EYE CONTROL INTERFACE (ECI) FOR ACCESSIBILITY

21BAI1365 DEV SHARMA

ABSTRACT :

- In this paper we will be talking about how we can use our eye movement to control the mouse cursor. This project is mainly developed to help physically disabled people. We can accurately detect the movement of eye by detecting the position of iris present in our eyes this can be done by converting the recorded image into edges and counters, here we use regression tree algorithm or Decision trees algorithm. This algorithm is used to give the best possible outcomes of the eye position using the decision tree algorithm so that the eye movement is detected and the mouse moves accordingly. It also enables the user to open and close the applications by blinking of the eye.

INTRODUCTION:

In today's digital age, accessibility to technology is paramount for individuals with disabilities, ensuring their independence and inclusion in various aspects of life. To address this need, the Eye Control Interface (ECI) project was conceived and implemented. The ECI project aims to provide a user-friendly solution for individuals with disabilities, particularly those with mobility impairments, by leveraging eye-tracking technology to facilitate interaction with digital kiosks in public venues.

Traditional input methods such as keyboards, mice, and touchscreens may pose challenges for individuals with disabilities, limiting their ability to access information and services independently. The ECI project seeks to overcome these barriers by harnessing the power of eye movements for cursor control and blinks for clicking, thereby empowering users to navigate digital interfaces with ease.

By utilizing computer vision and deep learning techniques, the ECI project offers a novel approach to accessibility, enabling individuals with disabilities to interact with digital kiosks in a natural and intuitive manner. This innovative solution not only enhances the user experience but also promotes inclusivity and equal access to information and services for all members of society.

Through the implementation of the ECI project, we aim to contribute to the advancement of assistive technology and promote social inclusion by providing individuals with disabilities the tools they need to navigate the digital world independently and with dignity.

LITERATURE REVIEW:

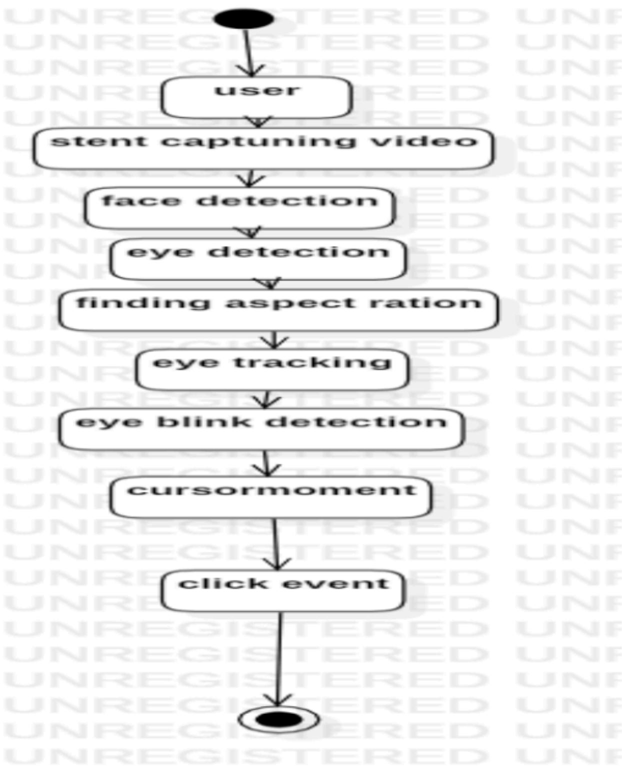
The project developed uses a simple mechanism .besides, the user doesn't need to interact with the system physically. This is a simple solution for physically disabled people using eye tracking. All we need is a computer or laptop with a web cam pre-installed built-in webcam in laptop or pc. Firstly, with the help of web camera, the video is said to be recorded. The recorded video is converted into Frames. From the frames it is further converted into Grayscale for the background elimination .After the elimination of background it takes a proper face image to find counter and Edges in the image. From edges and counters it Identifies Eye and Mouth in the Frame. After identifying we calculate Aspect Ratio of Eye and Mouth. Eye Blink and Head Moment is Detected through Decision Algorithm .Here both the eyes are used for a better or faster processing time. [1]

User can carry out the identical tasks in roughly the same amount of time as they can be carried out with a mouse. After tracking the pupil, the coordinates are saved in variables, and the mouse cursor is moved in accordance with changes in these values and the detection of blinks. At this point, the eye mouse begins functioning properly[2]

The detection of eye is done using haar cascade classifier. Haar-like features are digital image features used in object detection. In the detection phase of the VJ object framework, a window of the target size is moved over the input image, and for each subsection of the image the Haar-like feature is calculated. This difference is then compared to a learned threshold that separates non-objects from objects. Because such a Haar-like feature [9] is only a weak learner or classifier (its detection quality is slightly better than random guessing) a large number of Haar-like features are necessary to describe an object with sufficient accuracy. In the Viola– Jones object detection framework, the Haar-like features are therefore organized in something called a classifier cascade to form a strong learner or classifier [3]

The process flow of the proposed method that consists of three processes: facial-feature detection/tracking, eye model estimation, iris tracking, and gaze estimation using calibration points. The facial-feature detection/tracking process detects facial features that are used in both face/eye model estimation and gaze estimation processes.It allows a classifier trained with sample views of a particular object to be detected in a whole image. An eye image is captured with a zoom-in camera of high resolution. This provides iris images with more number of pixels. [4]

State chart Diagram: State machine diagrams are used to capture the behavior of a software system.This diagram is used to examine the different states of object. A statechart diagram is created for a single class Statechart diagrams are useful to model the reactive systems.[5]



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Eye Features Detection: There are two important eye features necessary to detect the PoG were to identify, Pupil and Eye Corners. These are the techniques which are used for eye extraction. Here in the following equation, x and y are the co-ordinates which is used to calculate the Center of Eye(COE)

Aspect Ratio calculation: The basic formula for calculating the aspect ratio is: Aspect Ratio = (old Width / old Height) . In this project to calculate the aspect ratio we need to check the movement of eye in the previous frames to the current frames: Aspect ratio = (new frame/ old frame) [6]

$$COE_x = \frac{TopRightCorner_x + TopLeftCorner_x}{2}$$

METHODOLOGY :

EYE GAZE DETECTION DIAGRAM

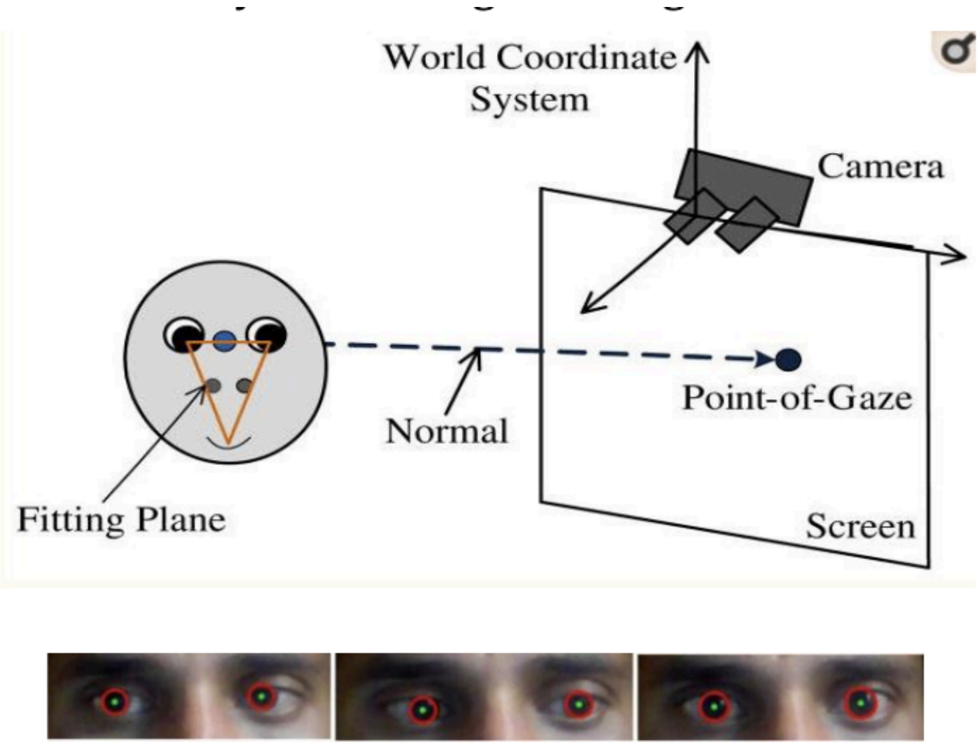
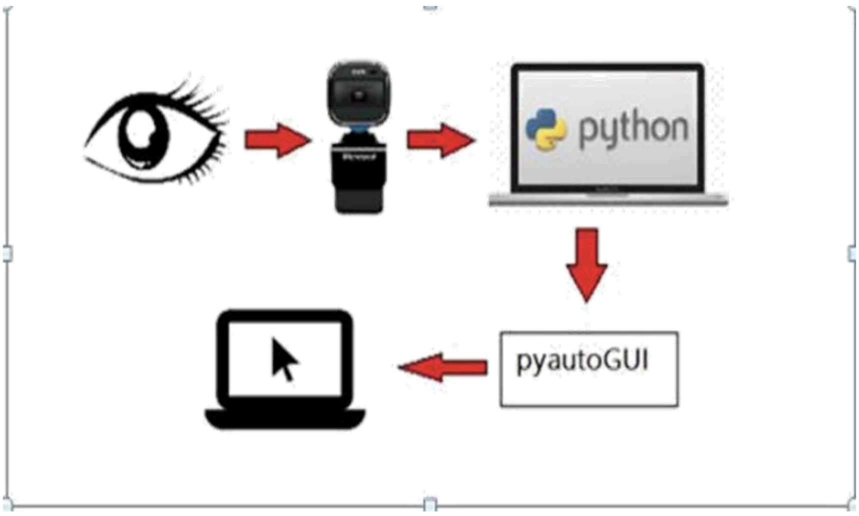
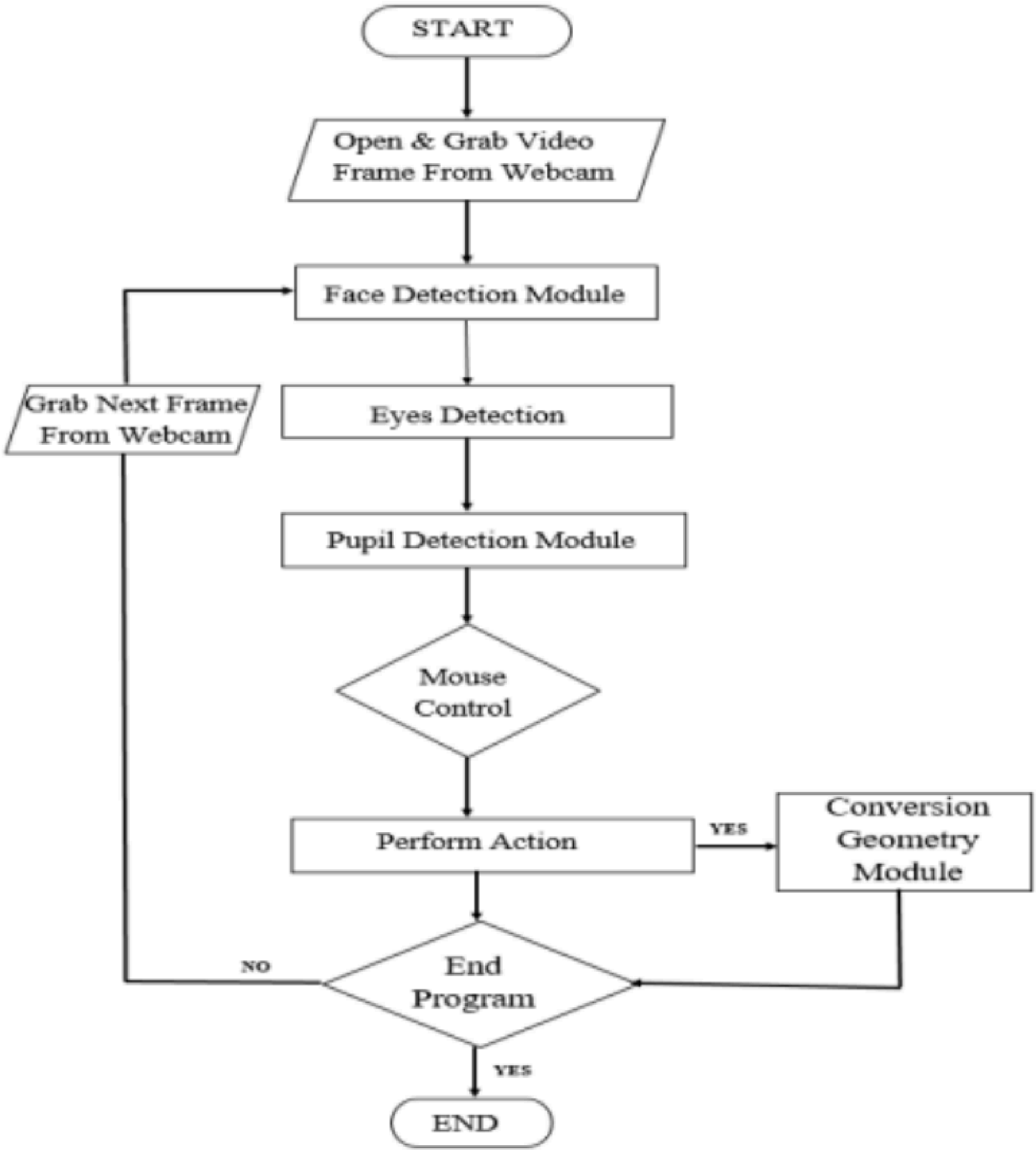


Fig-1 Detection of point of gaze

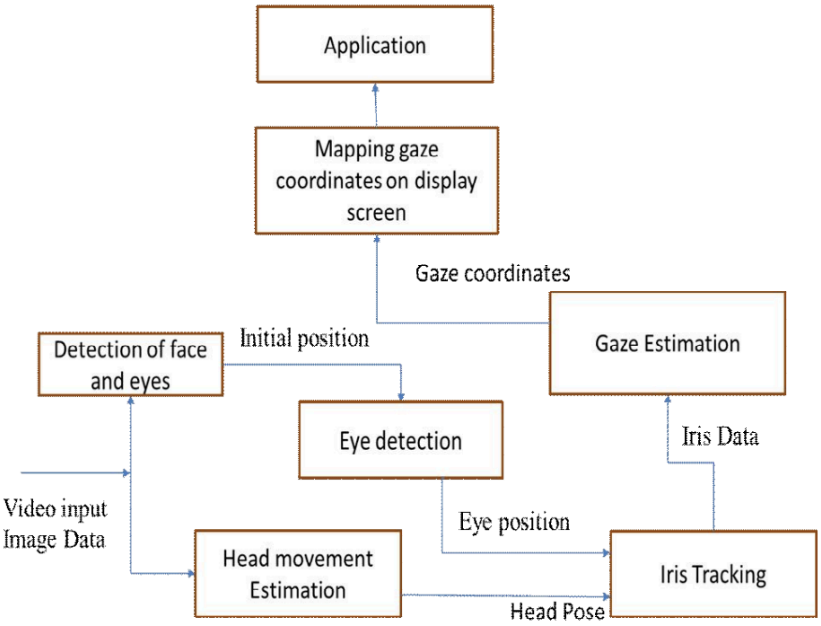
WORKING OF PROJECT DEPICTION



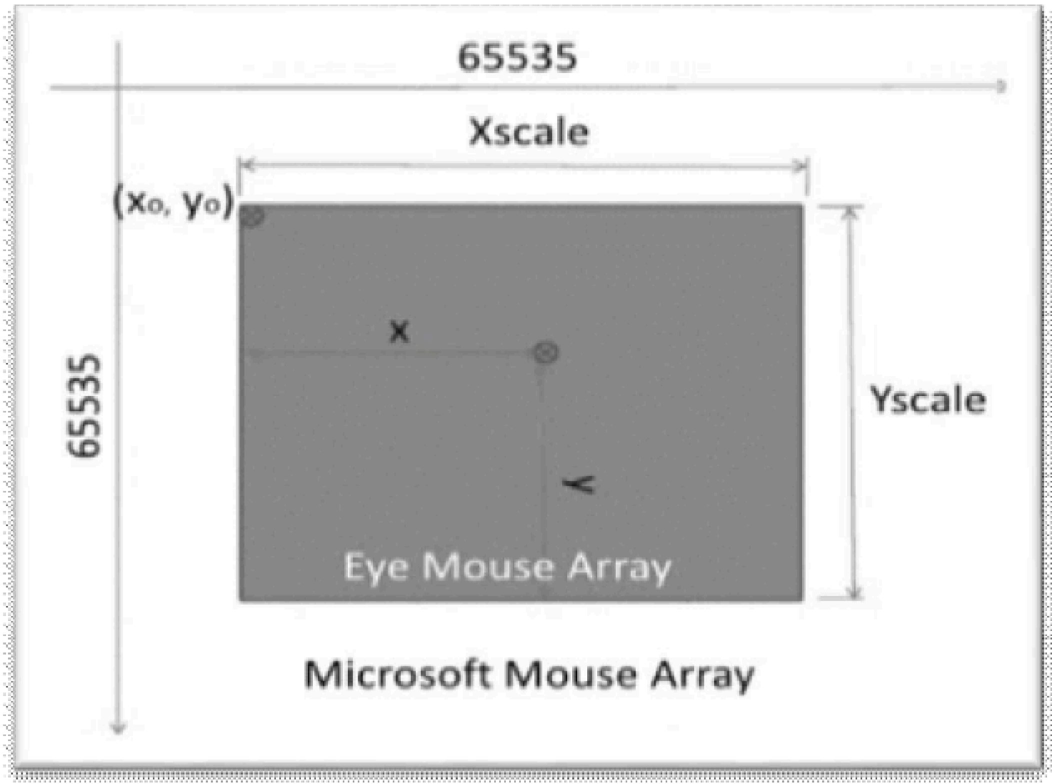
FLOWCHART :


START
Open & Grab Video
Frame From Webcam
Face Detection Module
Grab Next Frame
From Webcam
Eyes Detection
Pupil Detection Module
Mouse
Control
Perform Action
YES
Conversion
Geometry
Module
NO
End
Program
YES
END

SYSTEM ARCHITECTURE :

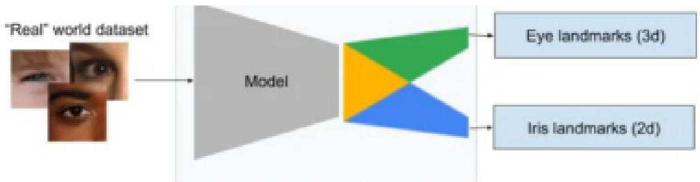


SCREEN MAPPING :

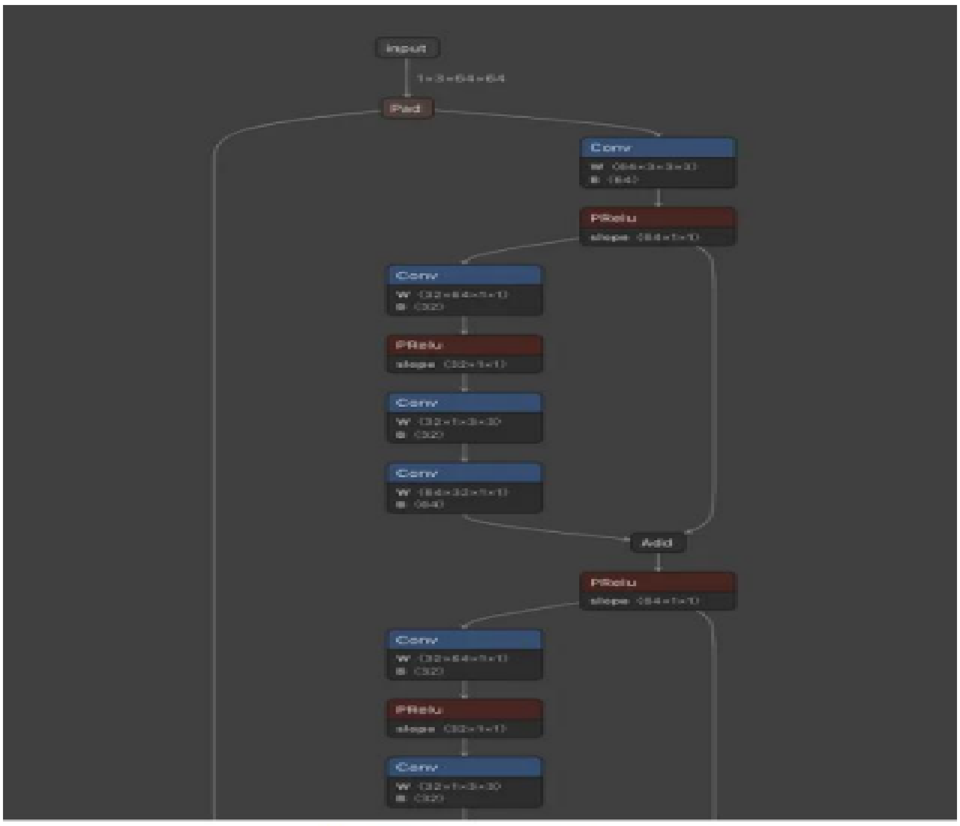


DL MODELS DESCRIPTION AND MATHEMATICAL REPRESENTATION:

Google's MediaPipe framework for iris detection does not rely exclusively on a specific dataset. Instead, MediaPipe utilizes a combination of pre-trained models and algorithms, often fine-tuned or trained on various datasets containing images of human eyes and irises to ensure accurate detection. These datasets may include publicly available datasets like CelebA, LFW, CASIA-IrisV3, or custom datasets collected by researchers or organizations specifically for iris detection tasks



Cropped eye regions form the input to the model, which predicts landmarks via separate components.



Netron visualization of MediaPipe Iris

CASIA Iris V3 :

The CASIA IrisV3 dataset is a comprehensive collection of iris images designed for iris recognition research. Here are the detailed technical specifications of the dataset:

Image Modalities: The dataset includes iris images captured using two distinct imaging modalities: near-infrared (NIR) and visible-light (VIS). This dual-modality approach allows researchers to evaluate the robustness of iris recognition algorithms across different spectral bands.

Image Conditions: The dataset covers a wide range of imaging conditions to simulate real-world scenarios

Image Resolution: The iris images in the dataset are of high resolution, ensuring clarity and detail for accurate analysis. Typically, the images have a resolution of 640x480 pixels or higher, providing ample detail for iris segmentation and feature extraction.

Subject Diversity: The dataset contains iris images from a diverse set of subjects, representing various demographics, ages, and ethnicities. This diversity ensures the generalizability and robustness of iris recognition algorithms across different populations.

Sample Size: The CASIA IrisV3 dataset is substantial, comprising thousands of iris images collected from hundreds of unique subjects. Each subject typically contributes multiple iris image samples, resulting in a large dataset suitable for extensive training, validation, and testing of iris recognition algorithms.

Annotation and Ground Truth: The dataset includes precise annotations and ground truth labels for iris segmentation and feature extraction. These annotations are essential for algorithm development and evaluation, providing accurate reference points for comparison and validation.

Data Format: The iris images in the dataset are typically provided in standard image file formats such as JPEG or PNG. Alongside the image files, the dataset may include accompanying metadata files containing additional information about the images, such as subject ID, image capture parameters, and annotation details.

Overall, the CASIA IrisV3 dataset offers a comprehensive and diverse collection of iris images accompanied by detailed technical specifications, making it a valuable resource for iris recognition research and development.

Subset Characteristics	CASIA-Iris-Interval	CASIA-Iris-Lamp	CASIA-Iris-Twins
Sensor	CASIA close-up iris camera	OKI IRISPASS-h	OKI IRISPASS-h
Environment	Indoor	Indoor with lamp on/off	Outdoor
Session	Two sessions for most iris images	One	One
Attributes of subjects	Most are graduate students of CASIA	Most are graduate students of CASIA	Most are children participating Beijing Twins Festival
No. of subjects	249	411	200
No. of classes	395	819	400
No. of images	2,639	16,212	3,183
Resolution	320*280	640*480	640*480
Features	Cross-session iris images with extremely clear iris texture details	Nonlinear deformation due to variations of visible illumination	The first publicly available iris image dataset of twins
Total	A total of 22,034 iris images from more than 700 subjects and 1500 eyes		

DL MODELS :

The model architecture of MediaPipe Iris is based on MobileNet, which is a combination of Convolution, DepthwiseConvolution, and PRelu. The input image size is 64x64.

DEPTHWISE CONVOLUTION

Depthwise convolution is a key operation in deep learning, particularly in convolutional neural networks (CNNs) for tasks like image recognition. It processes each input channel independently using separate filters, reducing parameters and computational complexity compared to traditional convolution. Depthwise separable convolution combines depthwise convolution with pointwise convolution for even greater efficiency. It's widely used in modern CNN architectures for tasks requiring real-time inference or deployment on resource-constrained devices.

$$\textbf{Convolution Operation} : \mathbf{G} = H * F$$

$$G[i,j] = \sum_{u=-k}^{k} \sum_{u=-k}^{k} H[u,v]F[i-u, j-v]$$

$$\textbf{Correlation Operation} : \mathbf{G} = H \oslash F$$

$$G[i,j] = \sum_{u=-k}^{k} \sum_{u=-k}^{k} H[u,v]F[i+u, j+v]$$

PRelu.

PReLU, or Parametric Rectified Linear Unit, is an activation function commonly used in deep learning models. It extends the traditional ReLU (Rectified Linear Unit) by introducing learnable parameters that allow the activation function to learn the optimal slope for negative inputs during training. This adaptability helps address the "dying ReLU" problem, where neurons may become inactive during training. PReLU has been shown to improve the learning capability of neural networks, especially in scenarios with large-scale datasets and deep architectures.

$$f(y_i) = \begin{cases} y_i, & \text{if } y_i > 0 \\ a_i y_i, & \text{if } y_i \leq 0 \end{cases}$$

EVALUATION METRICS :

As the pupil moves, the mouse pointer will begin to move. Based on the blinking of the eye, the mouse clicks. We test our system by shifting the position of the eyes and introducing fluids to the eyes. We also run short- and long-distance tests on this system. In terms of distance, the results varied.

Distance	Max	Min	Average
10cm	6.458523cm	4.50689cm	1.0965423cm
20cm	6.890525cm	4.90598cm	0.5898252cm
30cm	7.588226cm	5.25595cm	0.4281392cm
40cm	7.895558cm	5.59855cm	0.2272527cm
50cm	8.062259cm	5.95268cm	0.2802207cm

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