which thusly, decide the job of individual segments in facial acknowledgment [15]. In this exploration, a framework that characterizes face segments, by deciding the separation of face segments (for example eyes, nose, mouth) and other facial parts, has been created. The procedure is directed on a frontal single still picture to secure the parts. Separations between segments are controlled by distinguishing base skin shading, editing to ordinary face locale, and extricating eyes, nose and mouth segments. This investigated utilized 150 Indonesian face tests and was fruitful in deciding the face segments. From the test, it tends to be reasoned that the assurance of face segments and their separations can be utilized for ID of a face as a subsystem of a face acknowledgment framework. The trial of uniqueness of 150 examples was finished effectively. Results demonstrate that the eight face segment separations give preferable outcomes over the past one. Just three segments' separation was connected for the past one. The presence of various trademark for each face picture, was shown by the trial of uniqueness with eigenspace.

Smita Tripathi et al, the authors in 2011 showed a technique for extraction of face. The technique was spoken to with the blend of skin shading extractor and format coordinating plan [16]. Initial step was to concentrate faces with the assistance of skin shading extractor. The shading space model utilized for the extraction was YCbCr shading model. The motivation behind utilizing this shading model was that it effectively disconnects both non-skin and skin pixels. On account of skin shading extractor, it can undoubtedly separate among countenances and non-faces. In mix to this format coordinating technique was utilized so as to acquire faces all the more precisely and to evade non faces. By the functional upgrade of the examination it has been demonstrated that the proposed criteria is superior to anything the skin shading extractor. For the execution of the trial Windows XP was utilized as the working framework, a 2.2 GHz processor and the RAM was of 1GB. The execution was finished by MATLAB form R2007b. the dataset worked for the achievement to this plan was RGPV which contained 30 pictures. The structure of the pictures was with the end goal that it was having different various pictures of recognized shapes, sizes, shading, position and articulations. The underlying picture taken for the execution of the strategy was in RGB structure. The RGB picture was changed over into a grayscale adaptation. The grayscale picture was pursued and changed over to a YCbCr picture. At that point, to YCbCr picture, a limit is connected. On applying the edge, the limit picture is changed to the double picture. The qualities in this picture are circulated in two sections for example skin district changes into white shading with worth 1 and the non-skin locale changes into dark shading with worth 0. After this, skin extractor was connected to the picture that disconnected skin pixels and non-skin pixels, not simply this it likewise expels non skin pixels from the picture. Indeed, even after this, a couple non-skin pixels are probably going to be separated to maintain a strategic distance from this mistake sobel channel was taken into the technique for appropriate face extraction. The most precise strategy among the two was layout coordinating plan. Skin shading identifier additionally distinguished a couple non faces alongside countenances. For upgrading and ad libbing the idea of face extraction with this strategy was by diminishing the outcomes for the sort false positive (FP). To improve the idea of skin extractor, it was practiced alongside format coordinating. In future research it was proposed to execute utilizing different shading space and take a gander at their examination.

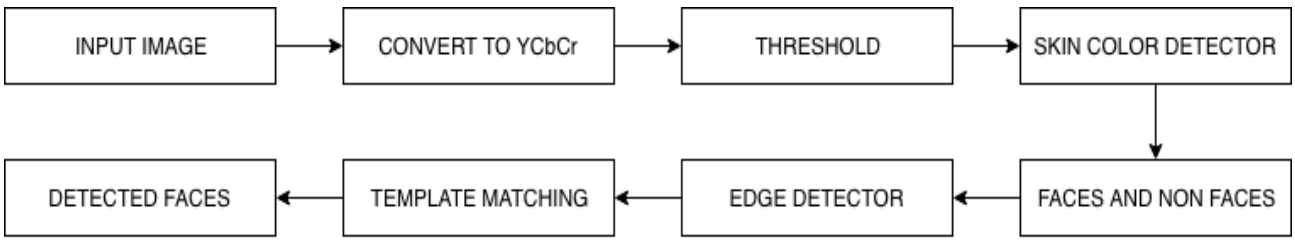


Figure 2.8 Algorithm for face detection

Hussein O. Hamshari et al, the researchers in 2011 did an investigation on Epidemiological examinations that have demonstrated that car drivers from better places need to confront many testing circumstances, for example, arranging, convergences, consolidating and overwhelming. It is our target to follow the face and eyes of the driver while they face distinctive driving situations, so as to further comprehend our hunt design conduct. It is standard, that location and following of articles in visual media, be performed utilizing explicit methods, which very as far as computational expenses and strength. This examination shows an ongoing structure based upon an establishment that is like boosting, which can be stretched out from students to trackers and displays that the possibility of a coordinated system utilizing various trackers, is useful in making an all inclusive durable following procedure. So as to display the intensity of trackers, a certainty parameter is acquainted with lessen mistakes created by off base matches and empower progressively powerful trackers with a more prominent certainty incentive to redress the apparent position of the objective.

Laura Sesma et al, According to different sources, a financially savvy eye identifying is an exceptionally testing subject of research. For the eye recognizing research network and look following frameworks the examination on a camera or a webcam, without including infrared light has been an incredible intention, so as to expand the applications dependent on eye recognition modules. Eye following modules dependent on the idea of PC cameras have numerous obstacles, for example, the view has more extensive field and picture quality isn't that engaging. Likewise, without infrared light the little flashes are not worthwhile for identifying any longer. In 2012, A profound and intensive research has been accomplished for estimating the accuracy of eye student as a decent trademark for look investigating which was a practical eye recognition plot. The plan was very like that of the understudy focus corneal reflection(PC-CR) vector [8]. The information utilized for the estimation was recently mimicked and was a continuous information. The yield of the investigation demonstrates that the places of the edge of the eyes comprises of a slight development if the subject is taking a gander at different spots on the item with a stiffed position of head. This made an abatement in exactness of look discovery by 2-3 degrees under basic environment. [31].

Michal Ciesla et al, the authors in 2012 described and tested three different algorithms for eye pupil location [13]. The database used by them was BioID through which the human face images were obtained. On the bases of this database algorithm efficiency was done. The eye movement based on the computer control supported all the eye localization methods that were implemented in a dedicated application. In this case webcam was used to acquire all the human face images which were processed in real-time. The three algorithms used by the authors were: (1) Cumulative Distribution Function (CDF) Algorithm, (2) Projection Function (PF) Algorithm and (3) Edge Analysis (EA). The first method described was CDF algorithm which is based on the fact that the eye pupil and iris are much dimmer than the cornea of the eye. At first the CDF of eye luminance is taken, which tends to change the intensity of each pixel of the input image.

The best parameter chosen experimentally to provide best possible results is 0.05. Followed by this, minimum filter is applied to compact the white region and remove the singular white points. Finally, the algorithm chooses the darkest white pixel from the original input image termed as PMI (Pixel with Minimum Intensity). Further processing in this algorithm is needed as the probability of the pixel belonging to iris and not to pupil is very significant. Therefore, the average intensity is measured in the original image in 10x10 pixel square around PMI. Further, the region is expanded to 15x15-pixel to which a minimum filter is applied. At last the eye center is obtained by assuming a geometrical center of the points whose intensity is lower than the AI calculated previously. The second algorithm taken under consideration was PF algorithm which is quite similar to that of CDF algorithm except for the case that in this the pixel intensities are projected on horizontal and vertical axes. In the third case that is of EA, for eye location in a human face, the edge pixel information was used. The most popular edge detection technique for digital images that is developed by Canny, was used. Before the application of edge detection technique, Gaussian filter is applied to remove the noise and then the further process is taken under consideration. he results

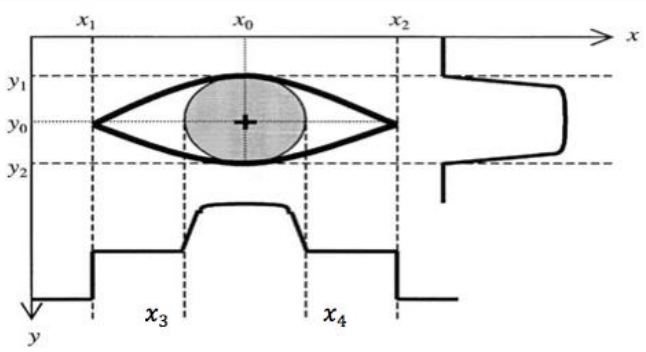


Figure 2.9 Projection function and their relation to pupil position

taken from the research were taken on the basis of both static images and webcam images. The final result obtained were on the basis of comparison amongst the three algorithms showing that the most efficient method especially in the case of real time that is webcam images was CDF algorithm. Also, CDF algorithm is not much dependent on the contrast of the image unlike GPF or EA.

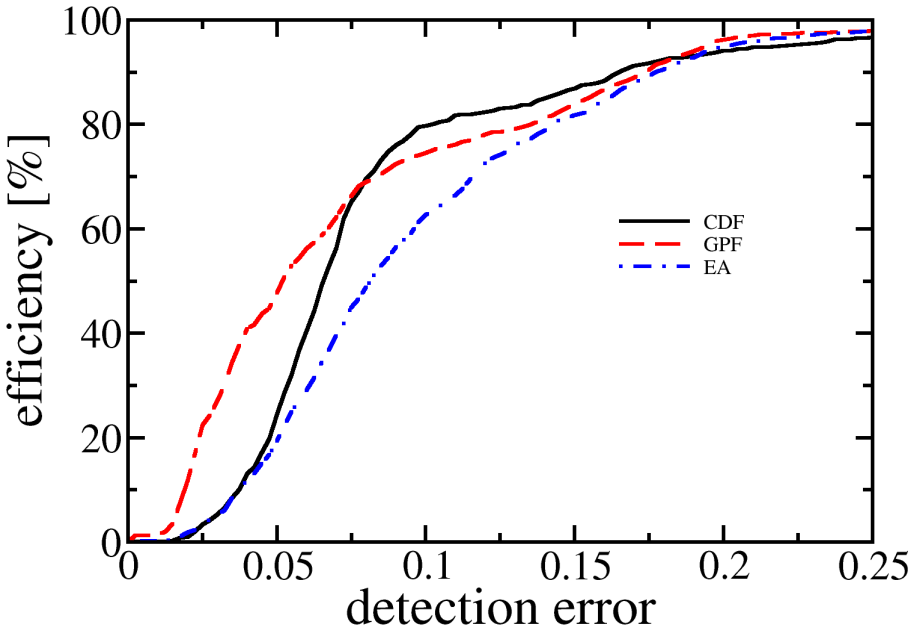


Figure 2.10 The comparison of three algorithms for eye pupil location

Table 2.6 Eye pupil location algorithms efficiency at selected levels of the detection error

dmax	CDF	GPF	EA
0.02	1.0 %	11.7 %	1.8 %
0.05	24.4 %	47.7 %	19.3 %
0.1	79.7 %	74.5 %	62.6 %
0.15	86.8 %	83.8 %	81.7 %
0.2	94.0 %	96.2 %	94.9 %
0.25	96.6 %	97.9 %	97.8 5

Manuel C. Sanchez-Cuevas et al, the authors in 2013 thought about the exhibition among different shading models that incorporates RGB, HSI, CIELab and YCbCr based on shading extraction[7]. The procedure of extraction suggest the transformation of the picture to the required shading space. The way toward detecting encourages the picture to remain in the RGB shading module. The most effortless transformation is the YCbCr as it just establishes a duplication in framework structure. The least difficult path for division of shading is gotten by characterizing an edge for every association with seclude the skin shading. The limit is chosen by examining a few examples of skin, and after that acquiring the histogram of every association of these formats. The extraction is finished by the correlation of every pixel with limit immersion. The depicted correlation was continued in MATLAB to achieve the demonstrated examination. So as to accomplish the correlation yields of the extraction and change under each shading module was taken. 31 pictures were commonly portioned that comprised just one face. At that point, the subsequent format of each picture was cross coordinated with the ground truth. The oversights are recorded in two sections false positive and false negative. A FP is a pixel called attention to as skin yet isn't a skin pixel, though the FN is a pixel brought up as non-skin yet is really a skin pixel. TP is a pixel appeared as skin and it is a pixel of skin, though a TN is a pixel named as non-skin and is a non-skin pixel. The best introduction is appeared by the YCbCr and HSI shading modules. These outcomes are gotten utilizing fixed limit. YCbCr is less tedious which makes the change among RGB and YCbCr less convoluted.

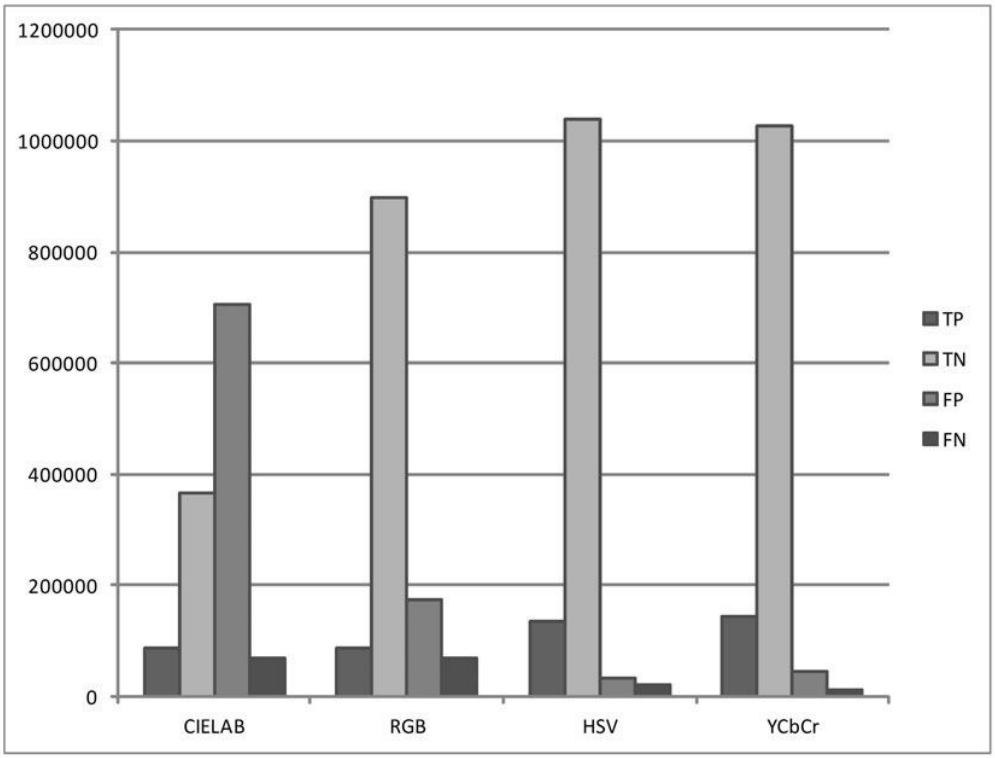


Figure 2.11 Comparison of color models

Yan Ren et al, the creators in 2013 exhibited an adaptable and proficient learning strategy to achieve the undertaking of correctly finding eyes in variation rotational conditions [6]. It was additionally expected to acquire definite eye positions not just in neighborhood eye areas and face pictures yet in addition in unique representations. The proposed calculation chiefly comprises of 3 primary stages. Initially, a Codebook of Invariant Local Features was built up which contains include based basic data of eyes. At that point every one of the examples get recently brought together portrayals dependent on the codebook. An endeavor to safeguard and transplant ideal invariant property of neighborhood highlights into eye restriction method was made. Furthermore, a 2-class Sparse Representation Classifier (SRC) with genuine esteemed yield was built to separate eyes from non-eyes. At that point the great SRC was connected to eye confinement with fine change, which could coordinate the past codebook. The last advance was a Pyramid-like finding strategy. An effective Heat Map of eyes dependent on the yield of SRC and some helpful earlier data, which is touchy of eye positions and invariant of eye turns was made. The examinations demonstrated empowering results on finding eyes in constrained nearby search districts, entire face pictures and unique human pictures. The strategy can be reached out to other limitation errands with the prerequisite of revolution invariance. The codebook of invariant highlights likewise disregarded the scale changes of eye designs which makes it intriguing to ponder the presentation on confining eyes with various scales or with both various scales and revolution edges later on. Other potential augmentations may incorporate improving the finding exactness in increasingly confounded circumstance and achieving a few other item restriction undertakings significantly more absolutely and proficiently. The principle bearing for the future work remains the invariant limitation framework.

Mitra Tajrobehkar et al, the makers in 2014 proposed a general symptomatic procedure subject to a camera-based eye-following framework and a discrete Kalman channel as an iris tracker. In an event driven setting, the iris-following system is used to perceive and pursue the subject's eye-improvement by contrasting it with a ton of requested common and typical movements. The database depends on a couple of examinations coordinated with run of the mill subjects despite available accounts. The approach showed uses feature based strategies for face, for instance, skin concealing while revelation of the eyes used a histogram-based procedure and SVM was used as a two-class classifier to seclude the district into eyes and non-eyes plans. In perspective on these results, the proposed strategy gives a gainful eye-revelation and following system with a precision of 99.1% by and large.

Muhammad Affian Zia et al, the creators in 2014 exhibited an examination in the zone of face and eye identification in pictures utilizing skin shading division and roundabout hough change [4][34]. The initial step is to find the essence of the individual. Face discovery here is finished by division through skin shading utilizing versatile thresholding strategy as this technique adjusts consequently to the skin shade of the client. After face recognition eyes are recognized and followed. The essential houghman circle recognition

calculation is utilized to process the picture and identify the iris. The situation of iris is then contrasted with deference with the aligned focus point with the assistance of a square framework on which a calculation is connected to ascertain the speed and edge of the wheel seat. The picture is obtained utilizing USB camera and the essence of the individual is found in the picture. The got picture is 640x480 pixels RGB picture spared in jpeg design. The technique for skin shading division was utilized for the identification of face in the picture. Choice of shading space being a significant factor for proficient skin division, the picture is changed over from RGB shading space to Lab shading space. In Lab shading space L is the delicacy part and an and b are shading adversary measurements. The daintiness part L of the picture is expelled and an and b are changed over to parallel picture. These paired pictures are then increased component savvy to expel the non-skin districts. The subsequent stage pursued by face recognition is to find the eyes and discover the iris in the face area for which roundabout hough change is utilized. A 3D hough cluster was made in which initial two measurements speaks to the directions of the circle and the third one determines the radii. The qualities in this exhibit expanded each time a circle was drawn. The analyses was performed on appearances with changed skin hues and various foundations with various light powers. The consequence of the calculation demonstrates that the strategy, hough change can appropriately recognize the understudy of an individual. Further examine in this examination should be possible by applying an increasingly strong strategy that is a shut circle versatile technique which can build the proficiency of the calculation.

Table 2.7 Algorithm results on different test subjects

	FACE DETECTED	ONE EYE DETECTION	TWO EYES DETECTION
PERSON 1	Yes	Yes	Yes
PERSON 2	Yes	Yes	Yes
PERSON 3	Yes	Yes	No
PERSON 4	Yes	Yes	Yes
PERSON 5	Yes	No	No
PERSON 6	No	Yes	Yes
PERSON 7	Yes	Yes	Yes
PERSON 8	Yes	Yes	Yes
PERSON 9	Yes	No	No
MEAN	88.9%	77.78%	66.67%

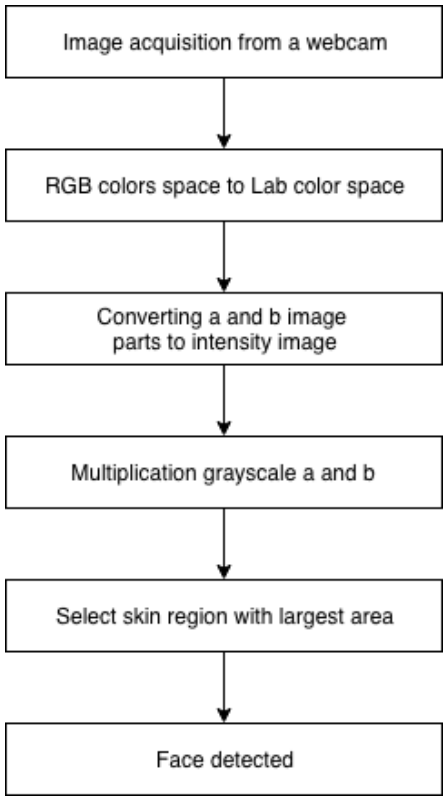


Figure 2.12 Alg orithm for face and eye detection using skin segmentation and circular hough transform

Nikolaos Poulopoulos et al, the authors in 2017 proposed a calculation based on change in the rendition of Radial Symmetry Transform. This will in general improve the exactness and diminish the blunder of the iris identifier [3]. The system comprises the accompanying advances: at first, the face is distinguished and the two eyes that is the Regions Of Interest (ROIs) are chosen. A channel to save the edges is connected to ad lib the round state of the eyes and isolated from the skin. At that point, a changed Radial Symmetry Transform (RST) is utilized to confine the focal point of the eyes. In particular, its greatness segment came about because of the red shading segment of the first picture while its direction segment from an appropriately sifted form of the first one. At that point, the superposition of their standardized partners is utilized for the exact recognizable proof of the eyes. The proposed strategy was tried among the most testing, regarding corruptions, face databases and outflanked in precision the vast majority of the cutting edge strategies. The assessment of the proposed strategy lead to the decision that it establishes a hearty and exceptionally exact restriction technique. the proposed technique manages the most testing conditions including shadows, present varieties, impediments by hair or solid reflections and nearness of glasses. In the further audit, it was discovered that it neglects to precisely find the eye focuses in the situations when the eyes are completely shut or in extraordinary instances of unpredictable enlightenments, shadows and impediments where the eyes can be semi-covered up.

Jigmee Wangchuk Machangpaa et al, the researchers in 2018 planned a less expensive and trustable framework in which the wheelchair developments are taken care of utilizing the head motion. The head developments is estimated utilizing two sensors for example accelerometer and gyrator. The information is worked after utilizing the characterized calculation. The procedure is utilized for the customized limit for head development for quadriplegic patients. While exploring, the wheelchair maintains a strategic distance from snags, utilizing the earth data assembled through the ultrasonic sensor. The joined information (filtered) of accelerometer and whirligig guarantees appropriate wheelchair movement for quadriplegic patients. The custom fitted made limit for comfort of the clients. Also, the minimal effort of the get together pieces of this wheelchair has upgraded its affordability. Expansion of sun powered charged battery, Facility to work on conventional 6-volt soluble battery utilized in EVM's, Intelligent indoor route, Intelligent eye motion control can be coordinated for perusing utilizing Raspberry Pi and different innovations are a couple of further improvements that should be possible to this venture [1][31].

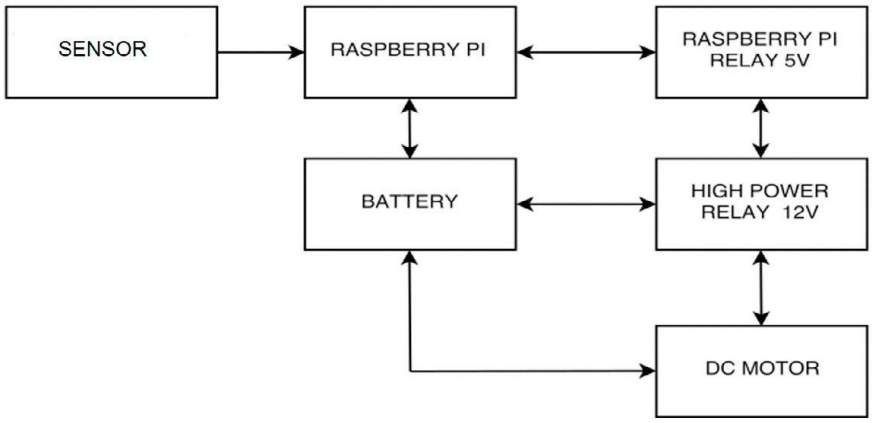


Figure 2.13 Block diagram (IW system)

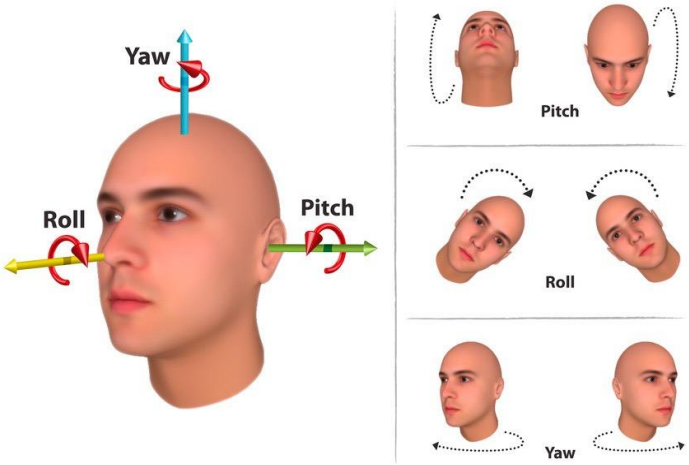


Figure 2.14 Head orientation for system control

2.2 RESEARCH GAPS

An evolution in the area of skin segmentation to eye localization and a vast range of other related processes has been done in the past years. A few of these research can be seen in the previous section that is literature reviews. Each of these research has various characteristics, advantages, disadvantages and most importantly identified gaps and future scopes of their own. One of these research gaps is localization of eye ball for non-frontal faces. Research in the area of localization of eye ball for frontal faces has been done which is used as a normalized application now-a-days that makes a challenge in localization of eye ball for non-frontal faces. With the term non frontal faces it is meant that the view or the image of the faces that are not directly shown from the front. Non frontal faces includes side views or other but front view of the faces. Such that if considering a side view of the face and only one half of the face is under view, only one of the two eyes in the viewable region of the face can be located. Thus, coordinates of features of face changes, also includes eye ball along with the degradation in the terms of accuracy. The main motive of the research thus, comes out to be:

- **Localization of eye ball for non-frontal faces.**
- **Determining the localization of eye ball at different face positions.**
- **Finding the accuracy using proposed algorithm i.e. experimental value.**
- **Comparing with the experimental value with actual value.**
- **Finding the error.**

Applications of localization of eye balls at different face positions:

- **Human computer interface,** this involves further more applications such as human computer interactive games, in which gaming controls can be done by the movement and gestures of eye balls.
- **Wheel chair controller,** a paralyzed person can control the wheel chair by oneself just with the help of eye ball movement.
- **Automated vehicle driving,** in this application automated vehicles can be controlled or dragged with the movement of eye balls.
- **Medical applications,** it involves applications such as detection of diseases, in which just by retina study a few diseases can be determined. Moreover, mental disorder can also be determined just with the help of behavior of eye balls.
- **Human mental behavior,** can also be determined with the behavior or eye balls or eye gaze, which is helpful for security purpose and much more. Mental state of a person can also be determined.

- **Dizziness/drowsiness detection,** it can be helpful in the case of drink and drive cases and many more such application just with the help of eye localization.

2.3 OBJECTIVE OF THESIS

On the basis of study and survey in the previous section, the main objective at first is to promote face extraction through the method of skin segmentation. Also, keeping a track of it with the help of true positive (TP), true negative (TN), false positive (FP) and false negative (FN) pixels. Thus, making the process of face extraction more reliable and simple to extract. Another motive of the thesis is to locate eyes in faces not just in from position but different face position. Finally, at last the motive is to match these experimental values where eye is located to the actual values of the location of the eye and thus finding the errors and its accuracy.

CHAPTER 3

METHODOLOGY

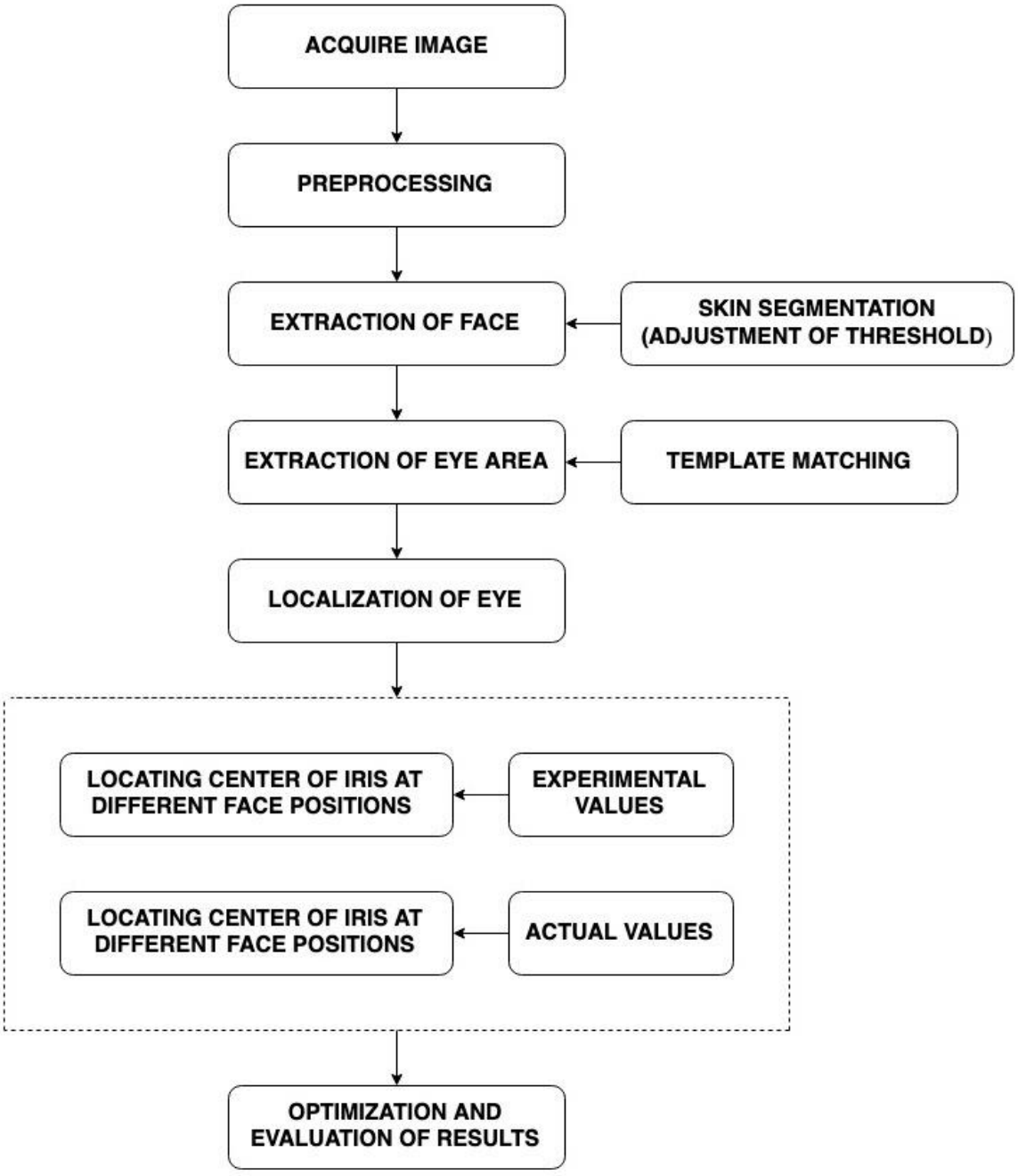


Figure 3.1 Proposed methodology

3.1 INTRODUCTION

In this chapter that is proposed methodology, the compete algorithm or method has been explained that has been accomplished in this thesis. This chapter is mostly dependent on the previous chapter i.e. literature review as many of the gaps are being understood in the area of eye tracking and skin segmentation a few of which are adopted to be fulfilled in this thesis. Not just this, various techniques have also been studied as can be seen in chapter 2 out of which a few are being used in one or the other manner in this thesis work. Starting from the next section, each block or step of the methodology has been briefly described till the last section of this chapter. The method consist of various blocks that are as follows: acquire image, preprocessing, extraction of face, extraction of eye area, localization of eyes, locaing center of iris at different face positions and comparing these experimental values with actual values and optimizing and evaluating results.

3.2 ACQUIRE IMAGE

The first step required to establish a research in this area is to acquire a database of various images of different positions of different faces in different illumination conditions, different positions and of different skin type both in frontal and non-frontal ways. The data base of images that has to be taken under consideration are of various skin types. The data base at first has been trained using various models and libraries. The training of data base has to be accomplished so as to make the project universal for any skin type. Such that any face with any skin type can be determined easily.

Figure 3.2 Acquired image

3.3 PREPROCESSING

After acquiring a database of images and training of various face images comes the preprocessing part of the image which includes scaling, shifting, rotating etc. as per the requirement on that particular image. Preprocessing also includes conversion of images such as from RGB to grayscale.

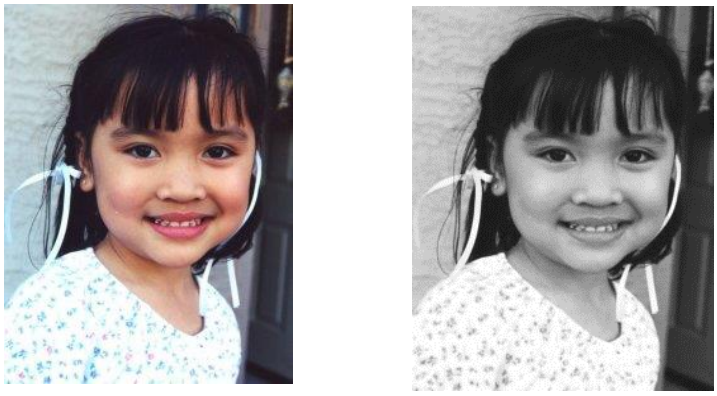


Figure 3.3 RGB to grayscale conversion

Furthermore, at the preprocessing stage itself filtering of noise is also established. as it is known that digital images are mostly and usually prone to noise during their transmission and acquisition. It has been a challenge in the enhancement of images to remove the noise and on the very same verge keep the features of the images in an active manner. The feature that are to be maintained during the processing of noise removal are such that, edges, texture fine details and many more. Majorly, there are two types of noises that come under consideration which have to be removed or at least have to be reduced to keep the quality of the image. The main two types of noises that occur in images are Gaussian noise and impulse noise which are introduced during the transmission and acquisition of image. The main focus always comes on the removal of Gaussian noise. Not only that, noise in the digital images can also occur if the damaged image is scanned. Also sensors in camera can also cause noise in the image due to any kind of malfunctioning in sensors. That’s not it, noise can get to an image even if there is any flaw in data transmission or even if there is any type of electronic interference. There have been a lot of methods introduced for the removal of Gaussian and impulse noise.

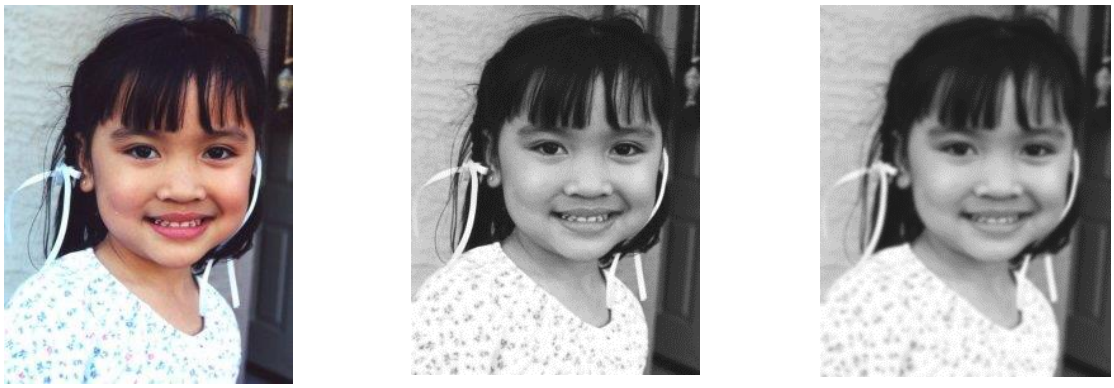


Figure 3.4 Noise removal

A few of these methods can be seen as follows, a noise removal method was introduced by Buyue Zhang known as Adaptive Bilateral Filter (ABF) [29]. The same method was also meant for the sharpness enhancement of the image. The sharpness of the image was managed by the increment in the slope of the edges of the image without the production of undershoot or overshoot by the ABF method. The ABF method provides a robust and more reliable and is efficient to implement. The ABF works very well for both text images and natural images. Another method for noise reduction was also introduced by Samuel Morillas known as FPGP (Fuzzy Peer Group Filter) [27]. It is basically a fuzzy set that takes a peer group as its support set. This method is capable of reducing both impulse and Gaussian noise separately as well as mixed. With an upgradation, another method known as SBF (switching Bilateral Filter) was released by Chih-Hsing Lin [23]. This method was meant to detect noise and act as a universal noise removal this method is very much capable of removing both impulse and additive Gaussian noise. This filter simultaneously removes both the noises that is Gaussian and impulse. Another method using fuzzy logic was introduced in 2012 by JG Camarena [12]. it has been described as afuzzy based adaptive mean filter to remove all the types of noise efficiently. It was further processed and another advanced filter was generated known as EEPGF.

3.4 EXTRACTION OF FACE- USING SKIN SEGMENTATION

After preprocessing, comes the process of extraction of faces from the image and the background [19]. Extraction of faces can be obtained from various means of skin segmentation, using various techniques such as Otsu's method. In this method a mean threshold value is taken from the skin and non-skin pixels. After this, small parts of the image value is compared with the threshold value. If the value comes out to be greater than the threshold value then it is the skin pixel, otherwise, it is the non-skin pixel. More such skin segmentation techniques can be applied for the extraction of face. For the extraction of face through skin segmentation a threshold value is defined depending upon the skin color. Testing on a number of values has been taken under consideration to obtain the actual required value in compatible to skin pixels. This makes the system compatible to all skin types that is all from lower threshold to higher threshold.

Figure 3.5 Extracted face

3.5 EXTRACTION OF EYE AREA- USING TEMPLATE MATCHING

Followed by the extraction of face, we begin with the process of eye area detection. The process of template matching is used for the extraction of eye area [14][16]. In this process, the system is trained by a good number of templates i.e. samples of the image of eye area. The templates are such that, they are a composed of combined data depending upon the complexion, region and other required features. This makes the system easier to locate eyes as it has already been trained with various such images [26]. The templates are not just in the frontal view but also in non-frontal scheme i.e. the templates are of different face position as well. First step that comes under the scheme of template matching is to create a template of the subject that has to recognized. In the case of extraction of eyes from face, templates of eyes are created before as the

data set. In technical terms, these templates are considered as eigenvalues. These eigenvalues or templates are then learned by the model which later on matches with the part to be recognized in the given input image which in this case are the eyes or the eye area. Template matching can be termed as finding the targeted imaging for the determination of the region of the images that are similar to the templates. This is how the eye area is extracted from the face [24].

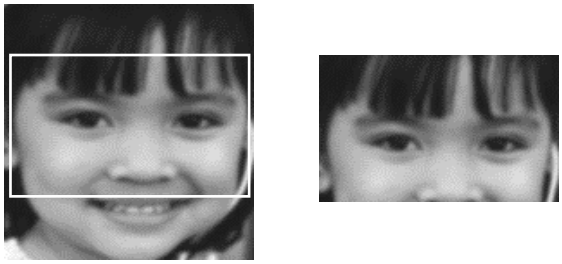


Figure 3.6 Extracted eye area

The database used for the training and testing purpose of template matching is ECU. It consists of 4000 image. The images are further divided into two parts out of which 30% i.e. 1200 images are for testing purpose and 70% i.e. 2800 are for training purpose.

3.6 LOCALIZATION OF EYE

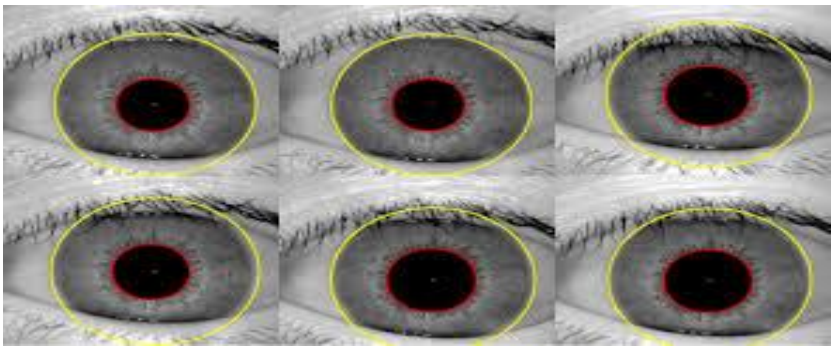


Figure 3.7 Eye localization

Followed by the extraction of eye area, process of localization of eye is to be taken under consideration. The process of localization of eye can be obtained through various techniques such as hough transform [11][18]. For the purpose of finding the iris we have to use circular Hough transform that depends upon the equation of circle. The equation of circle is:

$$\mathbf{r^2 = (x - a)^2 + (y - b)^2} \quad (1)$$

Here a and b are the coordinates for the center and r is the radius of the circle.

The parametric representation of the equation of circle is:

$$\mathbf{x = a + r\cos(t)} \quad (2) \qquad \mathbf{y = b + r\sin(t)} \quad (3)$$

An array of 3D hough is built with the first two dimensions that represents the coordinates of the circle. The third dimension is for the determination of the radius. As the circle is drawn the values of the array increases. As discussed in the previous section iris is not located only on the frontal face images but also in non-frontal images i.e. at different position of face [22][34].

3.7 LOCATING CENTER OF IRIS AT DIFFERENT FACE POSITION

Followed by the localization of eyes, the location of iris at different face positions are determined by the projection method. The output comes out to be in the form of coordinates of the pixel at the center of the iris. The actual coordinate values of the center of the iris by the cursor putting up to that point in MATLAB. Here comes out the experimental coordinates values and the actual coordinate values. Both the experimental and actual values are then compared. The mean square error is obtained between both the actual and experimental values. By further calculation the accuracy has been determined with the help of all the samples. As a result, only a few images are worked upon to determine the mean square error. This basically shows the deflection between the actual location of the center of the iris and the determined location of the center of the iris with the help of the method proposed. The deflection shows the actual error between both the locations. The location in frontal images comes out to be mostly the exact same while in the case of non-frontal images there is quite a deflection in actual and experimental values of the coordinates. The results of the terms deflection, error and accuracy are shown in the next chapter of the thesis.

3.8 OPTIMIZATION AND EVALUATION OF RESULTS

This is the final section of the methodology. In this part basically the optimization and evaluation of result has taken place. The evaluation and optimization of results consists of all the factors that are determined with the help of the complete method. The parameters that comes under this section are error, accuracy etc. after the evaluation and determination the final results in the form of images, graphs and tables are shown in next chapter. With the help of optimization and evaluation of results further conclusion and future scope are also being determined. After the determination, evaluation and optimization it comes out to be that the accuracy of the proposed method has been quite high and good. The accuracy is further evaluated in next chapter.

CHAPTER 4

RESULTS AND OBSERVATIONS

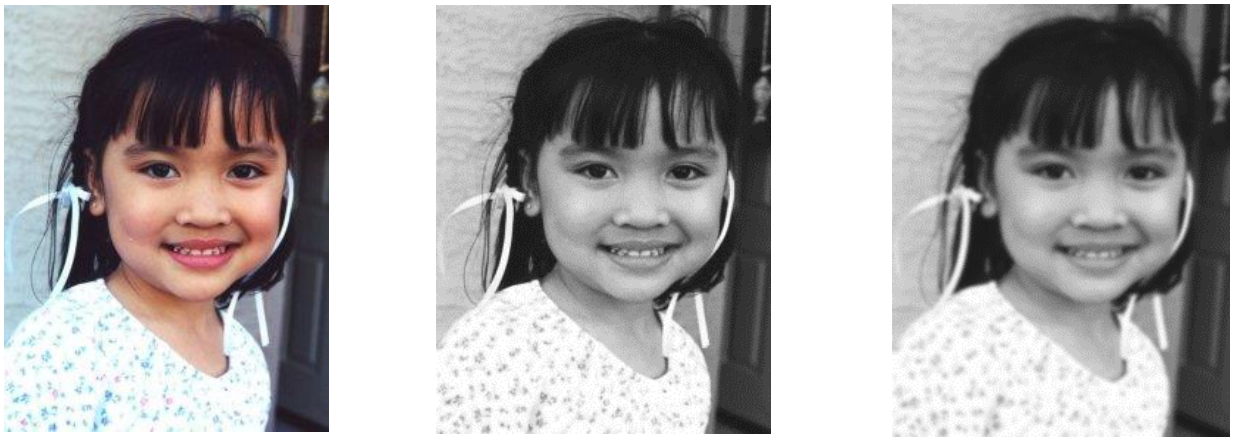


Figure 4.1 (a) original image (b) RGB model (c) Gaussian filteration

As can be seen from figure 4.1, at first the image is acquired which is then preprocessed as converted to gray scale (figure 4.1 b). Followed by this conversion the noise is reduced using Gaussian filter (figure 4.1 c)

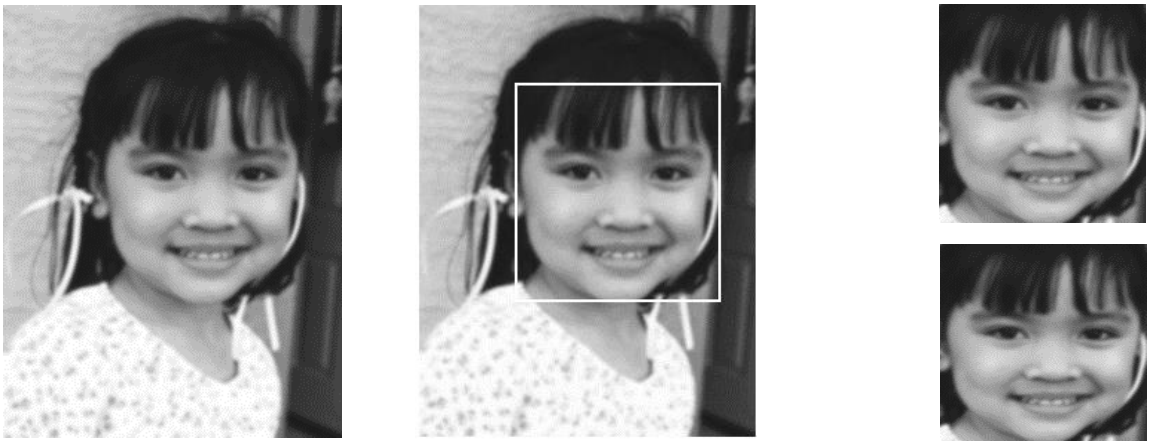


Figure 4.2 Extraction of face

Followed by the step of preprocessing, face has been extracted from the image by the techniques of skin segmentation as shown in figure 4.2.

Figure 4.3 Extraction of eye area

The next step in the methodology comes out to be the extraction of eye area. For the extraction of eye area template matching technique has been used [26]. The results are presented in figure 4.3.

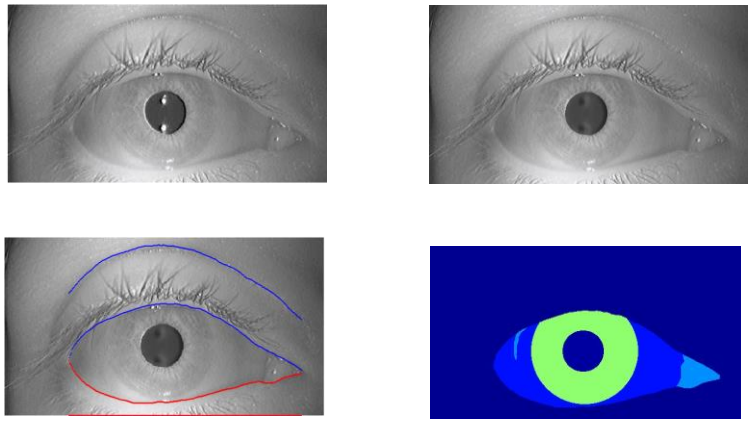


Figure 4.4 Preprocessing of the eye images

Once, the eye area has been extracted, the extracted image is again preprocessed before the application of further methodology as shown in figure 4.4.

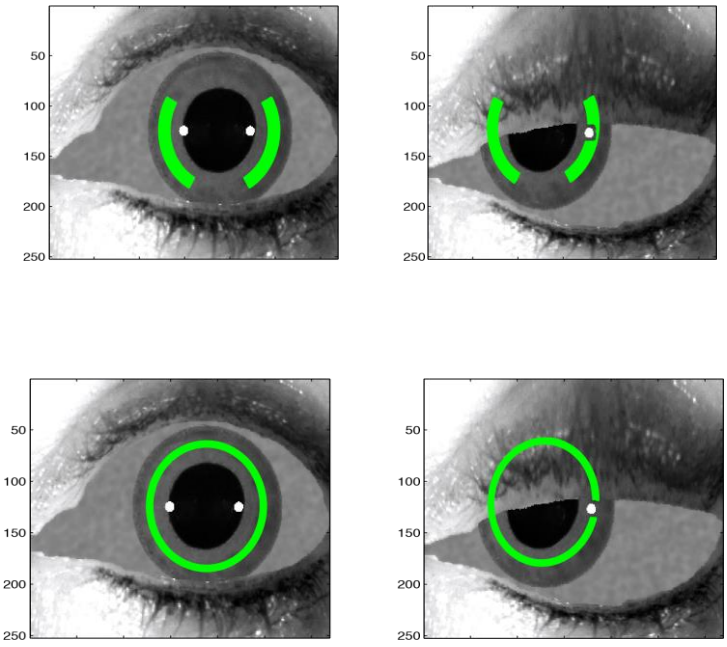
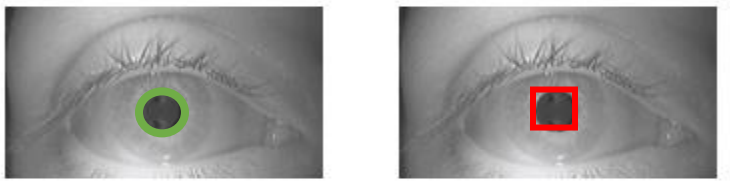


Figure 4.5 Localized eye using template matching

After the extraction of eye area and its processing, localization of eyes are taken care of. It can be seen from the figure 4.5 that the eyeball have been localized successfully with the technique of template matching.



(a) (b)

Figure 4.6 Coordinates of the center of eye (a) actual value (b) experimental value

Coordinates of the center of eye has been determine both actual values and experimental values. Figure 4.6 (a) shows the actual values and (b) shows experimental values.

Table 4.1 Error between the actual value and experimental values of the (x,y) coordinates

Actual value x coordinate	**Experimental value x coordinate**	**Actual value y coordinate**	**Experimental value y coordinate**	**Error E**
36	28	72	63	12.04
42	49	94	94	7
68	72	103	101	4.47
24	28	54	58	5.65
52	53	51	61	10.04
164	162	191	191	2
67	72	108	110	5.38

Table 4.1 shows a few values of coordinates out of all the values for the determination of error. The error is determined by the calculation between actual coordinate values and experimental coordinate values.

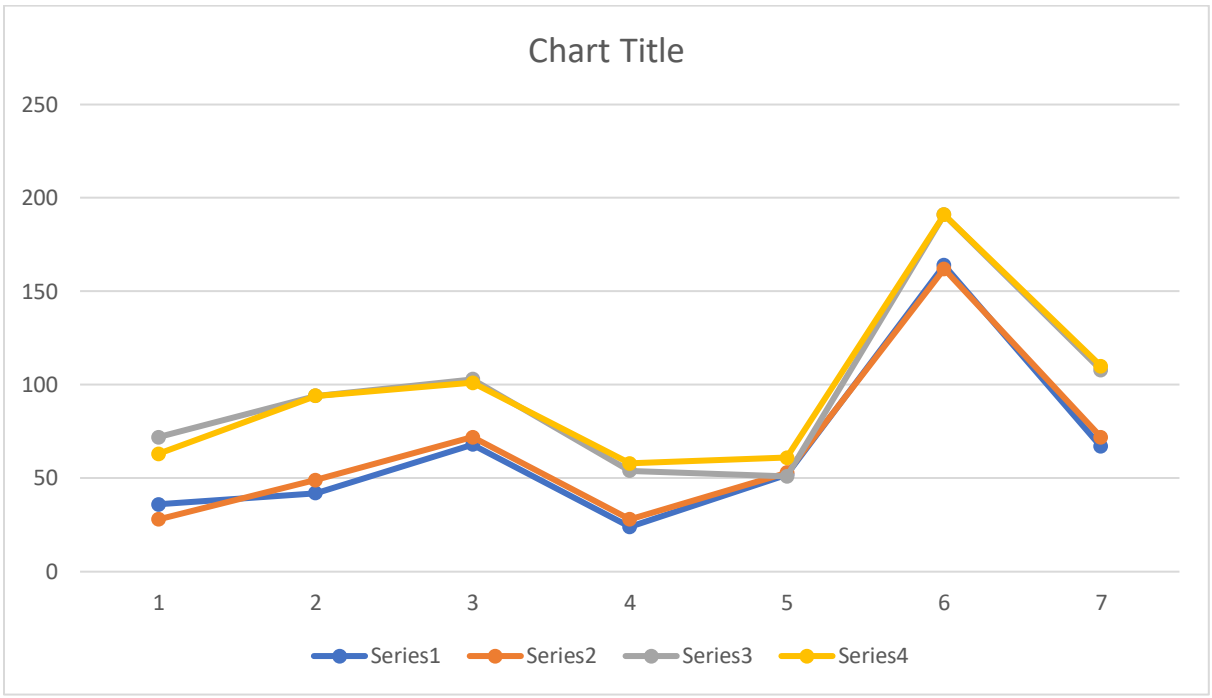


Figure 4.7 Graphical representation of actual and experimental values of (x,y) coordinates

Figure 4.8 Graphical representation of error between actual and experimental values of (x,y) coordinates

Table 4.2 Data set distribution

Dataset	**Classes**	**Input Dimension**	**No. of samples**	
			Training	***Testing***
ECU	14	4000	2800	1200

Table 4.3 TP TN FP FN configuration

	True Positives (TP)	False Positives (FP)
Total no of Data	3840	60
4000	False Negatives (FN)	True Negatives (TN)
	24	76

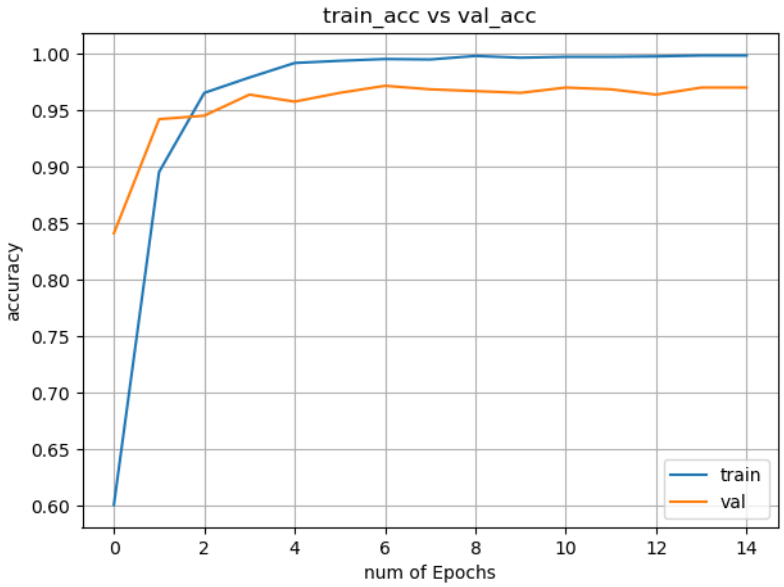


Figure 4.9 Training vs testing accuracy

After the completion of methodology, the accuracy has been determined as shown in the graph of figure 4.9.

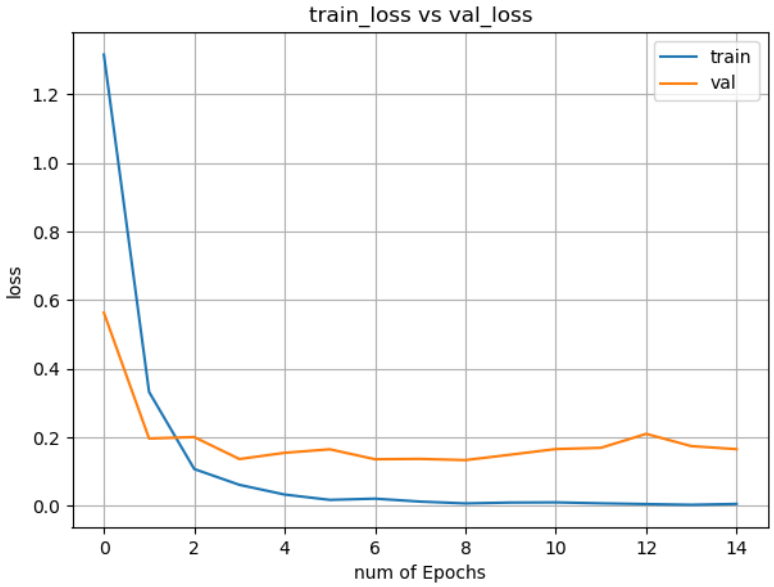


Figure 4.10 Training vs testing losses

Further, the error of the complete method is also obtained and represented in the graph such as in figure 4.10.

Table 4.4 Determined accuracy at each level of class

NUMBER OF EPOCHS	ACCURACY OF TESTED DATA
0	0
2	0.95
4	0.96
6	0.97
8	0.965
10	0.97
12	0.965
14	0.97

Total average accuracy comes out to be 0.9642.

Percentage of accuracy= 96.42%

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

A review of research papers has been done, as can be seen in chapter 2. Various research or studies have various characteristics, advantages, disadvantages and most importantly future scope. By looking at the review it can be concluded that in the area of eye detection in image processing, the eye ball detection can now be carried out not just in frontal faces but also in non-frontal images i.e. at different position of faces. A simple projection factor was applied for the localization of eyes at different face position i.e. the coordinate system scheme. On finding the error accuracy between the experimental and actual values it comes out to be quite relevant. Furthermore, it was also concluded that in the case of face extraction with the technique of skin segmentation, the process became easy due to skin segmentation which tend to extract any skin type due to the arrangement of threshold values. Also, in the case of extraction of eye area, template matching played a very good role. Due to the training of system with various templates it became easy to detect eyes in any case.

5.2 FUTURE SCOPE

As in the case of future research, localization of eye ball in the case of occlusions can be taken under consideration which is a whole new level of a research follow up. In the case of non-frontal faces or location of eyes at different face positions, accuracy can be improved and made more precise specially in the case of shaking and movements. Also, a lot of application devices and machines can be made as discussed above, such as by determining the position of eye ball concentration or attention detector can be installed or it can play an important role in automated driving vehicles leading it to an accomplished level thus, making it advantageous for many applications.

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