Eye Gesture Recognition Using Vague logic

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***Abstract* - Eye gesture recognition, as the name suggests is nothing but recognition of gestures made by eyes. Eye Trackers are common these days, they measure the direction in which our eyes are pointed and predict our gaze points, i.e. the object location in space that we look at. There are many people with forelimb disability in addition to speaking disability but having healthy eyes. So, these people can use their eyes for typing. In this project, a unique eye Tracker is implemented using feature extraction and fuzzy logic which recognizes eye gestures and type a particular character depending on gesture made by the user. In fuzzy logic involves vague values. These vague or intermediate values are used to determine the eye gesture. Here five gestures (straight, up, down, right, left) are considered. As there are five gestures, we display five alphabets (here A, E, I, O, U). Addition to typing, direction sign and audio telling the direction of eye gesture is the output.**

Index Terms— **Eye Tracker, Fuzzy logic, Feature extraction, Histogram, Human computer interaction, Pre-processing, Segmentation,**

I. INTRODUCTION

In the world there are many limb disabled people. There are various natural reasons for limb ability such as ALS (Lou Gehrig's disease), Brain injury, Cerebral palsy, Locked-in Syndrome (brainstem stroke), Multiple Sclerosis, Muscular Dystrophy, SMA (Spinal muscular atrophy, Werdnig-Hoffman syndrome),Spinal cord injury, Stroke. Due to limb disability they cannot do the typing like we do. But if their eyes are healthy, they can utilize eye based typing systems like proposed system. Due to usefulness in various applications, such as Human Behavior Studies ,Human Computer Interaction (HCI), Eye Disease Diagnosis, Virtual Reality, , and so forth , eye gaze tracking has become one of the most interesting and important research topics these days. Early eye tracking devices required of electrodes around the eyes which in physical contact with the user University of Virginia developed Erica System, based on image processing for gaze tracking and thereby used it typing application using eyes. Due to high processing speed and strong practicality, the Erica System was very popular with the people at that time. However, its cost was very high and for interfacing with a computer it required special adapter . Recently, Tobii TX 300 eye movement tracker is developed Zhang et al. which is easy to interference. It is capable of processing gazing data sampled up to 300Hz, this system satisfies some research requirements. But, it is also very costly and affordable only to wealthy users. To make the system affordable and practical novel concept of gaze tracking is proposed here.

This System is designed to recognize five gestures of eye. Here gestures are made by moving pupil in any of the five directions namely up, down, right, left and center (straight).These gestures are captured using webcam. Then preprocessing and feature extraction is done. Particular letter, direction sign and direction audio corresponding to gesture are returned as output.

II. DESIGN AND IMPLEMENTATION

Head-mounted camera captures snapshot of eye gesture made by the user. This gesture is compared for similarity with the pre-stored eye gesture images in the data base. If the gesture matches with any of the database images, depending on the letter, direction sign and audio assigned to each gesture , we get the corresponding letter and audio as the output. Here five letters are the vowels (A, E, I, O, U).Audio and direction sign is meant to tell the direction of the pupil. Fig.1 shows the block diagram of the system. Pre-processing and feature extraction is done for both the database images and captured images. Finally, Fuzzy logic is used for recognizing the eye gesture. In the next section, steps involved for implementation is shown.

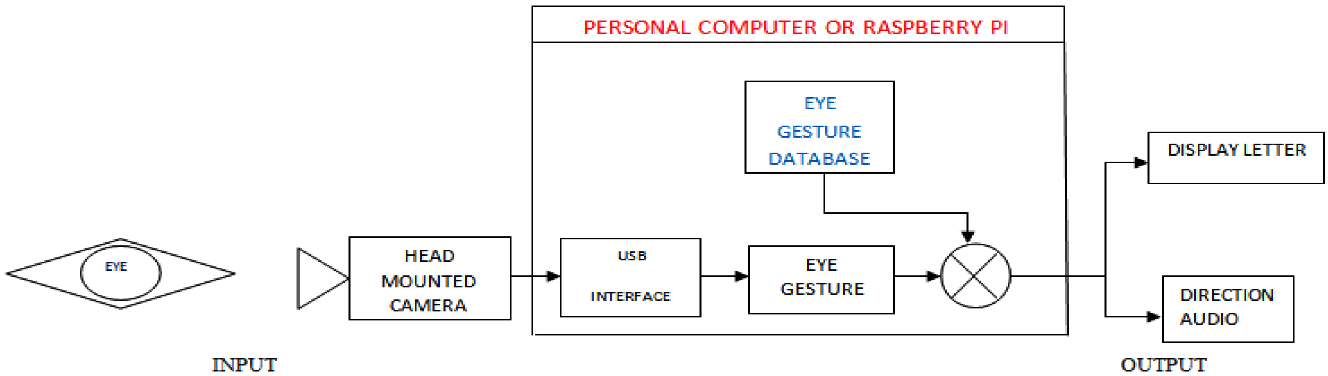

Fig.1. Block diagram of the System

III. IMPLEMENTATION PROCEDURE

Procedure for implementation involves Pre-processing, Segmentation, Feature extraction and feature classification.

Pre-processing

Any image has to be pre-processed to utilize it for application. Image pre-processing is the name for operations on images at the lowest level of abstraction whose aim is an improvement of the image data that suppress undesired distortions or enhances some image features important for further processing. It does not increase image information content. Its methods use the considerable redundancy in images. Neighboring pixels corresponding to one object in real images have the same or similar brightness value and if a distorted pixel can be picked out from the image, it can be restored as an average value of neighboring pixels. Image pre-processing tool in Matlab, realizes many brightness transformations and local pre-processing methods. Here, Pre-processing utilizes the following operators:

- *RGB to gray conversion*

RGB is converted to the grayscale intensity image. Here images are converted from RGB to grayscale by eliminating the hue and saturation information while retaining the luminance.Fig.2 shows Original RGB image is converted to monochrome grayscale

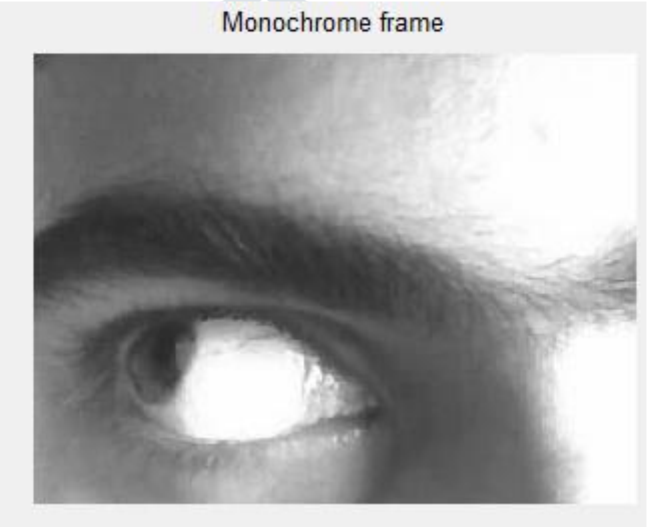

Fig.2 RGB to Gray Conversion

- *Histogram Equalization*

Histogram equalization is a method in image processing , in contrast adjustment is done using the image's histogram. The method is useful in images with backgrounds and foregrounds that are both bright or both dark. Here, Contrast is enhanced by transforming the values in an intensity image, or the values in the color-map of an indexed image, so that the histogram of the output image approximately matches a specified histogram Thus, histogram equalization is done to enhance the contrast, as it will be very useful for further processing. Fig.3 shows the histogram equalization of monochrome image.

Fig.3a Before and after Histogram equalization

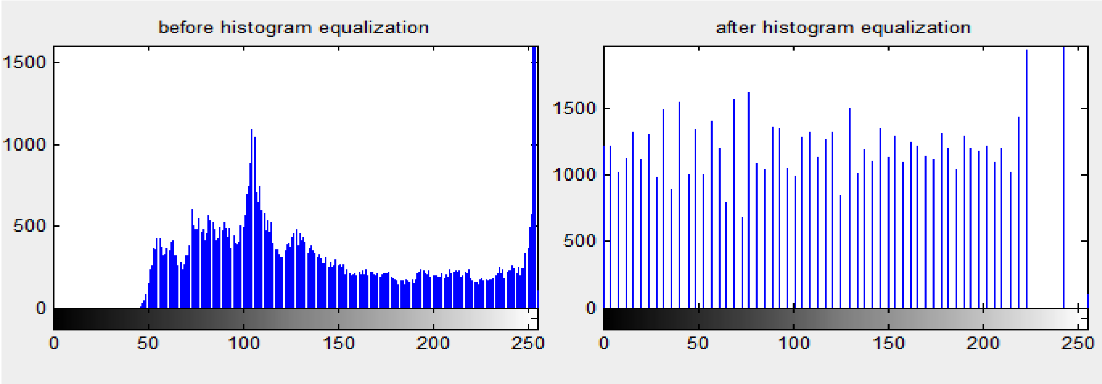

Fig.3b Before and after Histogram equalization

- *Filtering*

Filtering is done in order to remove the noise. Here filter used was predefined filter which was in the form of correlation kernel. unsharp masking filter was applied to the grayscale image previously obtained. The unsharp masking filter has the effect of making, edges and fine detail in the image more crisp.Fig.4 shows the filtered image.

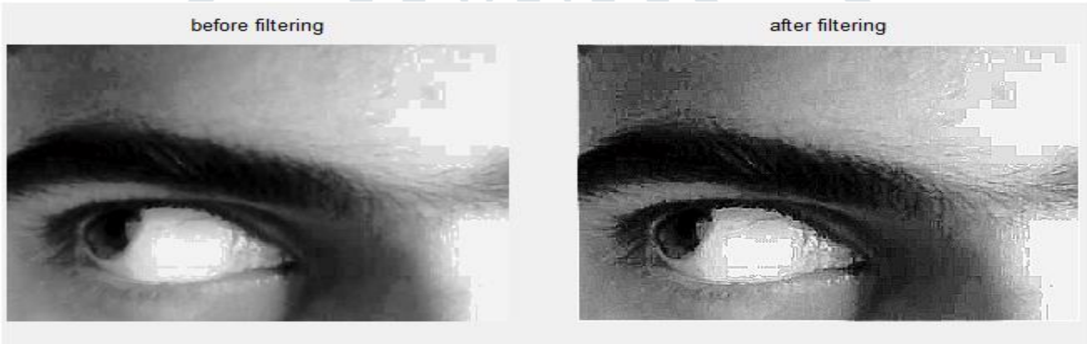

Fig.4 Before and after Filtering

Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. Here, Image segmentation is done by defining the required crux area and thereby eliminating the unwanted area. Here crux area encloses the pupil area. Thus pupil area is separated from the surrounding area. Fig.5 shows the segmented image.

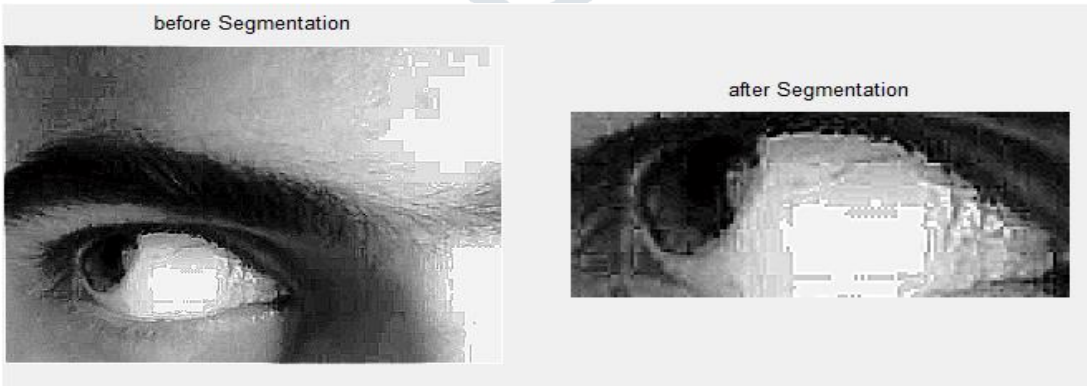

Fig.5. Before and After Segmentation

Feature Extraction

Feature extraction is done to reduce the amount of resources required to describe a large set of data. Feature extraction is a general term for methods of constructing combinations of the variables to get around these problems while still describing the data with sufficient accuracy. The best results are achieved when an expert constructs a set of application-dependent features Nevertheless, if no such expert knowledge is available, general dimensionality reduction techniques may help.

In this system image is divided into 9 regions. Basis for division is block method (3*3).To divide the image, rows and columns are specified for each region. Post region division, mean is calculated for all the nine regions. Mean value is stored in as spreadsheetfile. Fig.6 shows the extracted features of nine regions

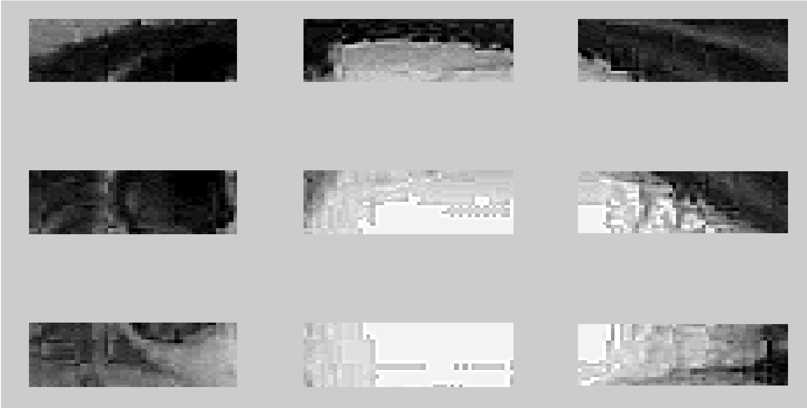

Fig.6. segmented image divided into nine regions

Feature Extraction using Fuzzy Logic

Theory

Fuzzy logic is a form of many-valued logic that deals with approximate, rather than fixed and exact reasoning. Compared to traditional binary logic (where variables may take on true or false values), fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false [1]. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions The term "fuzzy logic" was introduced with the 1965 proposal of fuzzy set theory by Lotfi A. Zadeh. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence. Fuzzy logic had, however, been studied since the 1920s, as infinite-valued logic—notably by Łukasiewicz and Tarski.

Feature Extraction

Mean values of the nine regions containing features of eyes, which are saved in the spread-sheet are read . Fig.7 shows the fuzzy logic table with mean values. Note that all the database images and the captured image contain these nine regions .These values are taken and assigned for different eye gestures. Fuzzy logic is used to define the range in which different eye gestures are located. Depending on the range, letter is assigned to each of the gestures. Here the gesture made by us is recognized based mean values in the table. Thus, depending on the mean value range, we get the output.

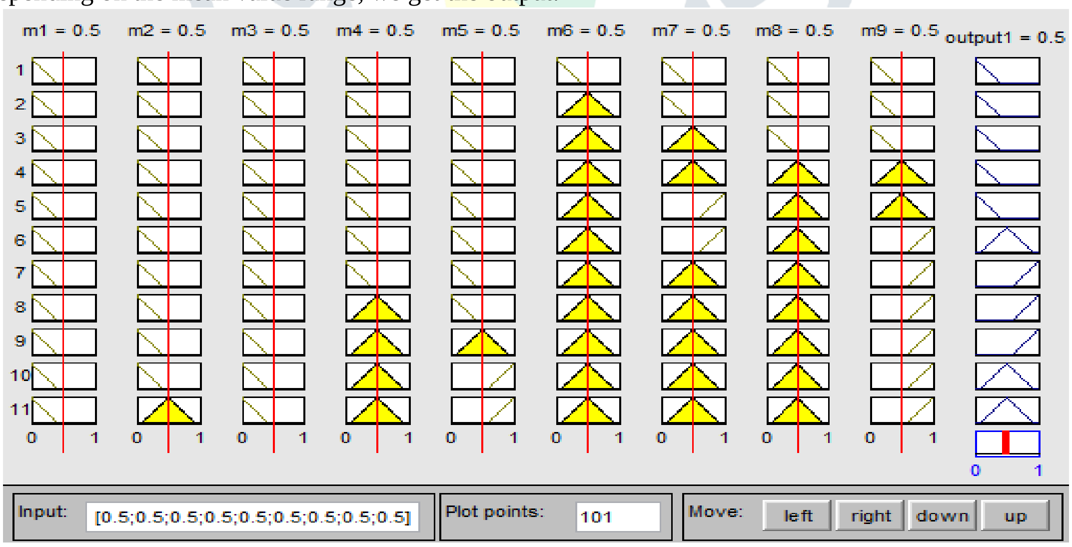

Fig.7 Fuzzy logic Rule editor

IV.RESULTS

Direction of the eye is shown as output. Also, letter is displayed with audio telling the direction of the image. We can see the result in Fig.8.

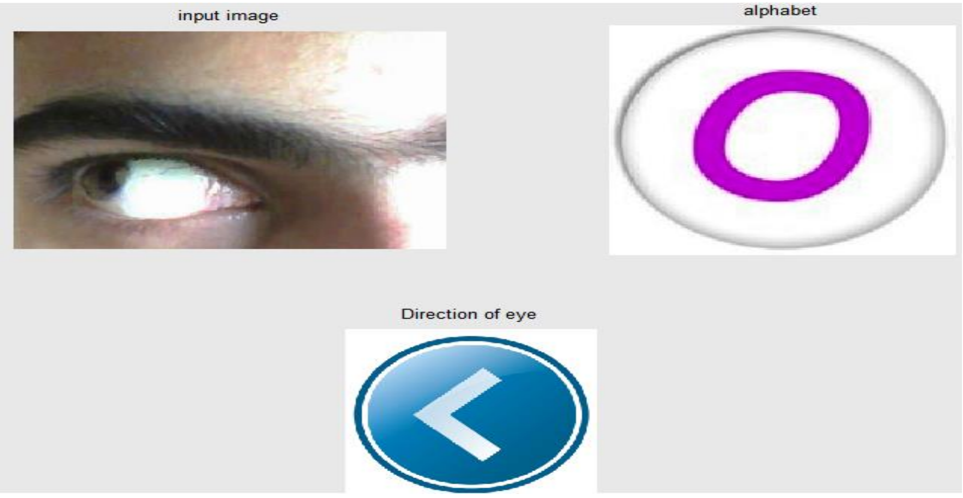

Fig.8 Output for corresponding captured input image

Similarly, for various other inputs results obtained were satisfactory i.e., right direction sign for right eye gesture, upwards direction sign for up eye gesture, downwards for down and left for left. This result is obtained using the fuzzy logic. Therefore, fuzzy logic can be used for recognize the eye gestures.

The only Limitations are: Eyes should be close to camera, as it will be easier to capture images accurately. As camera head mounted, it may be uncomfortable for prolonged use. There should be adequate light for system operation, in the environment without ambient light condition results acquired may be error-prone.

V. Conclusion

Results obtained were accurate. The low cost factor is satisfied. As the camera used was of low pixel, only the five gestures were considered. It can further be improved using camera of higher Pixel . And adding purkinje image detection would improve its accuracy and application can be enhanced. Furthermore, virtual keyboard can be added for typing more characters..

VI. Acknowledgment

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