Research Paper
Impact Factor: 3.567
Peer Reviewed Journal

IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

# COMMUNICATION AID FOR BEDRIDDEN PEOPLE USING EYE BLINKS

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***Abstract***
*This paper presents an implementation of a low cost eye-blink based communication aid which allows people with severe disabilities to access computers and communicates with other persons. This communication aid requires only one low-cost camera module and a personal computer. Here a method for detecting user's eye blinks and accurately measures their durations is introduced. The system will provide an alternate input modality to allow people with severe disabilities to access a computer. Voluntary long blinks trigger mouse clicks, while involuntary short blinks are ignored. The system enables communication using "blink patterns:" sequences of long and short blinks which are interpreted as semiotic messages. The location of the eyes is determined automatically through the motion of the user's initial blinks. Subsequently, the eye is tracked by correlation across time, and appearance changes are automatically analysed in order to classify the eye as either open or closed at each frame.*

***Key Words: Blink Pattern, Semiotic Messages, Detection Algorithm, Haar like Feature.***

## 1. Introduction
Nowadays we know that there are a lot of people who were unable to communicate with the outer world for their needs especially for those people who were permanently bed ridden. This paper is embarked upon the intension of building a communication aid for these bedridden peoples. The severity of their disability is such that they have little or no voluntary muscle contraction. Owing to this kind of extreme disability, many available popular assistive technology systems are not helpful to them. Under this circumstance, eye-motion-based systems may provide an alternative option for people with severe disabilities who only retain the ability to move their eyes. With the communication aid, bed ridden people are able to use their limited voluntary motions such as eye blinks for communications, manipulating computers, and it is possible to communicate with outer world.

## 2. Literature Review
There are mainly two ways for severely paralysed person who retain control of extra ocular muscles to communicate with computer:- brain–computer interfaces (BCI) and systems controlled by gaze or eye-blinks [5]. A brain-computer interface acquire brain electrical activity (Electro Encephalogram-EEG) hence no muscle activity is involved. BCI is very useful for people with severe disabilities [6]. Their main limitation is the need for special EEG recording hardware. More over in EEG based BCI, the person with disability should wear the electrode headset assembly. This will create some discomfort to the patient.

In one work an eye tracking system is developed by Applied Science Laboratories [7]. In this a wearing head-mounted cameras is used to track the eye movements. This system enables easier and more reliable performance. However, wearing a headgear is not suited for all users and may be uncomfortable.

In another work an eye-blink detection system is developed for human computer interface. This work is focused for developing a virtual on board key board for physically challenged people [5].

## 3. SYSTEM DESCRIPTION
The proposed communication aid for people with severe disabilities dichotomizes daily living necessities in an LCD display. The system also includes pre-programmed audio commands according to the option selected by the user. The system consists of a Raspberry pi development board (model B+)which is a single board computer[3]. The Raspberry pi model B+ consume less power, has better audio and better form factor. It offers more flexibility for learners than the leaner model A or A+, which are more useful for embedded projects and has more USB ports than model B. The various functional units of the system are shown in figure1.

IJMDRR
E- ISSN –2395-1885
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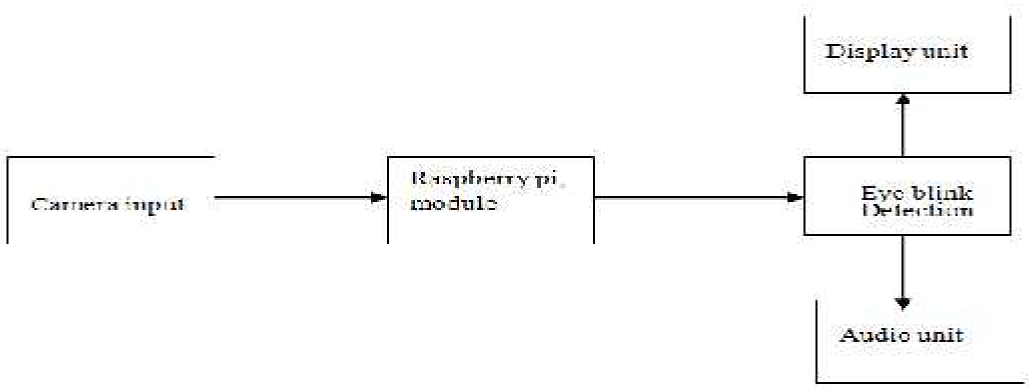


**Fig.1: Block Diagram of the Proposed System**

**4. Eye Detection Algorithm**

In this proposed system, Haar cascade algorithm is used for eye detection because of its very high detection rate (true-positive rate)and very low false-positive rate[4]. It can be used for real time practical applications. The algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Adaboost Training[2]
4. Cascading Classifiers

The various functional stages for detecting the eye blink is illustrated in figure2.In this algorithm digital image features used in object recognition which considers adjacent rectangular regions at a specific location and in a detection window, sums up the pixel intensities in each region and calculates the difference between sums (The value of any given feature is the sum of the pixels within clear rectangles subtracted from the sum of the pixels within shaded rectangles). In the detection phase, 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 [4]. The difference is then compared to a learned threshold that separates non objects from objects. An integral image can be obtained by computing the sum of two pixels above and to left of the original picture. The idea is to make rectangle which is used as a feature for comparison.

**Input IMA**

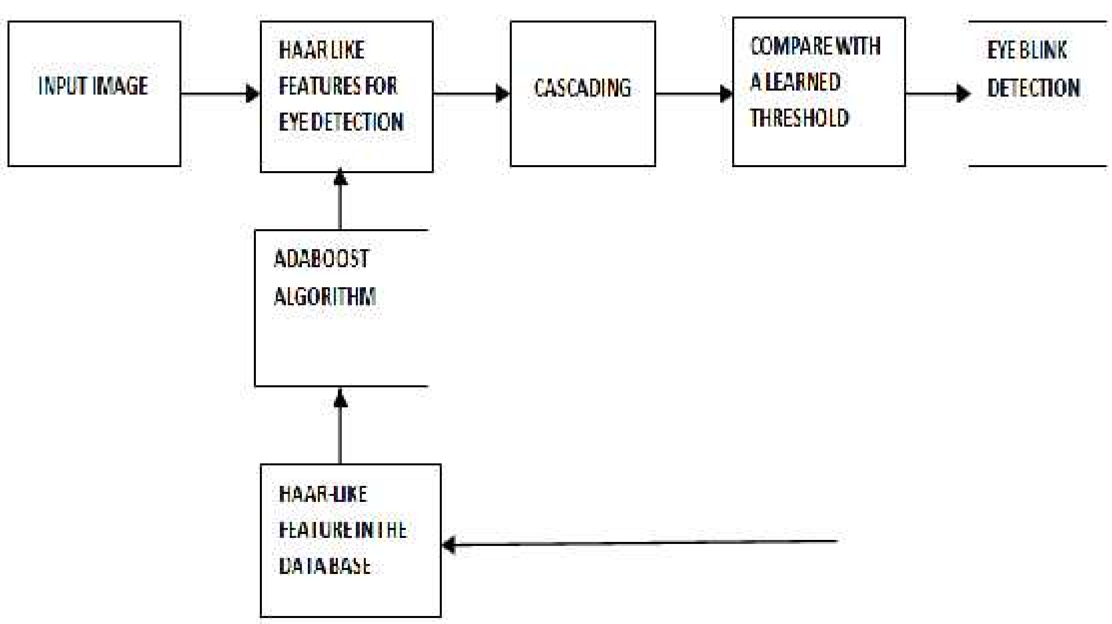


**Fig. 2: Illustrates the Various Functional Stages for detecting the Eye Blink**

IJMDRR
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All human faces share some similar properties. These regularities may be matched using Haar Features [4]. A few properties common to human faces are the eye region, which is darker than the upper-cheeks, the nose bridge region, which is brighter than the eyes etc.
The four features matched by this algorithm are then sought in the image of a face. Rectangle features:

- Value = Σ (pixels in black area) - Σ (pixels in white area)
- Three types: two-, three-, four-rectangles, Viola & Jones used two-rectangle features
- For example: the difference in brightness between the white &black rectangles over a specific area
- Each feature is related to a special location in the sub-window

An image representation called integral image evaluates rectangular features in constant time, which gives them a considerable speed advantage over more sophisticated alternative features. Because each feature's rectangular area is always adjacent to at least one other rectangle, it follows that any two-rectangle feature can be computed in six array references, any three-rectangle feature in eight, and any four-rectangle feature in nine.

In the proposed algorithm, the image is captured using the camera is converted to a grey scale form. After that, face detection is performed using HAAR like features [4]. Using this technique face is detected, and then we set the centre point of the face and set the region of interest (ROI). ROI is defined as a selected subset of samples within a dataset identified for a particular purpose. We have to set the centre point of the face as ROI because for the further computation we need to detect the eyes of the patient. After the initial eye region has been located, a rectangle with an appropriate size will be automatically moved to encircle the pupil. The system asks the user to blink his/ her eye when the user tries to start to use the communication aid so that the eye region could be effectively located by the simple frame differencing method [1].

**5. Working of the System**

The proposed systeminitially displays a screen which shows six basic needs as shown in figure3. The camera module is placed in front of the computer monitor. The camera unit will continuously input the video stream to the raspberry pi's graphics processing unit (GPU). The graphics processing unit will initially detect the face in the video input and then eye movements are tracked. The camera supplies 15 colour images of size 640×480 per second. To achieve real-time performance, the eye blinks detection algorithm processes only 320×240 pixels in grey level at an average 30 frames per second .It will scan for an eye blink which last for several frames of the video input which shows a selection. Simultaneously the detected eye blink makes selections on the display. If a particular option is selected it shows a confirmation message. If the audio output is required for the selected option the audio unit receives the appropriate command and pre-stored audio is selected and outputs to the speaker. Also the audio unit provides beep sounds for on screen selections as acknowledgement.


**Fig. 3: Included Services to the User**

**6. Results and Conclusion**

In this work a low-cost eye- blink-based communication aid is implemented. Six basic necessities ie; need for Food, Water, Toilet, Doctor, Sleep and Help were included. For each selection of the service, a beep sound and an audio acknowledgement is also provided. Figure 4 shows detection of eyes.

With a minor addition in software, the same system can be expanded to provide additional service features like type of food needed, sort of discomfort to the doctor, channel selection in TVs, controlling home appliances etc. Hardware upgradation is not required for this expansion. Thus the system can be made more user friendly and can be used to communicate the needs and feelings of the patient. So the developed system is extremely helpful to empowers people with disabilities to communicate and interact with the world.

IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877


**Fig. 4: Eye detection of the User**

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