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Emerging work on Smart Speaking System for Dumb People using BCI

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Abstract: Persons be acquainted with each other by assigning their ideas, opinion, and experiences to the community around them. There are abundant ways to attain this, and the best one among all is the gift of speech or verbal communication. Through address, everyone can very persuasively transfer their beliefs and appreciate each other. According to the All Indian Deaf and Dumb Society (AIDDS), there is one in every thousand people born dumb. There are many reasons for dumbness. By many years of investigations, a large number of methods and software solved the speech recognition problem, were developed. Still, there is no proper sensor interface available for creating a mobile interface and achieving accurate and safe BCI. Our study is to focus on the problem of dumbness due to paralysis, tongue cancer, Broca's problem, accident, and many more. This critical problem can be solved by using the Brain-Computer Interface (BCI). This paper aims to capture the signal from our brain using EEG. EEG is a noninvasive method to record the electrical activity of the brain along the scalp. Features are extracted from the pre-processed signals and classify them into their alpha, beta, delta, gamma signals classes. The Wernicke's area patterns of activity representing what is to be said and then sent through the arcuate fasciculus to Broca's area, which contains the programs for intricate patterns of muscle movement needed in speech. The vocal area programs are then relayed to the motor cortex controlling the lips, tongue, and vocal cord, which produce the speech sound. If the person has a problem in vocal area, they may not speak out, so we have the plan to get voice from where they are thinking (Wernicke's area, Broca's area) using EEG (Electroencephalography) and convert movements or signal into speech and get them into the receiver ie, .smart phones/tab.

Keywords: BCI, Broca's area, Electroencephalography, Wernicke's area

I. INTRODUCTION

The most incapacitating feature of deep paralysis due to accident, stroke, or sickness is loss of the capability to speak. The speech loss is not only makes the communication of needs to caregivers very complicated, but it also leads to deep social isolation of the affected individual. Even though there is Real-Time Speech Synthesis, decodable brain waves, and BCI support, artificial speech generation is still a questionable phenomenon [4]. Several issues are found in the Existing augmentative communication systems. The first issue is that the system is invasive, so it needs surgery, and there is a risk of the formation of scar tissue; it may severely damage the brain in the future. The another issue is a lack of mobility, and the third one is a sophisticated design and the training time for users to develop competence. To improve and optimize the design period for any task, it is essential to build the best interface for technology with the surroundings and the technology which can be used to realize the onsite problems and give solutions instantly. The vision of our project is to develop an artificial Broca's Area[1], which means an artificial speech generation area. Similar to Real-Time Speech Synthesis in which the subject will be able to carry the device anywhere, and the application will be in a smartphone. It is a simple design and easy to train the user. A brain-computer interface (BCI) [5], sometimes called a mind-machine interface (MMI), direct neural interface (DNI), synthetic telepathy interface (STI), or brain-machine interface, is a direct communication alleyway between the brain and an peripheral devices. BCIs are frequently directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions [15]. Brain-Computer Interface (BCI) accepts voluntary commands directly from the human brain without requiring substantial movement and can be used to activate a computer or other technologies.

EEGs or Electroencephalograms are not brain scans in the sense of an imaging technique. EEGs were, nevertheless, one of the first ways of non-invasively observing human brain activity [16], and remain in use today. An EEG device accounts electrical signals from the brain, specifically postsynaptic potentials of neurons, through electrodes attached either to the subject's scalp, subdurally (i.e., beneath the dura matter; the outermost, most robust and most fibrous of three membranes covering and protecting the brain and the spinal cord), or even on the cortex itself (these latter two cases are relatively rare). Like ECGs (electrocardiography), EEGs are based upon the theory of volume conduction of ionic current through non-empty extracellular space. The recording is obtained by placing microelectrodes on the scalp, typically after some abrasion, and with a conductive colloid to create a better get in touch with. The measured EEG activity is the combination of all the synchronous progression of all the neurons in the area underneath the electrode that have the similar estimated vertical orientation to the scalp. EEG Machines Detect The EEG detects the summed ionic currents of thousands of pyramidal neurons beneath each of the 16 and 25 individual macro electrodes and reports them as voltage differences across low resistance extracellular space.

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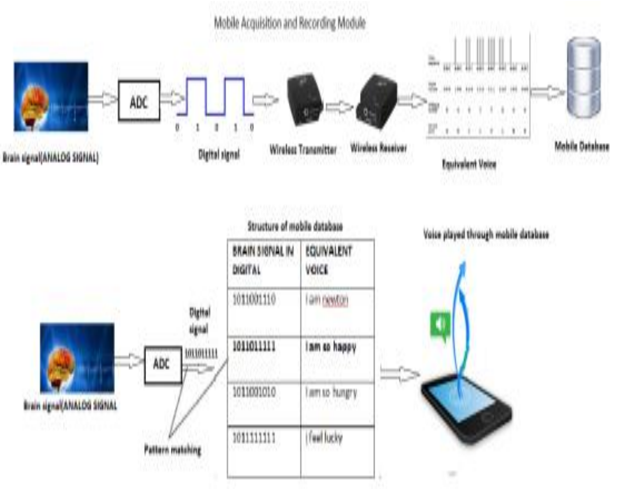
Specifically, the potentials recorded by the macro electrodes on the skin of the skull [3] are primarily generated by the extracellular current flow of synaptic potentials in pyramidal cells. Action potentials of the neurons are usually asynchronous and too fast-moving to generate detectable possibilities on the skin's surface. Brain cells other than pyramidal neurons such as interneuron and glial cells make relatively little contribution to skin potentials because, unlike pyramidal neurons, these cells are neither oriented in parallel to one another nor do their dendrites run perpendicular to the cortical surface. In contrast, pyramidal neurons run parallel to one another with large dendritic branches that run perpendicular to the cortical surface. EEG Machines Work The macro electrodes attached to a subject's scalp send out electrical signals to the EEG machine, which acts as in cooperation of an amplifier and as a galvanometer. The signals communicate to the EEG are typically amplified 10,000 times. Galvanometers are devices that detect and calculate small electric currents employing a copper hoop or coil of wire that redirect a needle in proportion to the current flowing all the way through the loop.

The galvanometers are, in revolve, captivated up to pens, which sketch the electrical signals on graph paper moving constantly underneath them. EEGs [2] allow researchers to record electrical impulses traveling across the surface of the brain and examine changes to those impulses. EEG recording has two useful features. First, they make a continuous recording with split-second accuracy. Second, EEGs can point out the general conscious status of a person, e.g., asleep, anesthetized, awake since each state is interrelated with particular EEG patterns. Thus, EEG recordings have been used to measure the time it takes the brain to process various stimuli. EEGs are also used to assess brain damage, coma, mental retardation, encephalitis, cognitive impairment, brain tumors, and epilepsy. EEGs are also used in sleep research. Nevertheless, the usefulness of EEGs is limited in that they do not reveal brain structures or anatomy, nor can they indicate the functioning of specific brain structures.

II. PROPOSED WORK

Our proposed work combines the features of BCI, mobile, and wireless acquisition to create artificial Broca's. The technique has two modules, namely, The Brain signals acquisition and recording module and the conversion of the signal to speech module. In the recording module, we make the dumb person to wear the 16 channel wireless EEG sensor machine on his head and cause him to think the specific statement, for example, "I am hungry." The sensor collects the signals generated from the brain, and the signal is recorded in the mobile phone. It has maintained a trained joint statement. When the dumb think the same account in the future, the brain generates the messages, and the EEG will collect these signals and transfer it to the mobile application. Our application pattern matches these signals present in the mobile database using a suitable mining process, and then the voice will be played in the respective smartphone. This will be the conversion module.3.1.MethodologyArtificial Broca's consists of two modules, The Brain signal acquisition and the recoding module and the conversion of the signal to voice module. A Schematic of the proposed model is provided in figure 2:1. The objective of this work is to develop a prototype of artificial speech production.



Convertion of signal to voice module

Fig. 2:1. Schematic of artifical Broca's proposed structure

The proposed system is designed to help users (Dumb people) to communicate with their environment. As discussed above, the proposed system consists of two modules. Both modules need a wireless 16-channel Electroencephalography (EEG) sensor with the receiver connected to a smartphone. This system is a non-invasive BCI [13]; anyone can use this, and the user could easily use it anywhere. Figure 2:2 is the Wireless Electroencephalography (EEG) Headset used to track the signal from the user in this proposed model. This type of EEG can be connected with any smart phones.

Fig. 2:2. The Brain Signal Acquisition and Recording

The electrical nature of the human nervous structure has been renowned for more than a century. It is well acknowledged that the disparity of the impending surface allocation on the scalp reflects practical activities rising from the primary brain. This surface potential variation can be recorded by attaching an array of electrodes to the scalp, and determining the voltage between pairs of these electrodes, which are then filtered, amplified, and documented. The ensuing data is known as EEG. Various techniques are now available to monitor brain function, e.g., electroencephalography (EEG), Magnetoencephalography, functional magnetic resonance imaging, and positron emission tomography. The latter three techniques are technically demanding and expensive. At present, EEG is the optimal choice for BCI Implementation. The first module is the signal acquisition and recording the signal to the mobile database. At the beginning of the proposed experiment, the user had to wear the 16-channel wireless electroencephalography (EEG).

This electroencephalography (EEG) is placed in the user's head, and the electrode is mainly concentrated on the left ventral premotor cortex(cerebella cortex). The Fig 2:3 is the Block Diagram of Acquisition and Recording of Signal. This module has two main processes. The first process is the acquisition of a brain signal, and the second process is recording the message to the database with an equivalent voice. The first process is an iteration process because to get the correct solution

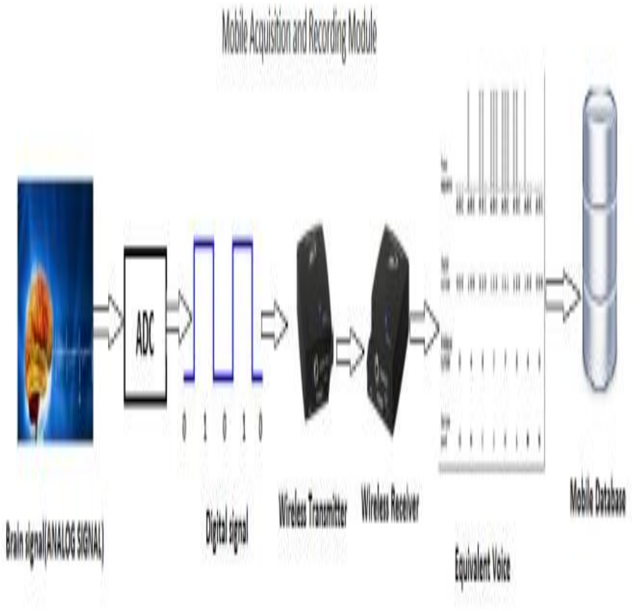


Fig. 2:3. Block diagram of acquision and recording of signal

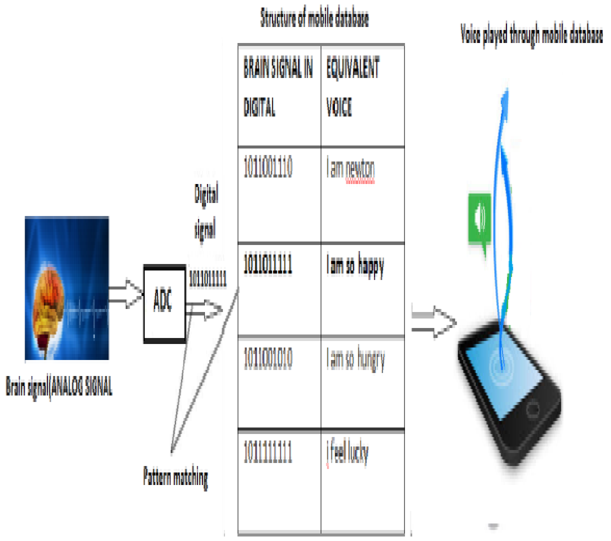
A. Signal Acquisition

The user is trained to concentrate and think the specific statement, for example, “I am hungry.” When he considers these statements, brain signals are generated, these signals are in Analog form, which is further converted to binary form by the wireless EEG sensor, and the binary message is sent to the smartphone by a transmitter in EEG.
Recording the Signal:
The user repeats the above procedure in different situations of user mood, such as happy, sad, walking, seating, etc. This iteration gives the Best solution, and the final result is stored in the mobile database along with the equivalent human voice. Likewise frequently used statement of an average human is made as a database for the user’s daily use.

B. The Conversion of Signal to Voice Module

This is the second module the Fig 2:5 shows the Block Diagram of Signal to Voice Conversion Module. In this module, user thoughts are converted into voice, and they can express themselves to their environment. When the user thinks the same statement in the future, the brain signals are generated, these signals are in Analog form, which is further converted to binary form by the wireless EEG sensor, and the binary message is sent to the smartphone by the transmitter in EEG.

Signal Acquisition

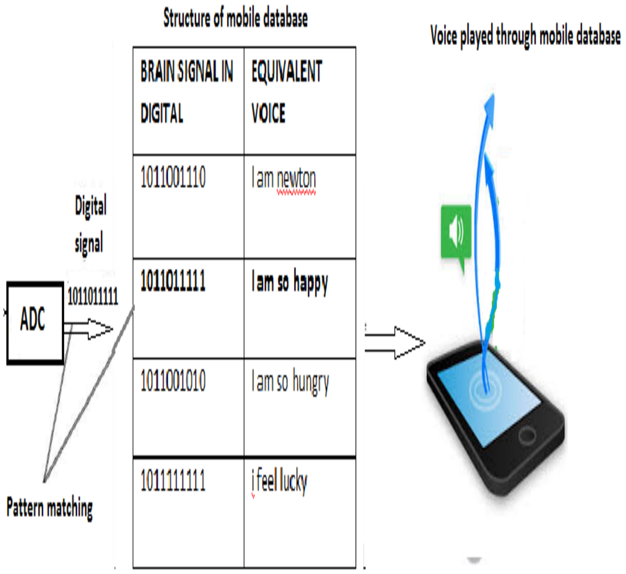


BRAIN SIGNAL IN DIGITAL	EQUIVALENT VOICE
1011001110	I am newton
1011011111	I am so happy
1011001010	I am so hungry
1011111111	i feel lucky

Fig. 2:5. Block diagram of voice conversion module

C. Pattern Matching

When the binary signal enters the mobile database, it pattern matches all the combination of a recorded statement in the database. If the correct message is matched, then the equivalent voice is played by the mobile speaker. Likewise, the users can communicate with their environment and satisfies their basic needs. Figure 2.7 describes the actual structure of our proposed database model and pattern matching process.



BRAIN SIGNAL IN DIGITAL	EQUIVALENT VOICE
1011001110	I am newton
1011011111	I am so happy
1011001010	I am so hungry
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Fig 2:7. Propsed structure of pattern match

III. RESULT AND DISCUSSION

The Wireless Brain-Machine Interface for Real-Time Speech Synthesis has several issues. The first issue is that the system is invasive, so it needs surgery, and there is a risk of the formation of scar tissue; it may severely damage the brain in the future.

The second problem is a lack of mobility, and the third one is a sophisticated design and the training time for users to develop competence.

To improve and optimize the design period for any task, it is essential to build the best interface for technology with the surroundings and the technology which can be used to realize the onsite problems and give solutions instantly. But the proposed model uses a non-invasive technique in which the signal is acquired from the brain using Electroencephalography(EEG) sensors; it is safe for the users. The proposed model is a mobile application user can carry anywhere and interact with their environment. This model can also help caregivers of users to some extent. By using Steady-State Visually Evoked Potential (SSVEP)[8], the user can identify a person's name by seeing the photo of the person on the mobile, and the final thing is that the model is simple and the training the user is also easy.

IV. CONCLUSION

The proposed system proves that it will give the best solution for the dumb and paralyzed person. On comparing with the existing system like Wireless Brain-Machine Interface for Real-Time Speech Synthesis, it is the more effective and reliable platform that can be used anywhere. By using this system, paralyzed patients can ask for necessities like water and food. The method introduced in this paper can help them to achieve an acceptable level of communication.

REFERENCES

1. Claudio Cantalupo & William D. Hopkins (29 November 2001). "Nature Asymmetric Broca's area in great apes". Nature 414 (505): 505. Doi: 10.1038/35107134. http://www.nature.com/nature/journal/v414/n6863/abs/414505a.html.
2. N. F. Dronkers, O. Plaisant, M. T. Iba-Zizen, and E. A. Cabanis (2007). "Paul Broca's Historic Cases: High Resolution MR Imaging of the Brains of Leborgne and Lelong". Brain 130 (Pt 5): 1432–1441. doi:10.1093/brain/awm042. PMID 17405763.
3. Kennedy PR (1989) the cone electrode: A long-term electrode that records from neurites grown onto its recording surface. J Neurosci Meth 29: 181–193.
4. Bartels J, Andreasen D, Ehirim P, Mao H, Siebert S, et al. (2008) Neurotrophic electrode: Method of assembly and implantation into human motor speech cortex. J Neurosis Meth 174: 168–176.
5. J. R. Wolpaw et al., "Brain-computer interface technology: A review of the first international meeting," IEEE Trans. Rehab. Eng., vol. 8, pp.164–173, June 2000.
6. N. Birbaumer et al., "The thought translation device (TTD) for completely paralyzed patients," IEEE Trans. Rehab. Eng., vol. 8, pp.190–193, June 2000.
7. J. R. Wolpaw, D. J. McFarland, G. W. Neat, and C. A. Forneris, "An EEG-based brain-computer interface for cursor control," Electroenceph. Clin. Neurophysiology, vol. 78, pp. 252–259, 1991.
8. C. E. Davila, A. Abaye, and A. Khotanzad, "Estimation of single sweep steady-state visual evoked potentials by adaptive line enhancement,"IEEE Trans. Biomed. Eng., vol. 41, pp. 197–200, Feb. 1994.
9. A. P. Liavas, G. V. Moustakides, G. Henning, E. Z. Psarakis, and P.Husar, "A periodogram-based method for the detection of steadystatevisually evoked potentials," IEEE Trans. Biomed. Eng., vol. 45, pp.242–248, Feb. 1998.
10. E. E. Sutter, "The brain response interface: Communication through visually-induced electrical brain response," J. Microcomput. Applicat. vol. 15, pp. 31–45, 1992.
11. Nijboer F, et al. (2008) A P300-based brain-computer interface for people with amyotrophic lateral sclerosis. Clin Neurophysiol 119: 1909–1916.
12. Donchin E, Spencer K, Wijesinghe R (2000) the mental prosthesis: assessing the speed of a P300-based brain-computer interface. IEEE Trans Neural Syst Rehabil Eng 8: 174–179.
13. Wolpaw JR, McFarland DJ (2004) Control of a two-dimensional movement signal by a noninvasive brain-computer interface in humans. Proc Natl Acad Sci USA 101: 17849–17854.
14. Kennedy PR, Mirra SS, Bakay RAE (1992) the cone electrode: Ultrastructural studies following long-term recording in rat and monkey cortex. Neurosci Lett 142: 89–94.
15. Vladimir Hinic, Emil M. Petriu, Thomas E. Whalen (2007) Human-Computer Symbiotic Cooperation Robot-Sensor Networks Instrumentation and Measurement Technology Conference – IMTC 2007 Warsaw, Poland, May 1-3.
16. Wanli Min and Gang Luo ―Medical Applications of EEG Wave Classification CHANCE VOL. 22, NO. 4, 2009
17. T. A. Skidmore and H. W. Hill Jr., "The evoked potential human-computer interface," in Proc. Annu. Conf. Engineering in Medicine and Biology, 1991, pp. 407–408.

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