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Real Time Eye Recognition

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***Abstract*-Tracking and quantifying the eye's state in real-time is crucial in computer vision systems for Human Computer Interaction applications. An eye-gaze-guided computer interface could enable computer use by the disabled peoples. The aim of ongoing research is to develop an application to replace a computer mouse for a people with physical impairment. The application is based on an eye tracking algorithm and assumes that the camera and the head position are fixed. The system after successful development will be able to interact with user at least on the level of simple application.**

***Keywords:* Eye Tracking, eye gaze, computer vision, human computer interface.**

I. INTRODUCTION

As the use of computer is increasing day by day, we cannot consider our life without computer. The internet technology plays a very important role to update our knowledge so it is very crucial part of our career. Unfortunately, the use of computer is limited to only those who can handle the input devices such as keyboard and mouse. Though the technologies are changing very rapidly the human computer interaction methodology does not provide a solution for those peoples who are suffering from the motor disability. So the physically challenged peoples are away from the use of computers. Therefore it is very necessary to take part in the research in the human computer interaction field and found solution how it would become possible to interact the user with computer in another way.

The Eye, very-very important part of our body is god gifted camera can be used for the interaction. Generally people use eye for visual communication and direction to some place here and there. In this paper this theme used to invent the new human computer interaction area and develop a new method for the interaction with the computer. It would not only help the physically disable peoples to interact with computer but also can open the new world for the various other applications.

The research in the field of real time eye recognition mainly focuses on the eye detection techniques and localisation of iris or the pupil to estimate the current state on the basis of which the cursor movement can be controlled on the monitor screen. Furthermore, blink detection is useful to perform the click operation similar to mouse click.

II. LITERATURE SURVEY

The eye tracking models are categorising on the basis of the experimental arrangement of the camera that is being used for video input. Some model based on the fixation of a camera with head wearing devices whereas another method uses the remote camera for the video input [2], [8]. The working principal of the eye tracking system involves various modules viz. Video Input from the camera, Face Detection, Eye Detection, Iris detection or Pupil detection, Gaze Estimation etc.

On the basis of the various kind of models proposed, the eye tracking techniques are categorise as Shape base techniques, Feature based techniques, Appearance based Techniques and hybrid models [6], [10].

A. Shape Based techniques

The shape based approach based on the geometric or photometric properties. These types of models are further classified as fixed shape models and deformable shape models. The parameters used in the geometric model contains rigid and non rigid deformation template. The eye is located in the deformation shape models by templates.

Complex shape-based models contain the complex structure modelling of the eye shape. The deformable model gives more accurate and the model incorporates energy functions for valleys, edges, image peaks, and internal forces. The eye corner locations are used for the initialization of a deformable template. This template can also be used to estimate the eye shape.

B. Feature Based techniques

The Feature based methods used to identify a set of distinctive features around the eyes. The eye localization can be made possible through the reflection from various features such as iris, pupil, limbus, and cornea. The feature based methods that detect the local features viz. line, edges etc. The eye has various features which can be used to evaluate its state. These approaches are very sensitive to the variations of the illumination. The feature based methods are generally gives more robustness during variations in the illumination.

C. Appearance Based Techniques

These techniques are also called as the Holistic methods or Image templates. These methods are useful to detect and track eyes directly on the basis photometric appearance as characterized by the colour distribution or filter responses of the eye. The appearance based approaches are carried out either in the spatial or in a transformed domain.

Appearance based methods can be image template based, where both the spatial and intensity information of each pixel are preserved or holistic in approach, where the intensity distribution is characterized by ignoring the spatial information. Image template-based methods have inherent problems with scale and rotational changes.

D. Hybrid Models

The hybrid models are developed by combining the different models in the single architecture to overcome from the difficulties found in the individual models.

III. PUPIL DETECTION METHODS

A. Gaze extraction using Laplace:

The first step in preparing the Camera frame to perform Laplace integral transform filter to every captured image, The Laplace integral transformation filter is a set of three by three kernels which approximate the LP integral transform operator, where an LP integral transform operator is defined as the sum of the partial second derivatives in horizontal and vertical direction simultaneously.

The LP integral transform operator is presented as an isotropic edge detector for images with low noise. The LP integral transform of an image highlights regions of rapid intensity change. The input for LP integral transformation filter is list of RGB images to be convolved and the output is a list of images that look like a night vision images, the number of output images must equal the number of input images. If the input image name equals the output image name the convolved image will replace the input image [11].

- *Filter sequence -Laplace:*

As it is known the input image is represented as a set of pixels "discrete pixels", to find a convolution kernel that will approximate the second derivatives in the definition of the LP integral transform, using one of these kernels, the LP integral transform can be calculated using standard convolution methods. The LP integral transform filters are high-pass filters that acts as a local edge detector. The kernel is a smallish matrix of numbers that is used in image convolutions. Differently sized kernels which contain the different patterns of numbers give rise to different results under the convolution [11].

- *Filter sequence - convolution:*

This is a mathematical operation that is fundamental to many common image processing operators to produce a array of numbers of the same dimensionality. The convolution is performed by sliding the kernel over the image, generally starting at the top left corner, so as to move the kernel through all the positions where the kernel fits entirely within the boundaries of the image. Each kernel position corresponds to a single output pixel, the value of which is calculated by multiplying together the kernel value and the underlying image pixel value for each of the cells in the kernel, and then adding all these numbers together [11].

- *Filter sequence - Monochromatic conversion:*

This is the process through which the image is modified in which all colours are shades of gray. The reason for differentiating the colours in image is that less information needs to be provided for each pixel. In fact a gray colour is one in which the red, green and blue components all have equal intensity in RGB space, and so it is only necessary to specify a single intensity value for each pixel, as opposed to the three intensities needed to specify each pixel in a full image.

Monochromatic intensity is stored as an 8-bit integer giving possible different shades of gray from black to white. If the levels are evenly spaced then the difference between successive gray levels is significantly better than the gray level resolving power of the human eye [11].

- *Filter sequence - colour conversion:*

The main idea behind colour conversion stage is to invert the colour in an image. Invert simply switches 0 to 255 and 255 to 0 and likewise switches mirror-fashion all values in between. In a simple black and white image, using 0 for black and 255 for white, a near-black pixel value of 5 will be converted to 250, or near white. The result is a photographic negative image.

For RGB colour images or any other image with more than one channel this process is applied to each channel. If a pixel has a high blue value and low red and green values, the blue value will end up low and the red and green values will be high to result in a yellow tone, followed by the edging stage which is the last stage of the phase; it will ensure that the accuracy is the highest we can get; the edging stage will distinguish the rapid variation of colours within the frame depending on the threshold value that is set while performing the canny transmission.

B. Gray Projection

The gray projection algorithm, bases on the principle of statistics which accumulates each pixel by row or column in gray scales [12].

C. Circular Hough Transform (CHT)

The Hough transform can be described as a transformation of a point in the x-y plane to the parameter space. The parameter space is defined according to the shape of the object of interest [12].

In order to simplify the parametric representation of the circle, the radius can be held as a constant or limited to number of known radii. To find the circles in an image using Circular Hough Transform, it is necessary to find all edges in the image.

D. Eye Pupil Location Algorithms

Methods used for location of an eye pupil are as follows:

- *Cumulative Distribution Function (CDF) Algorithm*

This method is based on the observation that an eye iris and pupil is much dimmer than cornea. Its name comes from the Cumulative Distribution Function (CDF) of eye luminance used in the algorithm [2][13].

The further step is the application of the minimum filter to remove singular white points and compact white region. Then the algorithm chooses one white pixel, which is the darkest on the original input image. This pixel is called Pixel with Minimum Intensity (PMI). As the probability that PMI belongs to an eye iris and not to a pupil is significant the further processing is needed.

- *Projection Functions (PF) Algorithm*

The idea of the method is similar to the one used in CDF algorithm, but in this case pixel intensities are projected on vertical and horizontal axes. Those projections divide the whole picture to homogenous subsets.

The effectiveness of this method depends on the specific definition of a projection function. The most popular options are the Integral Projection Function and the Variance Projection Function. However, the best results are obtained using the General Projection Function [12][13].

- *Edges Analysis (EA)*

In the edge analysis method the edge pixel information is used for eye location in a picture of a human face. However before that the Gaussian blur filter is applied to eliminate the undesired noise. This method is based on two threshold values, upper and lower. The upper threshold value defines the minimum gradient needed to classify pixel as an edge component. Such a pixel is also called strong edge pixel [13].

In the edge, there are also pixels of a gradient between the upper and lower threshold values, having at least one strong edge pixel as a neighbour. The lower threshold protects against splitting edges in low contrast regions. The output of the method is a binary picture with edges marked white The next step of the pupil detection process is to find vertical and horizontal lines sharing the next to highest number of points with the edges. The intersection of the lines indicates the pupil centre.

E. Robust pupil detection method

- *Pupil boundary detection algorithm*

The pupil boundary was determined by first identifying all points related to the pupil, i.e. defining a pupil 'blob.' The pupil blob was generated from the 256 grey level images using a threshold operation. Pixels with grey levels below the threshold value were assigned to a black blob and all others were designated as white 'background' pixels, resulting in a binary image.

The image usually contained multiple blobs due to artefacts such as non-uniform lighting conditions or eyelashes and shadows. Each blob was isolated and labelled using 8-neighbour connectivity analysis, which classifies pixels according to their relationship with the 8 surrounding pixels. The blob associated with the pupil was then identified as having the largest area and a small standard deviation of the interior points from the blob's center of mass.

- *Curvature calculation*

To facilitate an accurate ellipse fit to the pupil boundary, it is necessary to separate the visible pupil boundary from edge points lying on eyelids, eyelashes, corneal reflections and shadows. This was accomplished by using a heuristically based curvature algorithm. The curvature of an arc is defined as the rate of change of the angle with respect to the arc length*s*.

This estimate minimized the effect of noisy edge pixels. The difference between the average values of the two adjacent windows was then divided by the window length.

- *Peak transitional point detection*

The curvature function for the non-occluded pupil boundary is a small positive value, which is dependent on the size of the pupil in the image.

A sudden deviation of the curvature from the threshold values indicates an occlusion of the pupil boundary by an eyelid, eyelashes, corneal refection or shadow. The peak transitional point could be used to determine the location of the obstruction. Correct setting of the curvature threshold was crucial for obtaining accurate pupil center estimates. If the curvature threshold is set too high, the peaks associated with pupil occlusion are not detected, and boundary points associated with artefacts are included in the ellipse fit.

If the threshold is set too low, points on the smooth pupil boundary would be eliminated. In both cases, the accuracy of ellipse fitting would be reduced.

A curvature-scanning program has been developed which is calculated all the peak transitional points in the curvature function for a particular pupil blob then defined heuristics to segment the pupil boundary into regions occluded by artefacts, and non-occluded portions that was used in finding the pupil center.

- *Pupil boundary segmentation algorithm*

Various heuristics were developed which could be applied to the curvature function to segment the non-occluded pupil boundary from artefacts. These heuristics were based on observations of the curvature characteristics of pupil boundaries when occluded by eyelids, eyelashes, corneal reflections and shadows:

Eyelids are characterized by isolated breakpoints with positive peaks that exceed a distance threshold from their nearest neighbour breakpoints, both in terms of arc length and Euclidean distance. The positive peaks arise due to the convexity of the pupil and overlying eyelid, and the fact that the curvature function is computed in a clockwise direction.

Eyelashes are characterized by consecutive breakpoints which are closely spaced within a certain threshold in both arc length and Euclidean distance.

Corneal reflections are characterized by negative peaks bracketed by positive peaks on either side due to their concave nature. The distance between the two positive peaks in terms of arc length is much larger than the Euclidean distance between the two breakpoints.

Shadows are characterized by isolated breakpoints with negative peaks that exceed a distance threshold from their nearest neighbour breakpoints, both in terms of arc length and Euclidean distance. The negative peaks arise because of the concavity of the shadow–pupil intersection.

- *Ellipse fit to pupil boundary points*

Fitting a circle to the pupil boundary provides an accurate estimate of the pupil center for horizontal and vertical eye positions when all pupil boundary points are visible. A circle-fit is less accurate, however, when the pupil is partially occluded and in an eccentric position.

These algorithms are simple and accurate when sufficient data points are given, which closely describe the ellipse. Standard linear least squares techniques may fail when the data is sparse or very noisy. To overcome this problem, geometric algorithms have been introduced which minimize the sum of the squares of the geometric distances to the given points. These geometric algorithms are much more computationally expensive compared to the linear least squares algorithms.

F. Method using Morphological Features.

- *Morphological pre-processing*

In this method morphological operators are used as they are able to adapt the processing to the underlying object shape and apply closings for eyelashes impact reduction and openings for white spot and light reflections attenuation.

- *Coarse localization*

Once the images are enhanced, an initial coarse segmentation is performed to isolate the rectangular region of interest containing the pupil. To this end, a threshold was applied and the centroid of the resulting region is considered as a coarse position of the pupil center.

- *Refined localization*

The goal is to classify pixels having in consideration the fact that the pupil is typically much darker than its surroundings. The refined position of the pupil center will correspond to the centroid of the class with the minimum average intensity.

To this end, the Competitive Agglomeration algorithm is retained as a unsupervised clustering technique. This choice is motivated by its good classification accuracy without the need to specify the number of clusters. It combines the advantages of both partitioned and hierarchical classification techniques [14].

IV. APPLICATIONS

There are various fields where eye detection and gaze tracking is applied. Eye detection is most important step for various computer vision applications such as facial expression analysis, facial expression analysis, iris detection, pupil detection etc. The automatic recovery of eye position from image is an important topics for model based coding of videophone sequences and driver fatigue applications.

The applications of eye tracking mainly include two fields which are diagnostic and interactive. The diagnostic applications provide an objective and quantitative method for estimating the viewer's point of regard. The gaze based interactive user interfaces are used for giving a control or track the particular position on the screen. The gaze tracking can also be used for monitoring human attention. So, the tracking system tends to adapt its behaviour according to the gaze input. The eye tracking applications are very useful for the disabled people, where the eye movements are the solution for the interaction with the computer.

The eye tracking may be used for interaction with computer in a same manner to using the mouse so Eye tracking is the alternative for mouse. In automobile Industry Eye tracking can be used for observation and safety of the driver. The eye tracking is very useful in the field of the medical sciences.

V. CONCLUSION

This review paper categorize the various eye models on the basis of the different methods of detecting and tracking the eye images to computational models of eyes for gaze estimation. In this paper various eye tracking techniques are discussed on the basis of shape, appearance, feature etc. The eye tracking systems that would be developed in future should be low cost, easy to use, and more accurate than the previous one.

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