Eye Blink to Voice and Home Automation: Assisting System for Paralyzed

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Abstract— This project is a smart which is specially designed for MND patients. The concept of this system is to apply eye movement to communicate with the caretaker and to control the appliances. This system comprises of methods like face detection, eye detection, eye tracking, conversion of blink to voice and blink to home automation. The image processing module consist of webcam and the eye movement image is captured and transmitted to Raspberry Pi microcontroller for processing with OpenCV to derive the coordinate of eye ball. The system enables the patients to communicate with caretaker using blink patterns-sequences of long and short blinks which are interpreted as semiotic voice messages. The system proposed comprises of methods like face detection, eye detection, eye tracking, conversion of blink to voice and blink to home automation. The image processing module consist of webcam and the eye movement image is captured and transmitted to Raspberry Pi microcontroller for processing with OpenCV to derive the coordinate of eye ball. The system enables communication using blink patterns-sequences of long and short blinks which are interpreted as semiotic voice messages.

Keywords: Eye Blink Detection, Face Detection, Eye Tracking, Conversion of Blink to Voice, Blink to Home Automation, Raspberry Pi

I. INTRODUCTION

Motor Neuron Disease (MND) is a medical condition where the motor neurons of the patient are paralyzed and it is incurable. It also leads to weakness of muscles with respect to hand, feet or voice. Because of this, the patient cannot perform his voluntary actions and it is very difficult for the patients to express his needs. And even the patient face major problem like he won't be able to communicate with the world. A motor nerve gets damaged and stops working eventually in MND. Thus, the nerves that are damaged connected to the muscles lose the strength eventually. There are several subtypes. In every type, the symptoms that the patients face are in different ways. As the disease promotes, these symptoms of MND lean to overlap.

Paralyzed stroke patients are unfit to ordinarily speak with their condition. For these patients, the main piece of their body that is under their control, as far as solid development, is their eyeballs. Some examination around there has concentrated on researching new effective specialized devices for deadened patients for making an interpretation of their eye developments into suitable correspondence messages. The most concerning issue that deadened patients face is driving their own existence without anybody else help. This incorporates essential everyday tasks like exchanging on a machine or expanding the speed of fan. The greater part of the current framework utilize refined equipment and programming to make the control simpler and effective. However, the most serious issue which a deadened patient appearances while utilizing these framework is openness.

The advancement of the technologies has always fascinated us. On the other hand, we also found that, there are not significant researches on automation devices for physically challenged or disabled people. Therefore, we started to look into the published papers and innovations around us. Nowadays medical science improving day by day. On this developing procedure human beings innovating greater strengthen scientific accessories such as smart belt which locate patient respiration as well as electro dermal activity (EDA) sensors to sequentially display for physiology symptoms of seizures at night time. Medical operations are now getting easier. Newly developed high-tech gadgets implemented in patient's body to restore normal activities. Especially paralysis patients, such as Tetraplegic Patients who suffering a lot for their physical disabilities. It's now highly important to develop a system which may help paralysis patients like Tetraplegic Patients. Moreover, people are highly interested to digitize their daily life with less physical movement. To fulfill both requirements it's high time to develop a system which may help Tetraplegic Patients as well as people who are interested to use for efficient and comfortable life.

Paralysis is one among the major neural turmoil that causes loss of movement of at least one muscles of the body, wherein relying upon the reason, it might influence a particular muscle gathering or district of the body, or a bigger territory might be included. In quest for restoration, the eye can be viewed as one of the organs that can assist a deadened individual with communicating reasonably. Eye development can be utilized by the loss of motion patients and armless people to perform straightforward undertakings. This paper depicts the procurement and examination of eye developments for the enactment of home machines for loss of motion patients. The proposed strategy here utilizations an eye flicker sensor for eye development procurement in this way diminishing the event of antiquities, further after a straightforward hardware for usage of sign handling, which is additionally savvy and valuable from the client perspective. Furthermore, this prepared sign can be utilized as a contribution for a microcontroller so as to control home machines.

In introduction, discussion about disease called motor neuron disease is done in which the patient suffers from communication. There are several techniques introduced for these patients to ease communication. But the disadvantage is that these techniques are costly and uncomfortable. Thus, the main aim of this project is to develop an algorithm which is cost effective and user friendly.

II. LITERATURE SURVEY

There are a few restorative issue that can prompt an individual getting to be incapacitated or having engine discourse issue that represses discourse or voice generation. Conditions, for example, Locked-In Syndrome (LIS) or engine neuron infections, for example, Amyotrophic Lateral Sclerosis (ALS) and Cerebral Palsy are among the basic ailments that influence discourse. In all or most such cases, the patient loses the capacity to speak with the outside world in a viable way despite the fact that his knowledge is for the most part unaffected. Not exclusively does that reason extraordinary misery to that individual, yet in addition to his family and companions. Some redone Augmentative and Alternative Communication (AAC) gadgets have been built up that utilizes signals from the patient and changes over them into some type of information that can be imparted however such gadgets are extravagant and are for all intents and purposes distant for the vast majority. In this framework, we have structured an amazingly low estimated gadget that peruses and changes over eye-squints from the patient to an all-around acknowledged correspondence code-The Morse code.

A. Brain-drive: a smart driver for controlling digital appliances using cognitive command

For the impaired and debilitated, the universe of cerebrum PC interface has opened another skyline to lead an unassisted and least managed life. Be that as it may, the utilization of prosthetic appendages and counterfeit organs are as yet not financially accessible in a large portion of the nations. As of late built up some other brainwave based frameworks are generally costly, stable or assignment explicit. So as to conquer these issues, similar to the pen-drive, we have concentrated on building up a minimal effort control unit to be specific Brain-drive which changes ones contemplations into yield advanced electric sign. Certain considerations (mental assignments) with hard eye flickering (neural driven physical result) builds up certain activity potential, regardless of the eye squinting is unmistakable or not, it makes a huge change in electroencephalogram (EEG) or mind signal. Single channel EEG signal is gathered from frontal flap as it assumes an essential job in willful development utilizing a wearable Mind wave Mobile from Neurosky. The EEG information therefore recorded is preprocessed to decrease the impact of clamor and ancient rarities and after that dissected in time space. A lattice of cells are shown on a screen before the subject, which is associated with individual computerized yield stick locally available an implanted framework. To choose a cell, a client simply needs to look and produce an economical eye squint which can without much of a stretch be distinguished from the crude estimation of brainwave.

Since eye flickering can be both cognizant and automatic, programmed intermittent eye squint of extremely low recurrence wavering is expelled to maintain a strategic distance from undesirable choice of direction. Not at all like webcam based eye squint locator, BrainDrive catches the sign for flicker instead of the visual yield of squinting. The framework can be prepared for individual explicit tweaked execution, considering exceptional necessities of a crippled or incapacitated individuals who can't speak with the outside world utilizing voice, movement or different techniques. With the assistance of intellectual order, the 'Cerebrum Drive' can be utilized to control wheelchair, home machines and even modern.

B. Efficient eye flicker recognition technique for debilitated helping area

Facial loss of motion causes patients to lose their facial developments, which can bring about eye harm even visual impairment since patients are unequipped for squinting. We plan and actualize a couple of brilliant glasses iBlink to help facial loss of motion patients to flicker. The essential thought is to screen the typical side of the face with a camera and animate the deadened side, so the squint of the two eyes become symmetric. Our commitments are: First, we propose an eyeblink discovery component dependent on help vector machine (SVM), which can recognize uneven squints of patients under different brightening conditions with an exactness above 99%. Our eye-picture library for preparing the model is distributed online for further related examinations, which contains in excess of 30,000 eye pictures. Second, we plan and execute a programmed incitement circuits to create electrical motivation for animating the patient's facial nerve branches, which can design operational parameters in a self-versatile way for various patients. Third, we execute the whole iBlink framework, which incorporates the two capacities above and a correspondence work module for tele-prescription applications. We lead explores in an emergency clinic to acquire the structure premise and confirm viability of our gadget.

C. Study and advancement of help device with flickers for physically crippled youngsters

In this investigation, we attempt to build up another application for physically impeded kids to speak with others by a squint. Because of restricted body developments and mental issue, the greater part of them can't speak with their families or guardians. Think whether they can utilize application in advanced cells or some other android gadgets by a squint, it will be huge assistance for them to tell parental figures what they truly need or need to tell and impart through voice and furthermore control the gadgets like fan, light, or some other android or Bluetooth associated gadgets . Here we endeavor to distinguish an eye territory by utilizing Open Cv. At that point we build up the best approach to distinguish opening and shutting of eyes. We join the technique utilizing circumstance and utilizing intricacy of picture to get progressively exact outcomes to recognize a flicker. The dimension of impaired is extremely fluctuated in youngsters. So we will endeavor to build up the application to have the option to tweak relies upon the circumstance of clients. And furthermore, we will attempt to lessen the mistake to recognize a flicker and seek after the high accuracy of the eye pursued program.

III. BLOCK DIAGRAM

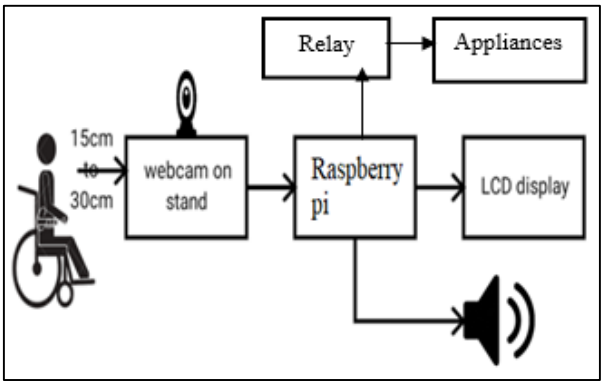

Fig. 1: Block diagram

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. This paper introduces 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.

A. HDMI display screen

The display screen is used in order to display the eye blinking and tracking motion. The screen is mostly important for the caretaker. It can guide him along the proper setup of the product.

For the proper display, we have chosen to use HDMI LCD display screen. The specification of it is shown below,

- 800 x 480 HD resolution
- Capacitive touch control
- Support Pi Raspberry
- Support OS: Pi Banana, Pro Banana, provide Ubuntu, Raspbian corresponding mirror
- Support Black BB, provide the corresponding mirror image Angstrom
- General HDMI display, can be used as a computer monitor
- HDMI interface is used to display and USB interface is used to touch

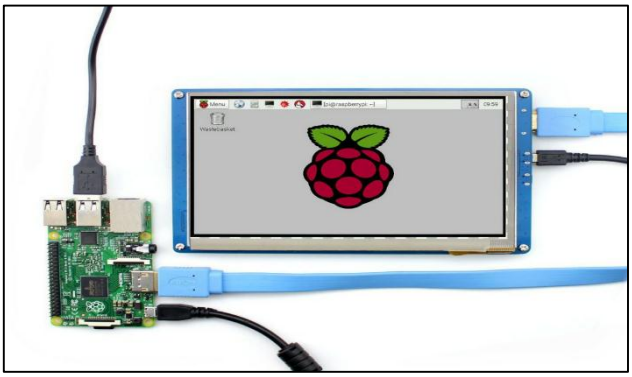

Fig. 2: HDMI LCD Display Screen

B. Raspberry PI

The Raspberry Pi is a Broadcom BCM2835 SOC (system on chip board). It is a smaller than normal PC and it is utilized to run various projects. It comes furnished with a 700 MHz, 512 MB of SDRAM and ARM1176JZF-S center CPU. The raspberry pi USB port 2.0 hogs utilizes just outer information availability choices. The Ethernet in the raspberry pi is the fundamental portal to interconnect with different gadgets and the web in model B. It draws control from miniaturized scale USB connector, with a base scope of 2.5 watts. It contains designs and concentrated chip tp accelerate the control of picture figurings. This is in worked with Broadcom video center IV link that is helpful on the off chance that you need to run a game and video through your raspberry pi.

Fig. 3: Raspberry pi2 model B

C. HD Night Vision Camera

It is a plug and play setup which is easy to apply. You can easily make video calls on major IMs. This Intex picture motions in 16 mega pixels interpolated digital clarity, making it apt for both personal as well as professional use. It offers high resolution clear picture, which is suitable for video conference.

Fig. 4: HD night vision camera

1) Features:

- Resolution of image: 16.0 mega pixels (4608x3456) interpolated
- Frame rate: Up to 30 fps
- Image control: Brightness, contrast, saturation, gamma, white balance
- Image flip: Horizontal, vertical
- Monitor type: CRT, LCD
- Image format: RGB 24, I420
- Power consumption: 160mW typical
- Operating system: Windows 98/2000/ ME/ XP/ Vista/ WIN 7

D. Raspbian

Raspbian is a Debian-based computer operating system for Raspberry Pi. There are several versions of Raspbian including Raspbian Stretch and Raspbian Jessie. Since 2015 it has been officially provided by the Raspberry Pi

Foundation as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012.The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low-performance ARM CPUs.

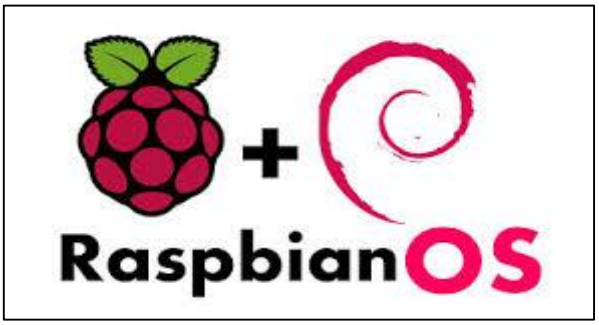

Fig. 5: Raspbian OS logo

E. Open CV

OpenCV abbreviated as open source computer version is a library with functions that mainly aim real-time computer vision. With OpenCV one can perform face detection using pre-trained deep learning face detection model which is shipped with the library OpenCV is written in C++ and its primary interface is in C++, but it still retains a less comprehensive though extensive older C interface.

OpenCV application areas include:

- 2D and 3D feature toolkits
- Estimation of Egomotion
- Facial recognition system
- Gesture based recognition system
- Human computer interaction (HCI)
- Mobile robotics
- Motion understanding
- Object identification
- Segmentation and recognition
- Stereopsis stereo vision: depth perception from 2 cameras
- Structure from motion (SFM)
- Motion tracking
- Augmented reality

IV. METHODOLOGY

The methodology used in our system is simple and effective. Use of various library packages has been the main part. As the video from the camera starts, leading to the capturing of live images. The facial recognition starts with facial landmarking. This is basically done with the help of NumPy library and Dlib library. NumPy is a package in python used in faster complex mathematical computing and Dlib is a special kit containing machine learning algorithms. With the help of the these libraries we are able to localize and represent salient features of the face such as eyes, eyebrows, nose, mouth and jawline. These are basically marked with 68 x-y points and then finally region of interest is taken.

No.of blinks	Output
1	Fan On
2	Light On
3	Fan Off
4	Light Off

No.of blinks	Output
1	Water
2	Food
3	Medicine
4	Alert

The formula for the EAR (Eye Aspect Ratio) is given below:

EAR = [(p2-p6) + (p3-p5)] / [2*(p1-p4)]

Therefore, whenever eye is closed the points p2 & p6 coincides and points p3 & p5 coincides and making the numerator zero. So the eye aspect ratio becomes zero which means eye closed. If the above mentioned points i.e. p2 with p6 and p3 with p5 does not coincides, it makes the numerator a non-zero value so that means the eye is opened. Accordingly, the winking of eye is further detected and sequences are generated. So total of 8 sequences in total can be generated but we have targeted of only 4 sequence generation with the following speech output giving the basic demands. Table 1 shown below shows the sequences and its output.

The system comprises of 3 phases:

A. Capturing

- The image of the driver is captured using HD night vision camera, which is known for its clarity and cost effective.
- This camera creates a video clip and concentrates on single frame containing paralyzed patient eye blink.
- The captured video is then divided into frames for analaysing.

B. Detection

- This phase first involves the detection of face of the patient.
- Face detection is done using facial landmark which results in locating the face in a frame.
- Only facial related structures or features are detected and all other types of objects like buildings, trees, bodies are ignored.
- In our method eye is the decision parameter for finding the state of the patient.
- Eye Aspect Ratio(EAR) is the ratio of number of eye blinks to the width of the eye.

C. Correction

- The actual state of the eye is found, if it is closed or open or semi closed or semi open.
- The identification of eye status is most important requirement.
- If the systems detects that the eyes are open then it is repeated again and again until closed eyes are found.

V. RESULTS

The proposed project aims to bring out a solution for the paralyzed people without any harm to their body externally or internally. It overweighs the previously developed prototypes in this field because none of the components are in direct contact with the patient's body hence it definitely will prove to be safer. Use of Raspberry pi is simple and also

developing tremendously in the market today. The tool had advantages over the older conventional tools.

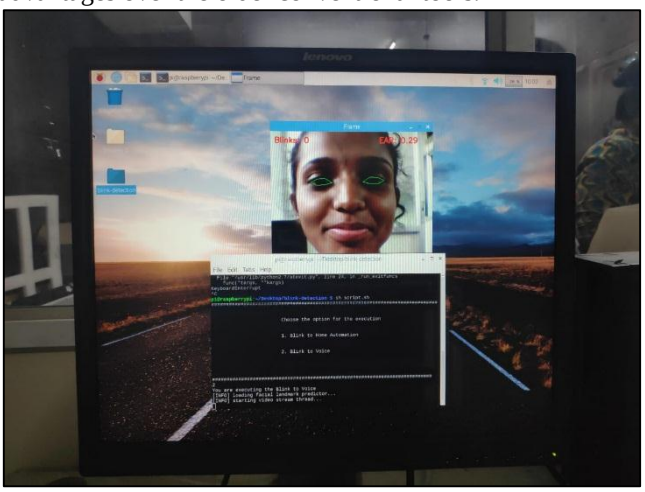

Fig. 6: Detection of eye blinks

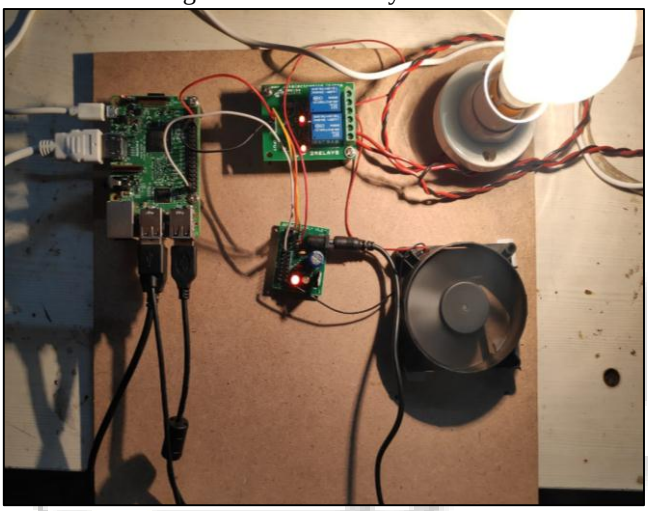

Fig. 7: Results of eye blink to home automation

- To make cost effective: The main objective of developing algorithm of a real time video Oculography system is that to provide cost effective for those people who cannot afford. The existing technique for such patients to communicate is too costly.
- Thus, it is necessary to design a system which is affordable to common people which includes cost effective components for designing.
- Electrode less system: To develop a system in which the patient can communicate without any application of electrodes. Because this electrodes need to be pierced to the skin of human body which is very painful. The use of electrodes is the technique available as of now which is cost effective but it is painful and makes the patient conscious every time and this technique is uncomfortable too.
- Fast: There are few algorithms which are developed for video Oculography system for communication. The main focus of our project is to develop an algorithm which is extremely fast compared to the existing ones.
- Accuracy: The main focus of our project is to develop an algorithm which is more accurate compared to the existing ones.

VI. FUTURE SCOPE

As far as the future of this system is concerned, the microcontroller will be interfaced with an LCD module to display the speech output as text simultaneously. In case, the caretaker misses out on listening to the speech output, he can just see it on the display and assist the patient. Further on, to avoid the clause of dependency of the patient, Blinkom can be developed into a human-machine interface where different devices can be interfaced and the microcontroller can be programmed in a way that based on the eye blinks, the corresponding operation is also performed.

For example, if the patient blinks the right eye once followed by the left eye once, along with the corresponding text display and speech output as " light on" , the light in the room is switched on. In this manner, the patient will have control over basic electronic devices around him. With feature of IoT coming into picture, we can handle the needs of the MND patients from any place. It is as simple as this that the demand signal generated can be passed on automatically through an alert signal to the caretaker and he can with aid of IoT, can do the function such switching of light-on or off / fan-on or off / TV & AC on or off etc.

VII. CONCLUSION

The proposed project aims to bring out a solution for the paralyzed people without any harm to their body externally or internally. It overweighs the previously developed prototypes in this field because none of the components are in direct contact with the patient's body hence it definitely will prove to be safer. Use of Raspberry pi is simple and also developing tremendously in the market today. The tool had advantages over the older conventional tools.

As already discussed previously, our device is very unique when compared to the conventional devices already existing in the market. There is no need of piercing any electrodes through the epidemics of the patient's skin, hence very user friendly. Also, by the use of the camera stand in our prototype, we are able to achieve flexibility by which the device can be set up at any time and at any place without much inconvenience. But, it is the family's or the care taker's responsibility to train the MND/ paralyzed patient regarding the different combination of eye blinks required for different type of outputs at the speaker.

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