

# Smart Mirror Using Eye Gaze Tracking

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**Abstract** – The smart mirror is a signature detail of futuristic news and advertisements. While you're brushing your teeth or admiring your beautiful visage in the morning, the smart mirror serves you up your notifications and the latest news. It displays news on each corner of the screen so that one can have the latest news which is drawn from application program interface (API). The aim of the proposed paper is to determine the news that the user has most interest at. This is done using the eye gaze tracking technique. Eye gaze tracking is a powerful tool that can be used to measure the user's attention and spontaneous responses to the content of the smart mirror. The news on which the user's gaze lies most is assumed to be the news that he/she has most interest at [1]. This is carried out by capturing user's gaze using a webcam. The gaze is determined by extracting low level features related to the pupil of the eyes from images taken from the webcam. The horizontal and vertical movement of the pupil is calculated to identify the news feed that the user is looking at. Eventually, the news on which the user spends most of the time is enlarged to read it further. Thus the proposed work constitutes a less complex method for gaze tracking using a webcam.

**Key Words:** Smart mirror, Application Programming Interface, Pupil detection, Eye gaze tracking

## 1. INTRODUCTION

The history of eye-tracking goes back to the 19th century when scientists tried to study the reading process by direct observation [2], [3]. Eyes are the most important features of the human face. So effective usage of eye movements as a communication technique in user-to-computer interfaces can find place in various application areas. Eye tracking and the information provided by the eye features have the potential to become an interesting way of communicating with a computer in a human-computer interaction (HCI) system. Along with the development of eye-tracking equipment, experimental studies in psychology and engineering have taken advantage of this new form of implicit human feedback opting for the day that every screen will have an affordable embedded eye-tracker. Some approaches to exploit this implicit feedback can be found in [2]. Eye tracking equipment's are usually costly. The proposed system uses a simple webcam rather than special eye tracking equipments. The images are taken frame by frame from a live video using webcam in order to track the position of pupil. This has less complexity when compared to the expensive commercially available eye trackers. A real-time user adaptive framework is introduced which is capable of measuring the interest of the users to images that appear on the screen by tracking their eyes.

The technique of eye gaze tracking has never been before incorporated with smart mirror. In this busy world people find it difficult to spend their time reading newspapers or any magazines. But one needs to be aware of the events happening around the world. Smart mirror provides people the opportunity to explore the events happening around the world just by looking it. The mirror can be used while getting ready. The attractive feature of the mirror is eye gaze tracking. Using eye gaze it determines the news the user has most interest. The user screen is divided into four quadrants each with a news of different category like entertainment, sports, politics etc. Once the gaze is determined the news of interest is selected and it is enlarged to the whole screen.

The rest of the paper is organized as follows. Proposed algorithms are explained in section 2. Experimental results are presented in section 3. Concluding remarks are given in section 4.

## 2. SYSTEM DESIGN

A person's visual interest is determined successfully with the help of eye tracking using a webcam. An XML file haarcascade in OpenCV is used to extract the eye from each frame of a live video. OpenCV already contains many pretrained classifiers for face, eyes, smile etc. Those xml file are present in haarcascade. Object detection using Haar feature –based cascade classifies is an effective object detection method. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is used to detect objects in other images. Position of the iris at each frame is used to determine where that person is looking at. The user screen is divided into four quadrants each providing a news of particular category. Eye tracking is used to find the interest level of a person for images. Successive frames are taken using a webcam and pupil is identified in each one of them.

The entire system can be divided into two modules. One is the eye tracking part and the other is the determination of news of interest. The proposed system is done in Python. The eye is tracked using an xml file haarcascade using OpenCV. An algorithm is written to determine the news the user is looking.

The process of eye tracking is elaborated as follows. The user is asked to stand in front of the webcam. Every incoming frame from the webcam is transformed to the gray scale color space. Eyes are detected using a trained cascade classifier. It is followed by histogram equalization of the image. Histogram equalization is used to enhance contrast. Then the image undergoes a thresholding. From a gray scale

image, thresholding can be used to create binary images. Then by applying binary erosion on this extracted iris region will remove all small black areas other than the iris. This is to done to clearly get the iris region in the eye area. The results after applying these operations on the extracted eye area and detected pupil are shown in Fig. 1.

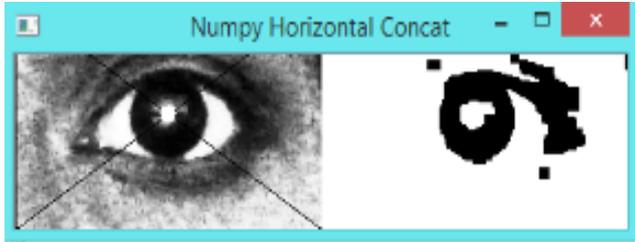


Fig -1: Detected pupil

Let  $cx$  and  $cy$  be the coordinates of the detected pupil. The quadrant on which the eye gaze lies is determined using following algorithm:

**Algorithm 1.** Determination of quadrant where user gaze lies

**Input :** Coordinates of the detected pupil

**Output :** Quadrant where user gaze lies

1. If  $(40 \leq cx \leq 60)$  and  $(25 \leq cy \leq 30)$  then,  
Quadrant = left down
2. Else if  $(20 \leq cx \leq 25)$  and  $(20 \leq cy \leq 25)$  then,  
Quadrant = right up
3. Else if  $(20 \leq cx \leq 30)$  and  $(10 \leq cy \leq 20)$  then,  
Quadrant = left up
4. Else if  $(40 \leq cx \leq 60)$  and  $(10 \leq cy \leq 20)$  then,  
Quadrant = right down

Then for every subsequent frame, the corresponding location of pupil is determined. If the user gaze lies on one particular quadrant for ten consecutive frames, then that particular news is assumed to be the news of interest.

The database for the proposed system consist of tables for news as well as eye. The table related to news contains links to news fetched from API. The table related to eye stores the quadrant on which the user gaze lies. As the gaze of the user lies consecutively for one particular quadrant its value get updated on the table related to eye. Then the news contained on the quadrant gets enlarged to the whole screen.

### 3. EXPERIMENTS AND RESULTS

The news of interest is determined using eye gaze tracking which requires a webcam. So it is necessary that the person is in correct position with respect to the webcam. In order to

detect eyes the webcam should be at top of the screen and it requires adequate lightening conditions as well. The user is instructed to have no head movement, to be close to the camera and to adjust the eye level below the webcam.

Chart 1 shows the mean accuracy of each quadrants. The experiments were done with four users. Each user is asked to gaze at one quadrant at a time. While testing the accuracy of proposed gaze tracker, each user was instructed to follow the instructions mentioned above. Based on the mean accuracy graph shown it is observed that an accuracy of 80 percent was obtained for left up quadrant. This was the quadrant which satisfied majority of the requirements for accurate pupil detection. Left down quadrant was found with least accuracy. This is because detection of eyes was found to be difficult when the person is looking down. Often the eyelids cover the eyes. The other challenge faced was that the accurate detection of quadrant was difficult. This is because the left-right as well as the top down trade-off was found to be too small. Hence, at times even if the user is looking left, it identifies as right. The same is with up, down determination as well. The performance is expected to increase if a high resolution camera is used. If a large screen is used left-right as well as up-down trade-off can be improved.

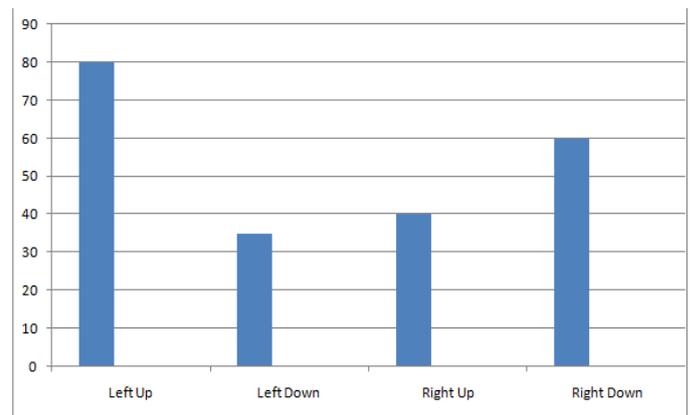


Chart-1: Mean accuracy of the system

### 4. CONCLUSION

The objective of the proposed project was to design and prototype a device that acted as a "Smart Mirror" by displaying the user's image and providing customizable information on the display. A "Smart Mirror" is a gadget that acts as a traditional mirror while also superimposing informational data, which can be customized by the user. Users are able to create a profile and customize the visual interface to display what specific data feeds they want. An XML file harcascade in OpenCV is used to extract the eye from each frame of a live video. Position of the iris at each frame is used to determine where that person is looking at. Once the news which is of prime interest to the user has been found out, the detailed news report is displayed.

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