Alternative Voice Communication Device using Eye Blink Detection for People with Speech Disorders

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Abstract: *Speech disorders is an inability to articulate sound due to medical ailments such as brain damage, stroke to paralysis and several other diseases. Research data suggests that about 15 million people in the world have partial or complete impairment of language expression due to brain damage, mostly from stroke. In this work a low-cost speech assistant device is proposed an alternate augmentative communication device for stroke or paralyzed patients. The eye blink sensor is used as the primary sensor for detection of eye blink. Based on the eye blink gestures the common words are displayed in the LCD and these words are also converted as voice output. This prototype will be an alternate communication aid for people with speech disorders.*

Keywords : IR sensor, eye blink, voice.

I. INTRODUCTION

Speech disorders can affect the way of a person articulating sounds to form words. Speech disorders can be due to certain medical ailments starting from brain damage, stroke to paralysis and several other diseases. It can also result from motor damage during accidents which can leave a person completely ineffectual to communicate [2]. In paralysis the ability to control muscles movement is limited even around the eye muscles and blinks are the only way for the patient to communicate. In such communication the interface is often intrusive, which require special hardware or depend on active infrared sensors. Since speech impairment is not directly detrimental to the immediate health of the patient, it is often a neglected player in the development of medical device.

The different technologies used for implementing the communication between paralyzed patient and the people attending and caring for them are mouth actuated joysticks, actuated breathe puffing straws, tongue movement analysis, switch mounted near user's head, etc. These systems are costly to implement, increase stress on the patients and need skilled labor to setup and maintain the system for proper functioning. Hardly any devices have been developed that can address this issue in a patient friendly and cost-effective manner.

This work aims to design a simple and cost-effective voice communication device for patients suffering from speech disorder using eye blink of the patient. Eye blink at regular intervals can be interpreted for forming words for communication. An efficient, real time blink detection algorithm can be used for almost any purpose like switching ON/OFF of appliances at home etc, [1].

II. METHODOLOGY

In this work a low-cost speech assistant device is proposed as an alternate augmentative communication device. The eye blink sensor is used as the primary sensor for detection of eye blink [5]. Eye blinking is one of the most common and convenient human activities that can be used as an input modality for a simple communication methodology [3,6] and eye blinking can be an indicator for certain human behaviors such as patients with Parkinson's disease have altered eye blink characteristics [4]. Based on the eye blink gestures the common words are displayed in the LCD and these words are also converted as voice output. This prototype will be an alternate communication aid for patients with speech disorders.
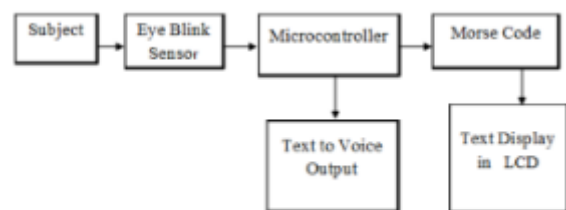
Figure 1 Block Diagram

The above block diagram describes the steps involved in the design of this augmentative device. IR led and sensor is used for detecting eye blink [1]. The voltage values during eye closed and eye open is fed to a microcontroller for analysis of the rate eye blink and the duration of eye blink [8,9]. These eye movement data are converted to the corresponding alphabet using Morse code. These are displayed in an LCD screen and the text is converted to voice through voice converter module.

A. IR Sensor Module:

IR sensor used in this work is QRD1114 which is a half LED and half phototransistor device. It can be used to sense objects in close proximity or even detect the difference between dark and light colored surfaces. The IR sensor used does not cause any harm or irritation to the eyes and has minimized or no effects on the eye tissues. The QRD1114 is a 4-pin device. Two pins break out the infrared

Retrieval Number: D5405118419/2019©BEIESP
DOI:10.35940/ijrte.D5405.118419

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LED, and the other two pins break out the collector and emitter pins of the phototransistor.

B. LCD and Audio Amplifier module:

6 x 2-character LCD display is used to display the words. LM386 is a low voltage audio amplifier. This audio amplifier is used to give voice output of the text displayed.

C. Interfacing with Microcontroller

Among the several available microcontroller modules Arduino microcontroller has been chosen for this work as it is user friendly, flexible and very economical. The IR sensor, LCD display and the audio amplifier are interfaced with the Arduino Microcontroller.
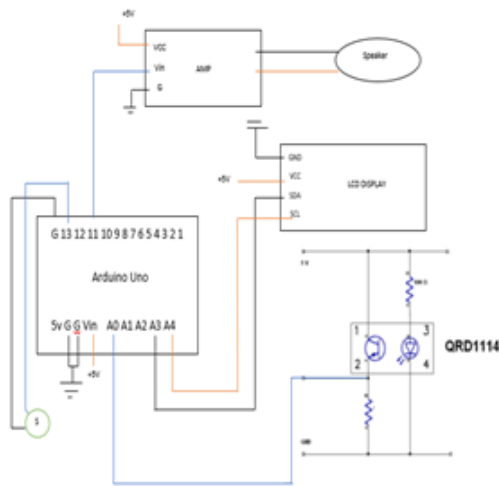
Figure 2: Circuit Diagram

D. Morse Code Interpretation

Morse code is a character encoding method used in telecommunication where the text characters are encoded as standardized sequences of two different signal durations. These signal durations are called as dots and dashes [12]. The duration of dot signal is the basic unit of time measurement and dash is thrice the duration of dot [11].
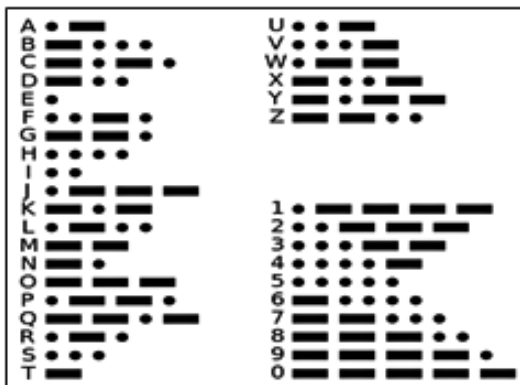
Figure 3: Morse Code

III. PROCEDURE

The IR sensor value differs for eye closed and open. This variation is marked as corresponding dot and dash of the morse code. Initially, training is given to the subject to do eye blinks at regular interval. A voltage threshold is set to differentiate the status of eye.

Since dash is three times duration of dot, each and every dot or dash within a character is followed by a gap or space equal to the duration of dot. This pattern is coded in Arduino microcontroller board to the corresponding alphabetical character or number.

IV. RESULT AND DISCUSSION

The IR Sensor senses the amount of reflected light from the eye and sends the signal to the Arduino. as the level reflection varies significantly between eye close and eye open, the voltage values are recorded to fix a threshold for eye blink. Table 1 shows the Eye open and close values.

Table I Eye open and Eye Closed IR sensor values

S.No	Eye open	Eye close
1	56	283
2	47	282
3	57	304
4	56	309
5	60	264

In this work, short blink of the person corresponds to a dot and long blink to a dash of a Morse code. The code for the alphabet I is a dot and a dot and for H is a dot and a dot and a dot and a dot. Figure 3 shows the LCD display of the word "HI".

Figure 4: LCD display of word "HI"

This pattern is fed to the audio amplifier and voice output of the words is obtained. Initially, the subject was trained with more interval of eye blink which is interpreted as Morse code by Arduino. The communication through eye blink was smooth and quick and was able to do with a lot of spontaneity as our regular communication method. Once certain familiarity has been achieved the code can work fast. While entering spontaneously it took an average duration of 5 seconds to communicate an alphabet. But this duration varies from one alphabet to another as some had more dots (short blinks) while some had more dashes (longer blinks).

V. CONCLUSION

In this work, a prototype of text to voice communication device with eye blink detection technique for person with speech disorders is designed. The variation of IR sensor value during eye blink is taken as threshold and the interval of variation is used as Morse code that is universally accepted code of communication. After every eye blink the microcontroller detects the change in the interval and stores as corresponding Morse code. This is detected as particular alphabet and it is displayed onto the LCD screen. This alphabet or command is converted to the voice output.

Retrieval Number: D5405118419/2019©BEIESP
DOI:10.35940/ijrte.D5405.118419

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