Video Oculographic System using Real-Time Video Processing

Akshat Gambhir [1], K.S Boppaiah[1], M Shruthi Subbaiah[1], Pooja M[1], Kiran P[2]
[1] 8th semester, Dept of Computer Science, RNSIT, Bangalore
[2] Asst Professor, Dept of Computer Science, RNSIT, Bangalore

ABSTRACT

Video Oculography (VOG) is a non-invasive, video based method of measuring horizontal, vertical and torsion position components of movements of both eyes using a head mounted mask that is equipped with small cameras. There are systems which use various techniques to detect the opening and closing of the eyes. The technique used in our project is simple and not time consuming. Using blinks to select a sentence or word and playing the sentence has not been used widely in the past. In our project we want to implement this and also build a system whose functionality can be extended to serve a variety of applications. In this system, we use a camera to take input from the user. The user blinks in front of the camera. This is taken as a video sequence and then it becomes the input to blink detection and counting code. The number of blinks is thus calculated and the sentence corresponding to this count is played. This system works with minimum specification. This would help the lower economical class. There are several methods which can be used to detect the eyes, the method which we have used in our project reduces the time taken for blink detection and also reduces the cost of the system by a large margin.

Keywords

Eye, Blink, Eye Recognition, MND, ALS, Face Recognition, Electrooculography, Image Processing, Video Processing

1. INTRODUCTION

1.1 Background

Amyotrophic lateral sclerosis (ALS) – is a neurodegenerative disorder with various causes. ALS is characterized by muscle spasticity, and rapidly progressive weakness due to muscle wasting.[6] This results in difficulty speaking, swallowing, and breathing. It became well known in US when it affected a famous basketball player "Lou Gehrig". Ice bucket challenge was used to create awareness about ALS. [2]

Ice Bucket Challenge is an activity involving dumping a bucket of ice water on someone's head. It went viral on social media in US. The challenge encourages nominated participants to take the ice bucket challenge within 24 hours and donate $10 else if forfeited they have to donate $100. Funding reported over $100 million to ALS association.

The term motor neuron disease (MND) is sometimes used interchangeably with ALS (Amyotrophic lateral sclerosis). MND are a small group of neurological disorders that selectively affect motor neurons, the cells that control voluntary muscle activity including speaking, walking, swallowing, and general movement of the body. They are generally progressive in nature, and cause increasing disability and eventually, death.

Stephen Hawking is currently suffering from MND. In 1963, Hawking contracted Motor Neuron Disease (MND). The condition has progressed over the years. He is almost entirely paralyzed and communicates through a speech-generating device. [1]

1.2 Purpose

The main purpose of, Video oculographic system using real time video processing is to assist MND patients. Patients affected by motor neuron diseases or paralysis are unable to communicate or even make gestures with their hands, A VOG system will help them to communicate in an easier and better way, through the blinks of eyes. [4] It also has lot of other applications as well like for deaf and dumb people to interact with outside world, a VOG system will ease them from use of hand signs. Also, during hijacking of planes, a pilot can send S.O.S signals to air traffic controller using VOG. Blind people can also communicate using VOG as it just requires them to blink their eyes.

In this proposed system we use the counts of the, number of blinks in order to communicate, that is, based on the counts of the blinks audio of basic sentences that are needed in our daily life will be played so that the patients can communicate easily with their caretakers.

Here we are attempting to develop the video oculography system [5] which would work on the system having minimum specification so that would help the lower economical class as well.

The VOG system includes a camera focused on the eye, video processing unit, system to generate speech and a speaker. The camera records the movement of eye i.e., it senses the opening and closing of eye lids. If it is a normal blink, the video processing unit does not process the data, but if the intensity of blink matches the required intensity then the video processing unit records the movement and processes the data. The recorded movement of eye and the corresponding count of the blinks is sent to system to generate the corresponding speech or sentence which is stored in a database. Speakers are used as the output for the system.

2. EXISTING SYSTEM

A goggle based light-weight VOG system: The goggle based light-weight VOG system is shown in the figure below. This is the simplest VOG device which is based on head mounted systems. The portable VOG system, is a goggle head mounted system with at least one digital camera of at least 30hz generally connected to and powered by a computer. The computer may be a laptop or portable computer (generally less than about 3 kilograms), whereby the entire system will be less than 8 kilograms and preferably less than 5 kilograms. The weight of the goggles is critical in that the lightweight goggles have lower inertia and move less improving accuracy of the system. The low inertia goggles of the present invention provide a 3D system and weigh less than 500 grams, preferably less than 300 grams and most preferably less than 200 grams.

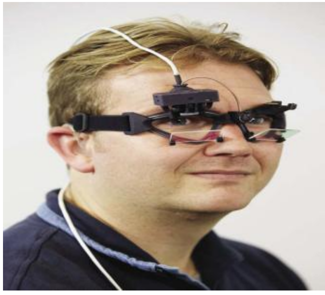

Fig1: A goggle based light-weight VOG system

3. PROPOSED SYSTEM

In our project, we are attempting to develop a video oculographic system which would work on a system having minimum specification. This would help the lower economical class. We use a lower end camera (5mpeg), which is attached to the chair, and by using certain low cost connection it is connected to the VOG system, which would process it in an optimal time period and the output is received at the speakers. The VOG system includes a camera focused on the eye, a video processing unit, a text to speech convertor and a speaker. The camera records the movement of the eye that is, it senses the opening and closing of eye lids using the intensity values of the pixels in each frame. Blinks are detected in this manner. If it is normal blink, the video processing unit does not process the data, but if the intensity of blink matches the required intensity then the video processing unit records the movement and processes the data. The number of blinks is counted and this count is sent to system to select the corresponding speech or sentence which are stored in a database. Speakers are used to speak out the sentence and it forms the output of the system.

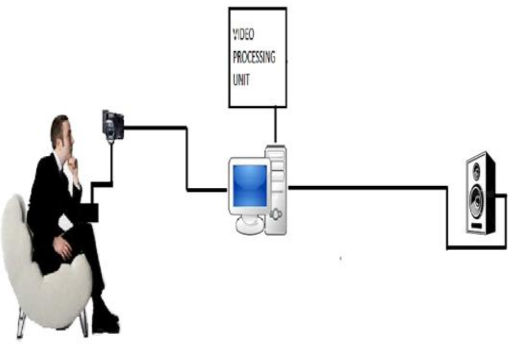

Fig2: Proposed System

3.1 Advantages of proposed system

- Cost effective and is affordable by all.
- Faster, as it selects a sentence at a time.
- Can be used for a variety of applications such as sending SOS signals in case of an emergency in flights, communication for the speech impaired, and patients suffering from paralysis or stroke.
- Can be used for drowsiness detection in drivers, thereby helping in the prevention of accidents.
- Non-invasive method.

4. SYSTEM DESIGN

As the camera starts it will record the video, and sends it to the video processing unit. Frames are extracted from these video frames using inbuilt functions in java, as frames are nothing but the entities of video file.[3] Then each frame is analyzed and only the eye part is segmented from rest of the face features in order to count the blinks. The normal blink is differentiated from the intended blink based on the intensity i.e., how long the eyes are kept close. Based on the number of blinks the prerecorded sentences will be played and to save the power, after certain number of blinks camera will be turned
off.

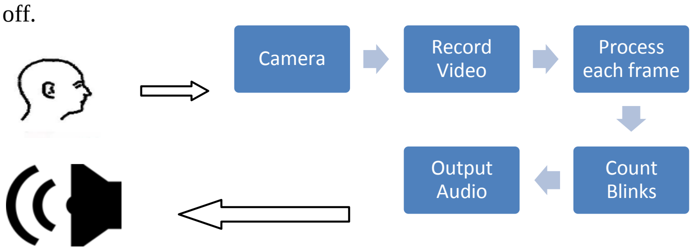

Fig 3: System Overview

4.1 Data Flow Diagram

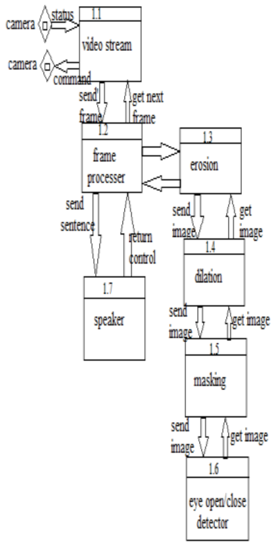

Fig 4: Data Flow Diagram

5. IMPLEMENTATION

The First, we create an object of blink class. This blink class has a method grabFile() which grabs the next frame from the camera, for processing. We use the method startcam() to start the camera, and then call grabFile() method to get the frame. Each frame is represented as an array which stores the intensity values of each pixel.

For image processing, we have converted the image to the Cr color model using the method colorconversion(),[6],[5],[7] and then performed erosion and dilation on these images by calling the methods erosion() and dilation() respectively. Erosion and dilation are performed in order to remove the noise/external disturbances in the image. After calling erosion() and dilation(), we call the method mask() to perform segmentation in order to extract the eye region in the image. The resultant image is a gray-scale image of the eyes.

For video processing, performing all the above mentioned steps creates a lot of delay and the system does not exhibit real-time behavior, so we have eliminated the erosion and dilation. Here, we have segmented the eyes by calling the method ero(), by darkening all other regions of the image except the eyes. This method works because MND patients are unable to move their face and hence the face will remain at a particular position throughout. Then we converted the image to a gray-scale representation using the method converty().

The method display() displays the image on the JFrame. Then we call the method eyelocate() which returns the state of the eye i.e., open(3) or close(1), and stores this value in an array blinkcount[].

From the blinkcount[] array, we retrieve the filter[] array, by checking whether 2 continuous values are the same in the blinkcount[] array. In this case, there is only one copy of the value in the filter[] array. If this is not the case, then the blinkcount[] value is copied exactly as it is into the filter[] array location.

To get a count of the number of blinks in the video stream, a variable count is used. This variable checks the filter[] array. For every blink, the filter[] array will have value 1 and 3 a blink is essentially an opening(value=3) and closing(value=1) of the eye and value of count is incremented for each blink. The count variable is used to select the sentence which has to be played.

In order to play the selected sentence, another object of blink class is created, and the method speak() is called. The sentence is then played.

If the eyes are closed continuously for 7 frames, the stop cam () method is called, and the camera stops and the program exits.

6. RESULT SNAPSHOTS

Our model is made up of 2 units namely a camera and a holder stand. The camera has a resolution of 1600 into 1200 mega pixel, 4 LED for night vision and 4x zoom. This camera is placed on the setup which is made using basic material such as thermocol and has a face holder which can be moved forward or backward depending upon the patient's convenience.

The camera can be moved in any positon, such that the light from the 4 LED's focus on the patients eye. The intensity of the light can be varied by a nob which is available at the mid-section of the wire connecting the camera with the system.

The face holder consists of 3 parts [1] the face holder [2] the base [3] camera holder. The face holder is cut in a crescent fashion so the patient can mount his face on it without any movement of the face. The camera holder is placed at a height which can be varied until there is a linear line of contact between the camera and the eye.

- The VOG system includes a camera focused on the eye, video processing unit, system to generate speech and a speaker. The camera records the movement of eye i.e., it senses the opening and closing of eye lids. If it is a normal blink, the video processing unit does not process the data, but if the intensity of blink matches the required intensity then the video processing unit records the movement and processes the data.
- The recorded movement of eye is sent to system to generate the corresponding speech or sentence which is stored is a database. Speakers are used as the output for the system.

The system differentiates between normal and long blink by the following

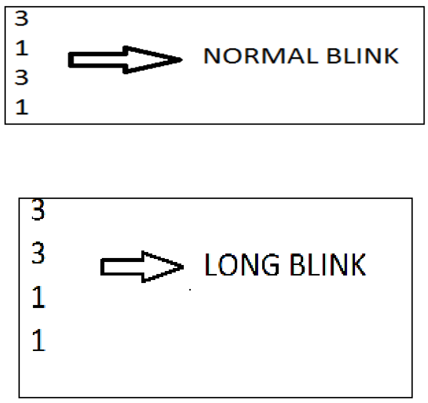

Fig 5: Differentiate between normal & long Blink

- There exists two tables namely the array table and the fetch table.
- The array table will record the blinks made by the person and the will perform count operation only on detecting a long blink , this is then recorded

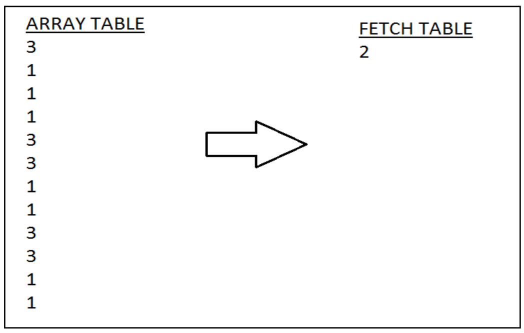

Fig 6: Fetch Table

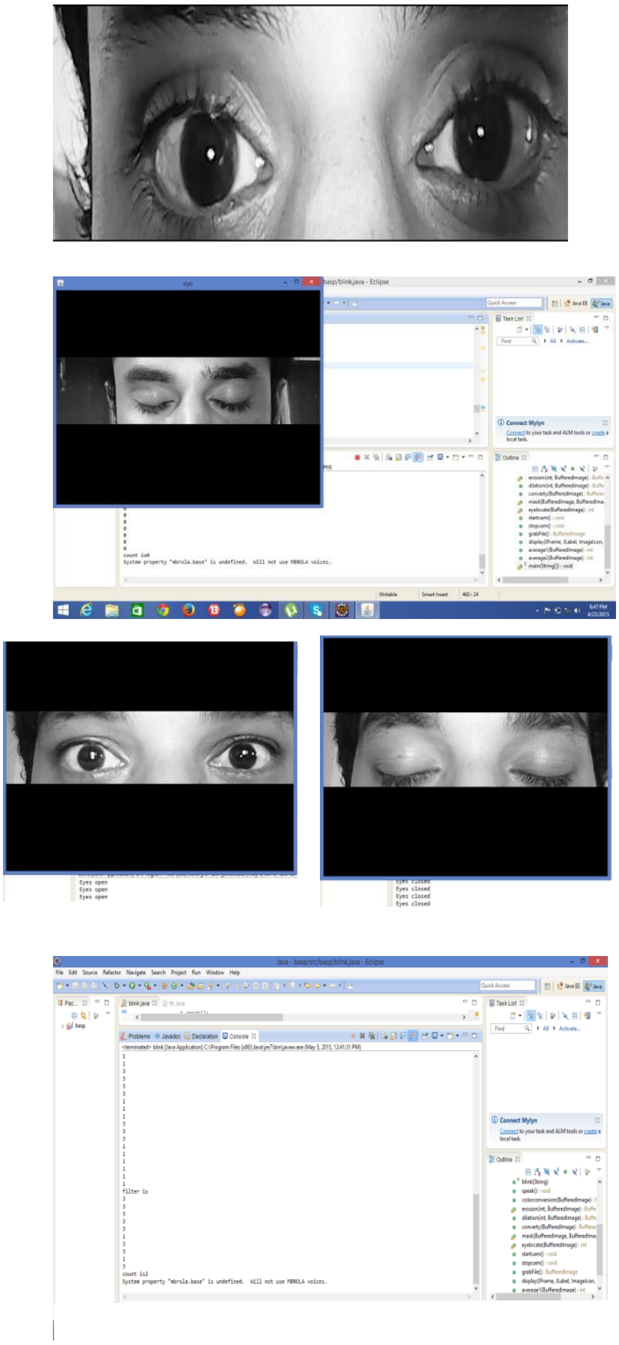

Fig 7: Counting of Blinks

7. CONCLUSION

Our We have developed a system that detects the blinks of the eyes, counts the blinks in a video stream and then play a previously assigned sentence for the corresponding blink count. There are several methods which can be used to detect the eyes, the method which we have used in our project reduces the time taken for blink detection and also reduces the cost of the system by a large margin.

Speed and cost are few the critical factors of our system because with the help our system, the patients affected by motor neuron diseases (MND) can communicate with their care-takers and also the outside world. This becomes a life line for patients suffering from paralysis, stroke and even verbally challenged people. Our project can be extended to a huge variety of applications as mentioned earlier.

One limitation of our project is that it is highly dependent on the surrounding illumination. Light creates a problem whether it is too much or too less. Since we detect the eyes based on the intensity values, the light conditions affect the reliability of the system and hence limit its functionality.

In the future, we aim to extend the functionality of our system to perform various jobs such as opening a mail on selection of the corresponding sentence. We also aim to reduce the dependency of the system on the surrounding illumination. We also plan to use a wireless connection between the computer and the camera and computer and the speakers, so that the patient need not carry the computer at all times..

8. REFERENCES

[1] Stephen Hawking - Lectures http://www.hawking.org.uk/.

[2] Datta, S.; Banerjee, A.; Pal, M.; Konar, A.; Tibarewala, D.N.; Janarthanan, R., "Blink recognition to detect the possibility of eye dystonia based on electrooculogram analysis," Control, Instrumentation, Energy and Communication (CIEC), 2014 International Conference on , vol., no., pp.186,190, Jan. 31 2014-Feb. 2 2014

[3] Rupanagudi, S.R.; Ranjani, B.S.; Nagaraj, P.; Bhat, V.G., "A cost effective tomato maturity grading system using image processing for farmers," Contemporary Computing and Informatics (IC3I), 2014 International Conference on , vol., no., pp.7,12, 27-29 Nov. 2014

[4] Ravoor, P.C.; Ranjani, B.S.; Rupanagudi, S.R., "Optimized fingertip blob recognition for image processing based touch-screens," Recent Advances in Computing and Software Systems (RACSS), 2012 International Conference on , vol., no., pp.104,108, 25-27 April 2012

[5] Rupanagudi, S.R.; Ranjani, B.S.; Nagaraj, P.; Bhat, V.G.; Thippeswamy, G., "A novel cloud computing based smart farming system for early detection of borer insects in tomatoes," Communication, Information & Computing Technology (ICCICT), 2015 International Conference on , vol., no., pp.1,6, 15-17 Jan. 2015

[6] Rupanagudi, S.R.; Vikas, N.S.; Bharadwaj, V.C.; Sowmya, K.S.; Manju; Dhruva, N., "Novel methodology for blink recognition using video oculography for communicating," Advances in Electrical Engineering (ICAEE), 2014 International Conference on , vol., no., pp.1,6, 9-11 Jan. 2014.

[7] Ravoor, Prashanth; Rupanagudi, Sudhir; BS, Ranjani; "Novel algorithm for finger tip blob detection using image processing,", 4th International Conference on Electronics Computer Technology, 2012, ICECT 2012