International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-6, March 2020

# Eye Blink Detection System for Paralyzed Patients

**Kavitha H. S., Suguna G. C.**

***Abstract: Paralysis of an human being is caused due to the degeneration of motor neurons which weakens the muscle, so that it does not allow patient to move, speak, breathe , and loss in the voluntary actions. It is an incurable disease. To understand the feelings of a paralyzed patients Brain wave technique and Electro-oculography techniques were used. These techniques are afflictive, discomfortable and leads to unconsciousness of the paralyzed patient. The real time video oculography system fills the communication gap between the patient and the world. Video Oculography (VOG) is video-based method of measuring the vertical, torsional and horizontal position components of both the eye blinks with the help of small cameras placed in the head-mounted mask .This paper presents different visual technologies, such as eye blink detection, eye center localization and conversion of the eye blink to speech. The video oculography could achieve accuracy of 0.968.***

***Keywords : VOG, Eye Blink detection***

## I. INTRODUCTION

Paralysis is a metabolic disturbances caused by the impairment of voluntary muscules. This is due to the degeneration or loss of group of motor neurons. Due to the motor neuron disease paralyzed patient cannot communicate with the external world. Eye organ could be used as effective tool for communicating with the external world. The eye movement of a paralyzed patient is analyzed to determine the action. The acquisition and analysis of eye movements of paralyzed patients is presented in the paper. An eye blink sensor is used for detecting eye movement thereby reducing the occurrence of artifacts and a cost effective simple circuitry is designed for implementation of signal processing.

In this paper, small video cameras are mounted on head and IR illuminations are used to capture an image of an eye. Algorithms are developed for extracting vertical and horizontal movements of eye from video images. Developing a method for determining eye blinks is more complex. Low contrast images can also be tested by this algorithm using IR-wavelengths for illumination.

Manuscript received on February 10, 2020.
Revised Manuscript received on February 20, 2020.
Manuscript published on March 30, 2020.
* Correspondence Author
**Mrs. Kavitha H. S.,** Assistant Professor and Research Scholar, Electronics and Communication Engineering, JSS Academy of Technical Education, Bengaluru.
**Mrs.Suguna G. C.,** Assistant Professor and Research Scholar, Electronics and Communication Engineering, JSS Academy of Technical Education, Bengaluru.



This paper presents design and implementation of an algorithm detecting torsional robust movement of eye for VOG. The algorithm used here uses new approach for measuring torsional movement of eye and it is suitable for videos which are of low contrast. It is implemented and compared with the performance of other techniques.

## II. LITERATURE REVIEW

Joshua et.al, implemented portable Video-Oculography device to evaluate mild ocular motor function and intensity of head trauma. VCO is of low cost portable eye tracking device .The device evaluates the movement of an eye to assess higher cortical functioning and to suspect the head trauma. The drawback of this device is unease to test[1]. Sudhir et.al , implemented a novel algorithm for the extraction of face , analyze the blinks ,identify the type of the blink and convert the same into speech. The analysis of the blinks were done based on the intensities sclera, edge of the iris , central part of the iris and back to the sclera and the diameter of the iris[2]. Masaru et.al ,has implemented pupil tracking algorithm which determines pupil area by the selection of reliable contour points, verified the same with former frames, evaluated the pupil area detection over obstacles and estimated of pupillary light-reflex parameters like precision, recall and F-measures[3]. Jansen et.al , have designed and implemented a ample VOG system based on the torsional eye movement detection algorithm. Region of interest (ROI) of the image is pre-processed, and enhanced. To determine the suitable horizontal and vertical translation and to calculate the degrees of rotation, one of the ROI is shifted with respect to the other ROI[4]. Akshat et.al , developed a VOG system in which camera focused on the eye detects and records the blink that matches the required threshold intensity. Pre processing of the recorded image is carried out with erosion and dilation techniques. Eye region in the image was extracted by segmentation technique. The recorded movement of eye is converted to speech [5]. Jacek et.al , has developed a VOG system based on a web camera which captures minute information about head shaking and eye position of a Parkinson's disease patients.

An algorithm was implemented for face detection, facial feature localisation and tracking, Iris localisation, Iris position registration[7].

## III. PROPOSED WORK

Video Oculography (VOG) is video-based method of measuring the vertical, torsional and horizontal position components of both the eye blinks with the help of small cameras placed in the head-mounted mask . There are several techniques used for detecting closing and opening of eyes and eye movements.

The technique used is simple and less time consuming. Blinks are converted to sentence or words, which is not been used before. The camera which is focused to the face of the user records the blinks and is considered as video sequence. It is then considered as the input for detection of eye blinks and code counting.

Calculating the number of eye blinks is done and the same corresponds to meaningful sentence according to the count. It works with less number of specifications. This also helps in cost reduction. For detection of eye blinks and eye blinks there are various methods involved. The method which is used in this paper reduces time for detection of blinks and lessens the cost by large margin. Figure 1 shows the overview of the proposed system from camera for recording to the speech output.

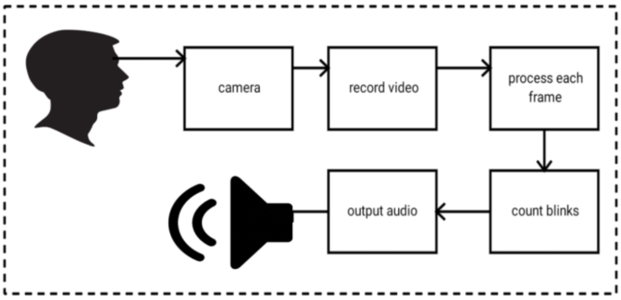


**Figure 1 Proposed system**

The more useful organ in human is eye which helps in visualizing the outside world. With the analysis of eye movement, lot of knowledge about human is disclosed. Analysis of eye movement is used for applications like disease diagnosing, state of mind recognition, recognition of activity, identification of a person etc. An algorithm which helps in detecting movements of eyes such as blinks which can be used for communication.

This technique which uses eye blink for communication is useful for people who have motor neuron disease where the patient feels hard in communicating with the world. The eye blinks can be converted to transmit messages to Morse code, in which eye blink is represented as dash or dot. For accomplishing this, an algorithm is presented which identifies first the facial region. and then identifies eye blinks with the help of image processing. The algorithm designed and developed here for FPGA Spartan 3e and then it is tested using software MATLAB.

## IV. METHODOLOGY

Figure 2 explains the methodology followed in implementing the proposed work.

1. Conversion of obtained video feed of the subject/patient into set of frames of images.

A simple Webcam is used to capture and relay the video feed. Python code along with OpenCV libraries are employed to convert analog video feed into discrete set of image frames. In our case, sampling rate is set as 10 frames/s.Then obtained set of color images are converted into greyscale images to facilitate processing operations.

2. Extraction of facial and eye features.

Haar wavelets i.e rectangular filters of different window sizes are evaluated over the obtained images resulting in edge, line and feature detection of the input face. Since evaluating all parts of face real-time results in computational complexity, Ada boost algorithm is made use to predict and evaluate only desired parts of face , in our case only regions around eyes. Haar classifiers are evaluated in stages , no of stages depend upon the desired accuracy of extraction. Such cascaded stages of classifiers are called Haar cascade classifiers

3. Blink Detection and conversion of gestures to voice.

For Blink detection , Eye Aspect Ratio (EAR) is computed using six coordinates placed on the eye, These co-ordinate points gives us vertical and horizontal lengths using which EAR is calculated.

$$EAR = VL/HL$$

For Eye movement monitoring, Eye Gaze ratio (EAR) is computed by processing white and grey areas of eye ball.Eye movement in our case is divided into Right , Left and Center. Eye gaze values are divided into sections to detect Left Right and center position of eye ball.

In our case , Gaze Ratio values between 0 to 1 corresponds to position Right 1 to 3 corresponds to position Center and more than 3 corresponds to position Left of the Eye ball. Now both EAR and EGR parameters are combined to obtain several combination of gestures. Each gesture then corresponds to a voice command which is played out louder to get the attention of the care taker and to convey the necessary vital information.

Real time Blink Detection basically employs 2 main algorithms:

- Facial Landmark Prediction Algorithm
- Eye Aspect Ratio (EAR) Algorithm

Steps followed to detect facial landmarks in an image is given below:

1. Localization of a face in an image is identified using Haar cascades or HOG + Linear SVM detectors .
2. Obtain the *2D* - coordinates of the face region ROI by applying the shape predictor, specifically a facial landmark detector.

Facial landmarks are nothing but face part extraction like nose,eyes, mouth, jawline, etc., Facial landmarks can be used for facial alignment , head pose estimation, face swapping , and blink detection .

Fast closing and reopening of a human eye could be called as eye blink. The pattern of blinking differs from person to person. The pattern may differ in the speed of closing, opening , a degree of squeezing the eye and the time taken to blink. The eye blink lasts approximately 100-400 ms. One may use the facial landmark detectors to localize the eyes and eyelid contours. The Eye Aspect Ratio (EAR) from the landmarks detected image is used to estimate eye open state or close state.

*Retrieval Number: F7368038620/2020©BEIESP*
*DOI:10.35940/ijrte.F7368.038620*
*Journal Website: www.ijrte.org*



*Published By:*
*Blue Eyes Intelligence Engineering*
*& Sciences Publication*

Per frame EAR may not necessarily recognize the eye blinks correctly, large temporal window of a frame into account is trained by the classifier. For every video frame, the eye landmarks are detected. The eye aspect ratio (EAR) between height and width of the eye is computed using the below given expression.

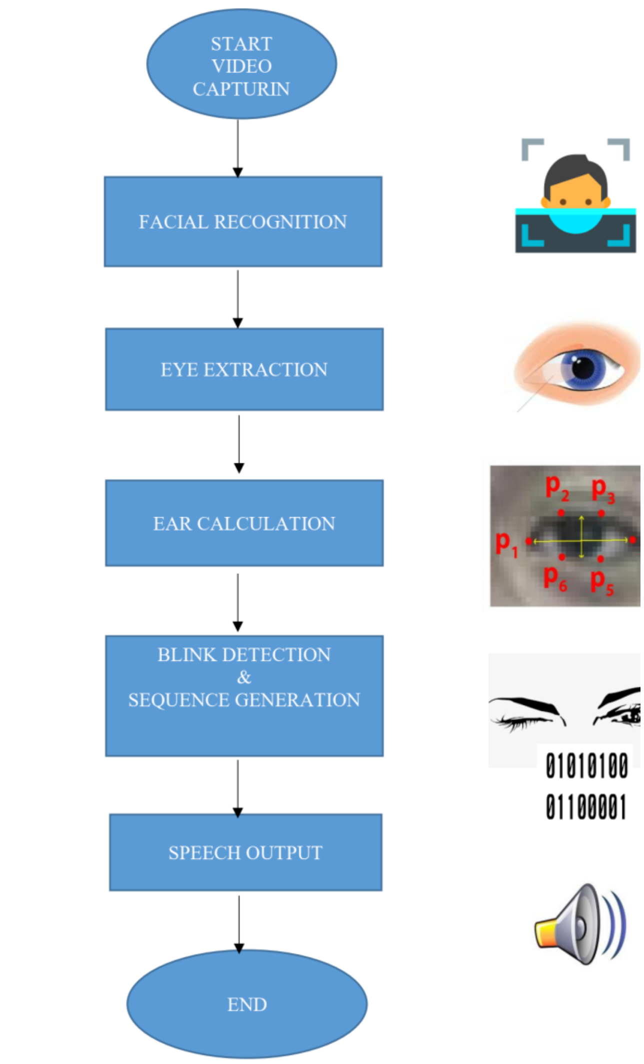


**Figure 2 Methodology**

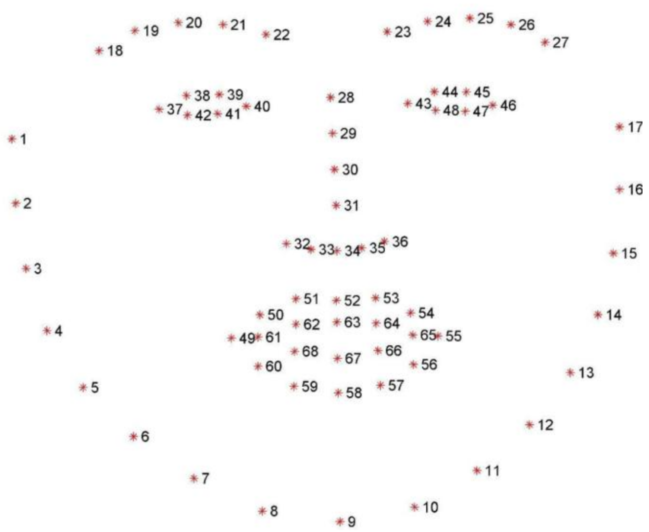

**Figure 3 Visualizing the 68 facial landmark coordinates**

$$\text{EAR}=\frac{\| P_2-P_6\| + \| P_3-P_5\|}{2\| P_1-P_4\|}$$

$P_1$, $P_2$, $P_3$, $P_4$, $P_5$, $P_6$ are the 2D facial landmark locations as shown in Figure 3.The distance between the vertical eye landmarks is computed by the numerator and denominator gives the distance between horizontal eye landmarks. Using this EAR one can avoid image processing techniques to detect blinking. The constant EAR represents the eye open and is falls below the threshold while closing an eye. The EAR of both eyes is averaged because both the eyes blink simultaneously.

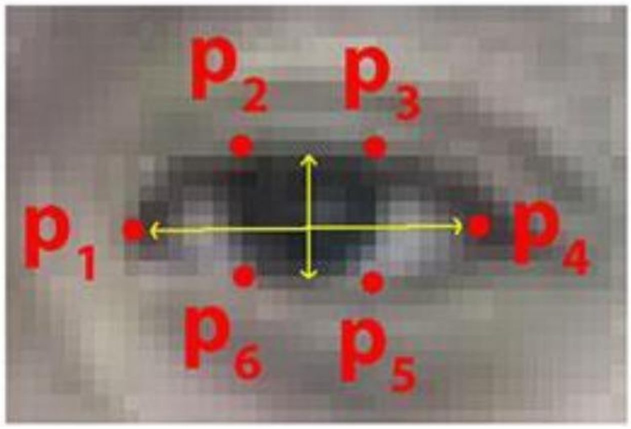


**Figure 4 (a) Facial landmarks points for Eye Open**

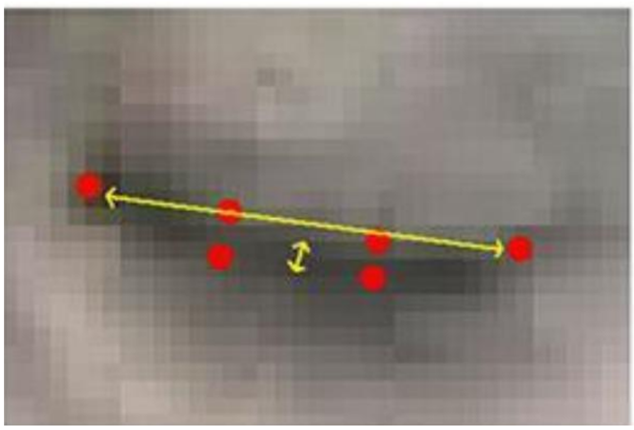

**Figure 4 (b) Facial landmarks points for Eye Close**

## V. RESULTS

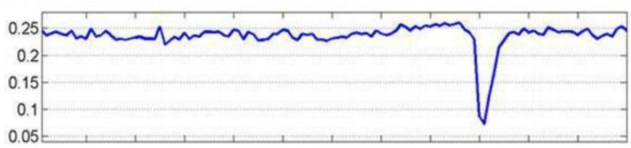


**Figure 5 EAR Values for eyes closed and open**

EAR Value for an open eye must be 0.4 and for a closed eye, it must be 0.00.The experimental results in Figure 5, show that EAR value is around 0.3 for an open eye and for a closed eye, the EAR Value is as low as 0.05.

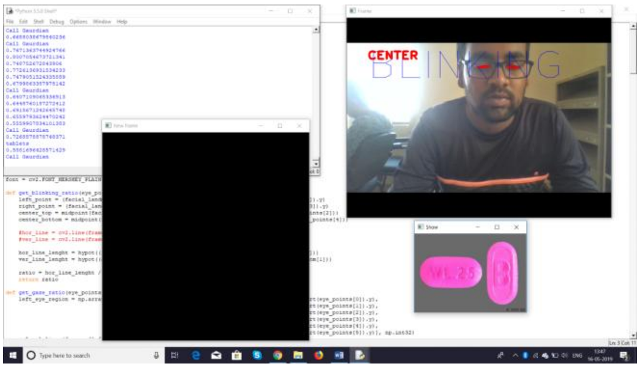


**Figure 6(a) User Interface for Eye movement and Blink Detection (Center of the Eye)**

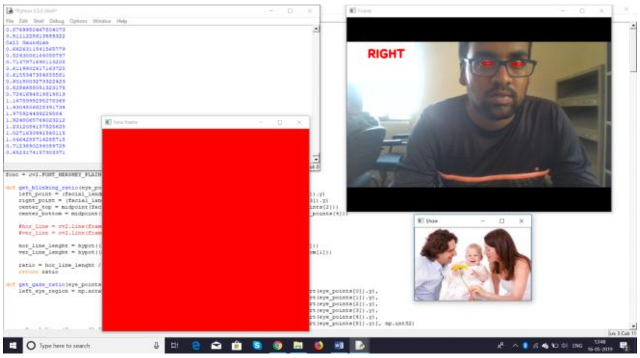


**Figure 6(b) User Interface for Eye movement and Blink Detection (Right Eye)**

## VI. CONCLUSION

The proposed method provides efficient and accurate eye detection. When an artificial light is used ,the overall and detection accuracy are 98% and 100% respectively for a distance equal to 35 cm. Each frame takes an average time of 71 ms for execution which is very efficient for real time application. The proposed system is able to bring out a solution for the paralyzed patients to communicate with the external world effectively. The developed system is different from previously developed prototypes because none of the components are in direct contact with the patient's body hence it will prove to be safer. Use of simple facial landmark technique reduces the use of image processing. Use of Raspberry pi is simple and developing tremendously in the market today. The tool had advantages over the older conventional tools. the micro-controller is interfaced with an LCD module to display the speech output as text simultaneously.

## ACKNOWLEDGMENT

I would like to thank my parents and my family who has helped me to carry out the work successfully, its my pleasure to address my guide who assists me with the full support in carrying the research work successfully.

## REFERENCES

1. Fischer, Joshua D., and Dawie J. van den Heever. "Portable video-oculography device for implementation in sideline concussion assessments: prototype." *2016 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. IEEE, 2016.
2. Rupanagudi, Sudhir Rao, et al. "Novel methodology for blink recognition using video oculography for communicating." *2014 International Conference on Advances in Electrical Engineering (ICAEE)*. IEEE, 2014.
3. Kiyama, Masaru, Hitoshi Iyatomi, and Koichi Ogawa. "Development of robust video-oculography system for non-invasive autonomic nerve quantification." *2012 IEEE-EMBS Conference on Biomedical Engineering and Sciences*. IEEE, 2012.
4. Jansen, S. M. H., et al. "A torsional eye movement calculation algorithm for low contrast images in video-oculography." *2010 Annual International Conference of the IEEE Engineering in Medicine and Biology*. IEEE, 2010.
5. Gambhir, Akshat, et al. "Video Oculographic System using Real-Time Video Processing." (2015).
6. Karthik, K. P., and S. Basavaraju. "Design and Implementation of Unique Video Oculographic Algorithm Using Real Time Video Processing on FPGA."
7. Naruniec, Jacek, et al. "Webcam-based system for video-oculography." *IET Computer Vision* 11.2 (2016): 173-180.
8. Joseph K George , Subhin K B, et.al , "Eye Controlled Home-Automation For Disables" IOSR Journal of Electrical and Electronics Engineering (2017): 06-08.

## AUTHORS PROFILE

**Mrs. Kavitha H. S.,** Assistant Professor and Research Scholar, Electronics and Communication Engineering, JSS Academy of Technical Education, Bengaluru. Published one international journal and two international conference papers and two national conference papers.

**Mrs.Suguna G. C.,** Assistant Professor and Research Scholar, Electronics and Communication Engineering, JSS Academy of Technical Education, Bengaluru. Published three international journal and two international conference papers.