BRAIN COMPUTER INTERFACE FOR EMERGENCY TEXT AND SPEECH CARE SYSTEM

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ABSTRACT

Brain computer interface (BCI) is one among the thriving emergent technology which acts as an interface between a brain and an external device. BCI for speech is acquiring recognition in various fields. Speech is one among the foremost natural ways to precise thoughts and feelings by articulate vocal sounds. Text is one of the way to keep caregivers an information about emergency needs of patients[21]. The purpose of this study is to restore communication ability through speech, text and display of the people suffering from severe muscular disorders like amyotrophic lateral sclerosis (ALS)[14], stroke which causes paralysis, locked-in syndrome, tetraplegia, Myasthenia gravis. They cannot interact with their environment albeit their intellectual capabilities are intact .Although few recent studies attempt to provide speech based BCI and text based BCI separately. Our work attempts to combine techniques for acquiring signals from brain through brainsense device(EEG signals) to provide speech and text to patients suffering from neurodegenerative diseases through python, Arduino code and some hardware components[1]. Experimental results manifest that the proposed system has an ability to impart a voice emergency command from the computer or laptop, send a text message regarding the emergency command to closed ones and also display the command on LCD screen. Ultimately, Brain computer interface for emergency virtual voice can be an efficient method for restoring communication pathway for paralyzed patients.

Keyword : *BCI for virtual voice , EEG signals ,BCI working ,Emergency Commands ,LCD display, Arduino uno*

1. INTRODUCTION

Brain computer interface (BCI) is that the piece of hardware that permits humans to regulate or communicate with technology using the electrical signals generated within the brain. A speech BCI would make it possible to talk in real time through neural correlations of attempted or imagined speech[6] which may potentially restore communication and improve the quality of lifetime of enclosed patients and other patients with serious communication disorders.

Formerly, research on BCI started at University of California in 1970. The mid 1990's cause the invention of first neuroprosthetic devices for humans which may augment nerves that aren't working. The year 1998 marked an interesting development in brain mapping field where the primary brain computer interface object was implanted into a person's being[18]. In December 2004, Jonathan Wolpaw and researchers at ny State Department Of Health's Wadsworth Center proposed a search report that signifies the potential of BCI to regulate the pc . during this study, electroencephalography [EEG] signals from motor area (region of the cerebral mantle involved in planning and controlling movements) of subjects were captured by wearing a cap that contain electrodes[21]. Features were extracted from that signals, and converted into the outputs that replace, restore, enhance, supplement, or improve human functions which is communication in this paper[11]. The varied neural signals recorded noninvasively by BCI researchers during the trials that involve electroencephalography [EEG][8], functional resonance imaging [fMRI], near- infrared spectroscopy[NIRS], magnetoencephalography[MEG], or invasively (e.g., electrocorticography).In Human brain, their will be billions of neurons which are interconnected. It generates

electrical charges during its working. These charges sum up together to get an electrical field having varying potentials of the order of micro- volts. The electrical activity of the brain are often recorded from the scalp. These recordings are referred to as Electroencephalogram (EEG). In EEG techniques electrode caps are placed on the subject's scalp to urge signals which hold direct or indirect potential of scalp and thus the actions. The classification of EEG signals is completed within the following bands: α, β, δ, θ, and γ [19]. Controlling various devices with the assistance of brain may be a wide field of research within the present scenario. so as to interact with computers or other devices using brainwaves we require an interface between brain and computer which is mentioned as Brain-Computer Interface (BCI)[13]. The BCIs allow people to speak with the devices through their thoughts instead of the systema nervosum . There are numerous applications of BCI like brain controlled robotic arm, brain controlled keyboard, brain controlled wheelchair, eye blink control etc. of those numerous applications, we'll be that specialize in brain computer interface for virtual voice output which provides a communication ability to disabled. [2] Brain-Computer Interfaces provides control and communication channels that aren't dependable on normal output channels of nerves and muscles. BCI uses EEG activity from the scalp or activity of neuron[7]. An attempt has been made to propose an idea controlled virtual voice, which uses the captured signals from the brain and eyes and processes it to supply voice output. Electroencephalography (EEG) headset is that the one which is placed on the uses scalp for the acquisition of the EEG signals which are captured and translated into voice commands by the arduino microcontroller which successively produces a voice output.

1.1 Types of BCI

• *Active BCI (BMI):* BCI derives its output from brain activity that's controlled directly by the user, independently of external events, to manage the applying.
• *Reactive BCI:* BCI derives its outputs from brain activity resulting from external stimulation, which is indirectly modulated by users to manage the applying[21].
• *Passive or Affective BCI (BMI):* BCI that obtains its outcome from spontaneous cognitive function with no intention of voluntarism.

1.2 Application of BCI

The scope of BCI is vast. Initially most BCI's were developed for medical applications which ranges from detection and prevention to neurorehabilitation that compensates any functional alteration [3].Later on it started spreading its wings on various fields like education, self-regulation, production, marketing, security also as games and entertainment which focuses on neurorehabilitation after neurological diseases or injuries, Entertainment and gaming, lie detection, sleep-stage or mood monitoring, brain fingerprinting, trust assessment, monitoring pilots, air traffic controllers and so on as shown in figure . In the last several decades, to supply an alternate communication tool for those with severe neuromuscular disorders (e.g., amyotrophic lateral sclerosis, medulla spinalis injury, and brainstem stroke) an excellent number of BCI systems have been developed. Research on BCI continues to open new doors!

1.3 BCI operation

Brain Computer Interface (BCI) is often used to resolve plenty of the impairments of disabled people[16] .BCI will provide access option for individuals with serious speech as well as physic al impairments which helps to avoid the utilization of other interfaces. When used for communication, BCI systems can be described a creative augmentative and alternative communication (AAC) device[5]. BCI can be applied to a variety of tasks, not all of which are limited to neurofeedback, restoring motor function to paralyzed patients, allowing patients to communicate with locked patients and enhancing sensory processing. It works in three main steps: At first gathering brain signals, and afterwards analysing those signals and as per the obtained EEG [15] signals instructions are delivered to the connected machine.
BCI imparts data exchange between brain and computer, to control a BCI four main steps has to be followed and later the brain signals are decoded accordingly as shown in below figure.
• Signal acquisition
• Preprocessing
• Feature extraction
• Feature classification
• Feedback to user
• Device output
Brain Signal: At this step, we receive the raw brain signals through neurosky mindwave and start decoding process of the extracted desired signals[9].

a) Pre-processing: Internal and external noise must be eliminated from the signals and at this stage it is best to do so using a time filter. This step has a huge impact on overall performance improvement.
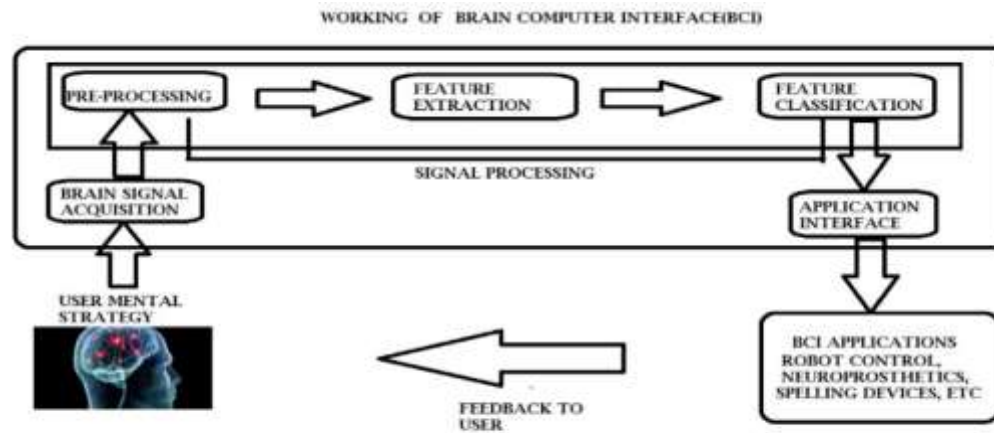

Fig 1 : Steps Involved In BCI

b) Feature extraction and selection: In feature extraction, Some selected features are extracted after eliminating noises from the brain signals. Performance can be adequately improved by using the extracted features. There are several approaches proposed which are CSP[12], discrete wavelet transform, power spectrum and AAR for feature extraction process. In this step, It is usually better to apply a few techniques due to the fact some features dimensions in EEG data are very excessive which reduces efficiency.

c) Feature classification and post-processing: In this step, brain signal classification process takes place where the classifier will be trained with some features of brain signals and decide on a new motor imagery[4].

d) Virtual voice output: This is the last step where the virtual voice of the words (memorised by the patient) will be produced as virtual voice output from computer through the speakers.[10]

2. PROPOSED WORK

The key motivation behind this project is to aim for people who are suffering from neurological disorders like amyotrophic lateral sclerosis (ALS)[14], stroke which causes paralysis, locked-in syndrome, tetraplegia, Myasthenia gravis that left them with an extremity and people with any impairment in motor or sensory function of the extremities.

In recent years, it can be observed that there is a growing of interest in Brain-Computer Interfaces (BCI) system for medical and multimedia applications. BCI device provides direct interface between human brain and computer. The users just need to think of imagined speech in order to get the voice output from the system. For this project an EEG signals generated from single electrode neurosky mindwave that placed on the forehead will be used as a controller to initiate user-intention command. Attention levels are detected from the EEG signal.

The specific objectives are:

1. To design a Brain Computer Interface based voice output for physically impaired people.
2. To acquire and process the EEG signal from non-invasive BCI (Neurosky Mind wave, EEG headset) device using Arduino Software.
3. To analyze the EEG signal in term of attention level by using their peak and average value.

3. HARDWARE DESCRIPTION

Hardware requirements for the proposed system are Brainsense, HC-05 Bluetooth Module, Arduino uno, Liquid crystal display (LCD) and Computer
system for voice output.

1. *Arduino Uno :* The Arduino may be a small, complete, and breadboard-friendly board supported the

ATmega328 . It works with a Mini-B USB cable instead of a typical one.

2.*Brainsense:* A sleek, single-channel, wireless headset that monitors your brain activity and translates EEG into meaningful data one can understand. We can measure your Focus,Meditation Level,Play games based on the science of neurofeedback to learn how to focus, relax, and meditate better[17].This EEG Headset has to be placed on the patient's head. This non-invasive BCI system shown in fig 2 here reads and collects brain waves using electrodes placed on the forehead of the patient exactly at the FP1 location of the 10-20 electrode system.

Fig 2 : Brainsense

3. HC-05 Bluetooth Module : HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. It as two work modes which are order - response work mode and automatic connection work mode, and three work roles which are Master, Slave and Loopback at the automatic connection work mode. When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically.

4. *LCD display:* LCD screens are an array of small segments called pixels, which might be manipulated for information displaying. Such displays have several layers, where two panels, fabricated from glass material freed from sodium and called substrate, play a vital role. The substrate contains a skinny layer of liquid crystals between them. The panels have flutes that direct the crystals, giving them a particular orientation.

4.   BCI FOR VIRTUAL VOICE WOKING

Components used are LCD, Arduino uno, HC-05 Bluetooth. The data of alpha wave obtained from Neurosky headset is sent to the Bluetooth module interfaced with the computer which is shown in the figure 3. In this work, HC-05 Bluetooth module has been used for receiving data, for processing data and sending command for voice output, Arduino Uno development board has been used to read continuous alpha values and to get attention average values. The attention average values are simultaneously displayed on the LCD screen and sent to the system where for each corresponding   command   virtual voice output is obtained.
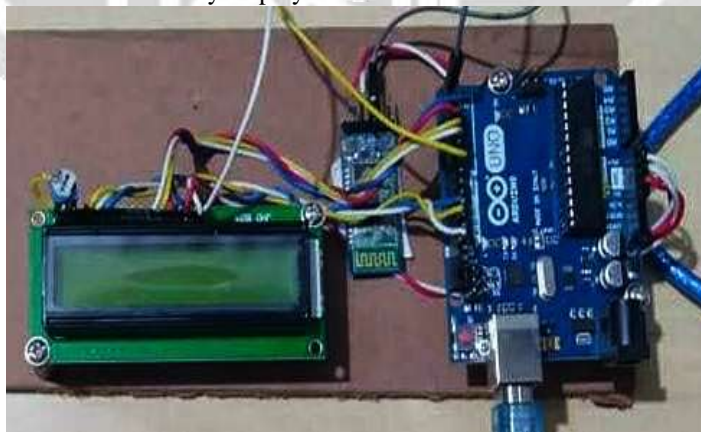

Fig 3 : Hardware connection

The patient initially has to switch on the sensor to start the process and check if the signal quality is good or poor. If the signal quality is good, then the data from the patient's brain is acquired and converted to signals using the

Brainsense Later the attention values are observed and average is calculated so that LCD code works to show the display on LCD and python code works to provide the voice output and send SMS to closed one's mobile as well.

When the patient thinks some emergency commands such as water , lunch or restroom, aurdino takes up the data and averages it so that it could provide the voice output along with SMS. If the attention Level is >=20 then the voice output and SMS sent would be RESTROOM, else if attention level is >=40 then the voice output and SMS sent would be LUNCH , else if attention level is >=60 then the voice output and SMS sent would be WATER.

The flowchart of operation for BCI for emergency virtual voice is shown in figure 4.
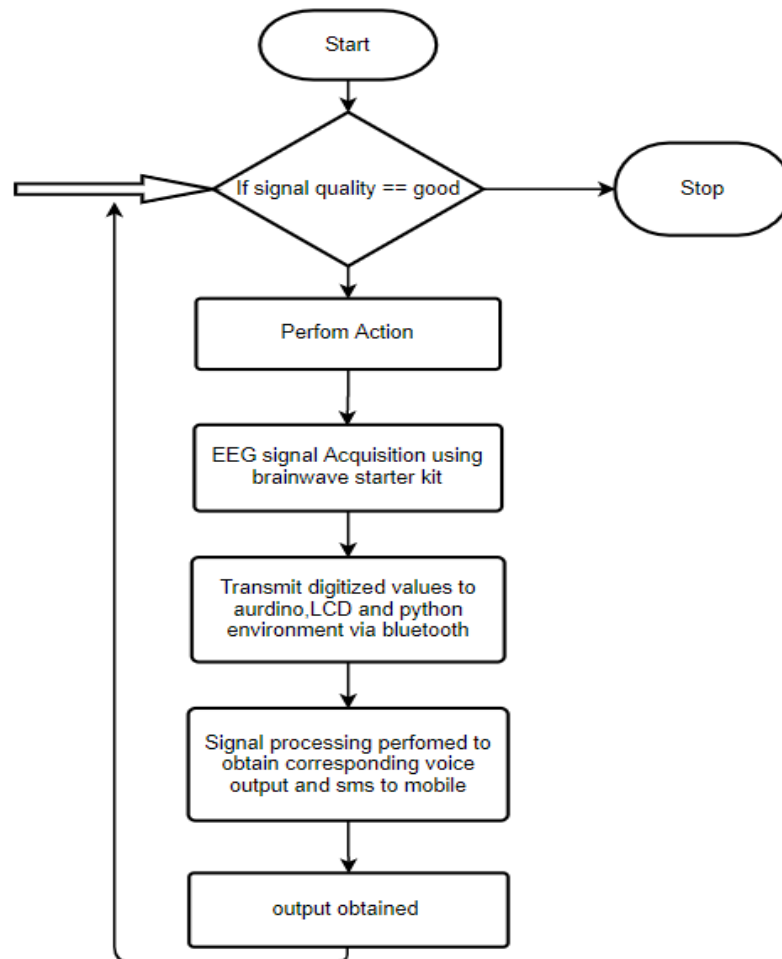

Fig 4: Flowchart of operation

4.1 Sending sms to closed ones :

We used twilio for this purpose. Millions of developers round the world have used Twilio to unlock the magic of communications to enhance any human experience. Twilio has democratized communications channels like voice, text, chat, video, and electronic mail through virtualizing the world's communications infrastructure via APIs which can be easy sufficient for any developer to use, but strong enough to strength the world's maximum demanding applications. Twilio can be a developer platform for communications: the Twilio Customer Engagement Platform. Twilio's programmable application interfaces (APIs) are a set of constructing blocks builders can use to create the right consumer reports they need. The Twilio Customer Engagement Platform may be used to construct nearly any virtual experience, the usage of abilities like SMS, WhatsApp, Voice, Video, electronic mail, or even IoT, throughout the consumer journey.

As an addition to virtual voice output corresponding messages are also sent to closed ones or care taker mobile phone., if incase no one is near patient while virtual voice output is produced. When the patient thinks some emergency commands such as water , lunch or restroom, aurdino takes up the data and averages it so that it could

provide the voice output along with SMS. The SMS sent to closed one is shown in figure 5, where we can see the water required , should use washroom and I am hungry give me food msessages sent by twilio whenever the patient think about any emergency commands of his/her choice to interact with outside environment.
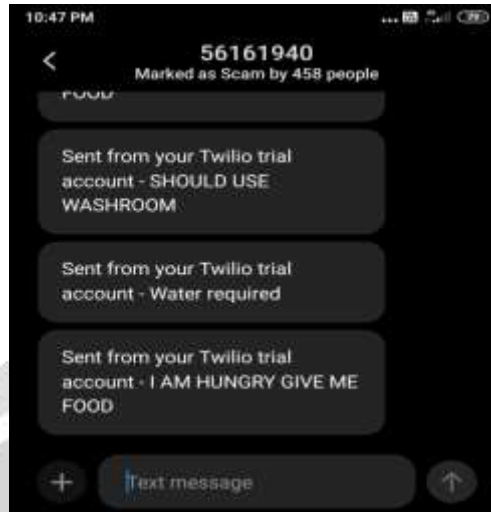

Fig 5 : sms from Twilio

5. SYSTEM IMPLEMENTATION AND EXPERIMENTAL RESULT

In proposed system user can think of any emergency commands such as LUNCH, WASHROOM and WATER where corresponding output is obtained as a virtual voice through system. The figure 6 shown below is the LCD displaying the attention level 0 when mindwave is not connected .

Fig 6: zero level attention

In this experiment subject were asked to do mental repetition of the emergency commands such as RESTROOM, LUNCH and FOOD , so the LCD display shows output of respective command with attention level on it. During the generation of display simultaneous voice output through the system is heard and also an SMS to closed one's is sent. The attention level data for different fuzzy spots were recorded at the Arduino Uno com port.
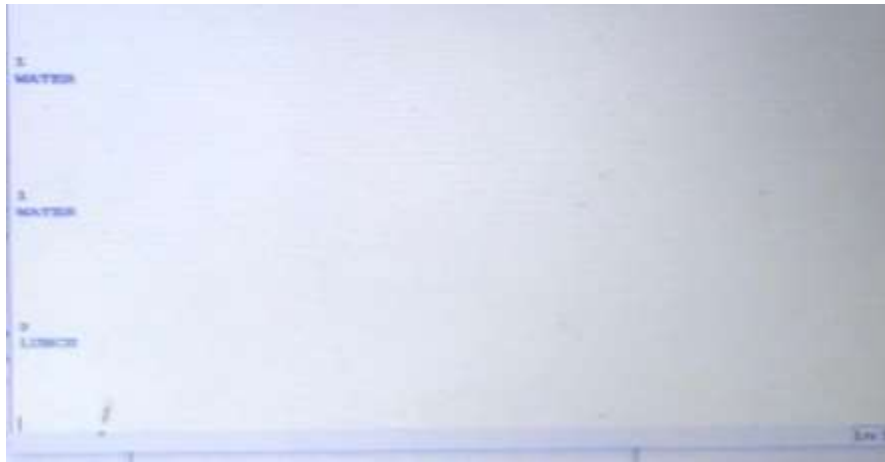
Fig 7: Emergency Commands on screen.

The emergency command **RESTROOM** is displayed on the LCD screen whenever the subject recite this command in mind which is shown in the figure 8.
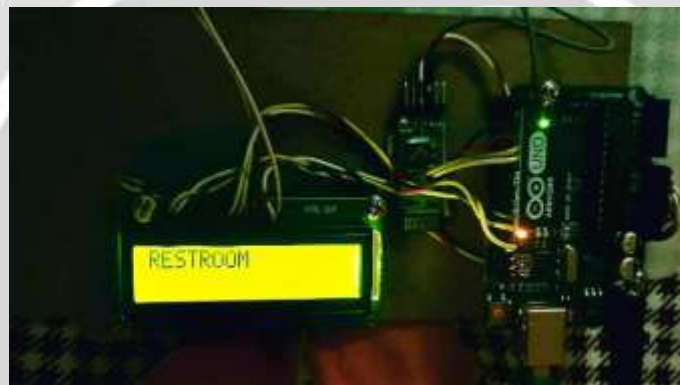

Fig 8 : RESTROOM command is displayed on LCD

The emergency command **LUNCH** is displayed on the LCD screen whenever the subject recite this command in mind which is shown in the figure 9.

Fig 9: LUNCH command is displayed on LCD

6.   CONCLUSION

Cultures may also have various ethics, however regardless, person liberties and human existence are constantly

valued over and above machines. What happens when human beings merge with machines?

From the Proposed system , Brain Computer Interface was used which enables paralyzed with a high level impairment (the amount of function is substantial and the number of voluntary muscle control is markedly limited) to get a chance of conveying their basic needs as and when required through brain signals. It provides direct data exchange between brain and computer. The development of BCI renders this technology feasible for patients suffering from neurological impairments causing to face many challenges in sensorimotor functions and communication with the environment. Using this proposed system the signals were sent from the headset to the arduino in order to get voice based output and SMS to mobile phones based on the inputs from the brain. With the Implementation of above hardware and software architecture a voice output with SMS sending application can be achieved successfully. Although this system is very raw it is an another step towards brain-controlled movement. The generation of voice output be solely configured to the signals generated by the mind. User based or precise modules can be created as a result producing a completely unique footprint. It makes use of upcoming and ever evolving technology so as to permit smooth and viable iterations. The components used are very low price but have an finest overall performance level.

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