International Journal of Research in Engineering, Science and Management
Volume-3, Issue-2, February-2020
www.ijresm.com | ISSN (Online): 2581-5792

Neuro-Voice

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***Abstract*: We don't have to think about it, when we speak, our brain sends signals to your lips, tongue, jaws and larynx, which work together to produce the intended sounds. Our project focus on tapping these brain signals to create a device capable of decoding the brain signals to audio and text. The brain signals decoding includes kinematics, acoustic, synthesize and it is decoded into speech waveform. Our project will provide a better environment and communication to the deaf and dumb and also it helps the people who have lost their speech ability due to diseases such as apraxia (motor speech disorder), dysarthria.**

***Keywords*: Acoustic, Apraxia, Decoding, Dysarthria, Kinematics.**

1. Introduction

Their abilities in some way. Scientists have long understood that different EEG waves are linked with different mental states: Alpha waves, at 8 to 12 cycles per second, are associated with a restful, meditative mind, and beta waves, at 13 to 30 cycles per second, with an alert, engaged mind. Primitive biofeedback machines that emit different sounds for each wave have been used since the 1970s to help meditators increase their alpha wave activity.

The output is generated by collecting the EEG signals from the brain using Neurosky mind wave sensor. This sensor can safely measure, transfer and decode the power spectrum and brain signals. The decoded brain signals includes kinematics and acoustic of speech signals and synthesize them into audio signals.

The output signals can be converted to audio and text (in LCD display). The display can be enabled (or disabled) by the user. We can place this display either as a wrist band or into his mobile phone.

2. Need of such a device

Speech is the process to address and interact with people around to deliver some message. There are surprisingly many ways for the power of speech to fail. There are disorders such as stuttering or apraxia, in which syllables are scrambled; motor neuron disease and cerebral palsy, which rob people of the muscle control required to articulate; traumatic brain injury; stroke; anatomical excisions like multiple sclerosis; autism. Before the invention of the first modern text-to-speech communication device in 1969, people with muscular or vocal disorders had to use "sip-and-puff" typewriters, which were operated by inhaling and exhaling through a straw. Some people with speech disorders are aware of what they would like to say but unable to articulate their thoughts. This may lead to self-esteem issues and the development of depression. Communication is very important in the life of everyone, especially in the student life.

3. Speech Impairment

Speech impairment, also called communication disorder, or voice disorder, is a condition in which you have trouble forming sounds. Speech impairments vary, from occasionally not being able to produce sounds, to not being able to produce sound at all. Symptoms of speech impairment include:
stuttering

- Adding extra sounds and words
- Elongating words
- Distorting sounds when talking
- Visible frustration when trying to communicate
- Taking frequent pauses when trying to communicate
- Problems with articulation
- Problems with your voice

Speech impairment can be a problem with the following activities:

- Articulation, or making sounds
- Phonological processes, or hearing and repeating sound patterns

Speech impairment can be caused by many things, such as:

- Developmental disorders
- Neurological disorders
- Genetic syndromes
- Hearing loss
- Illness

Other speech disorders include the following:

- Apraxia is a motor speech disorder caused by damage to the parts of the brain related to speaking.
- Dysarthria is a motor speech disorder in which the muscles of the mouth, face, or respiratory system may become weak or have difficulty moving. Dysarthria often is characterized by slurred or slow speech that

can be difficult to understand.

- Common causes of dysarthria include nervous system (neurological) disorders such as stroke, brain injury, brain tumors, and conditions that cause facial paralysis or tongue or throat muscle weakness.
- Vocal disturbances, which are changes in the sound and ease of your speech caused by any factor that changes the function or shape of your vocal cords.

4. Existing Technologies

A. Conventional Methods

Speech-language pathologists (SLPs), often called speech therapists, are educated in the study of human communication, its development, and its disorders. SLPs assess speech, language, cognitive-communication, and oral/feeding/ swallowing skills. Speech therapist will create a program for you, including:

- Activities to help you develop proper grammar and sentence structure
- Exercises to help you strengthen and learn how to move your lips, mouth, and tongue to make certain sounds
- Communication methods, such as sign language, gestures, facial expressions.

B. Assistive Technologies

Those with impairments will need assistive devices for daily activities that most of us don't think twice about. Any type of technology or additional device that assists a person in communicating is considered to be an assistive device. These devices might also be referred to as assistive technology. Some of them are as follows:

1) Augmentative and Alternative Communication (AAC) Devices

These devices allow people with speech and language impairments to express their wants and needs. Another example would be a picture board that allows the person to click on a picture or word that expresses what they are trying to say. These allow a person to type what they need to say, and the program will say it for them. For someone who might be paralyzed or unable to move their limbs, they might choose to wear a pointer that can shine a tiny red dot on the picture they want to choose. Most of the boards can be customized based on the person's age, knowledge, interests, and particular needs.

Fig.1. Augmentative and Alternative Communication (AAC) Device

2) Big step-by-step choice making communicator with levels

Big step-by-step choice making communicator with levels provides an exciting option for easy-tech, quick-ready communication. Big step-by-step choice making communicator with levels includes interchangeable switch tops (Red, Yellow, Green and Blue). User can press the activation surface to select the appropriate message, no matter where in the sequence of messages it was recorded.

Fig. 2. Big step-by-step choice making communicator with levels

3) Eye Gaze Communication

We make our eye communication devices for people with special needs and disabilities who struggle to use other forms of communication. Eye gaze communicators can be particularly helpful to people with very limited movement, such as those with cerebral palsy or spinal cord injuries. The eyes say it all with our popular, inexpensive but highly effective eye gaze communication board. In order to communicate, simply attach messages to the board, observe the users eye gaze and receive your message.

5. Hardware

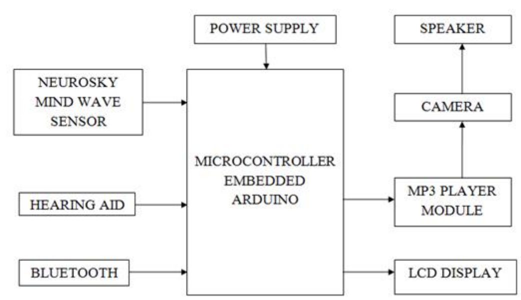

Fig. 3. Block diagram of neuro-voice

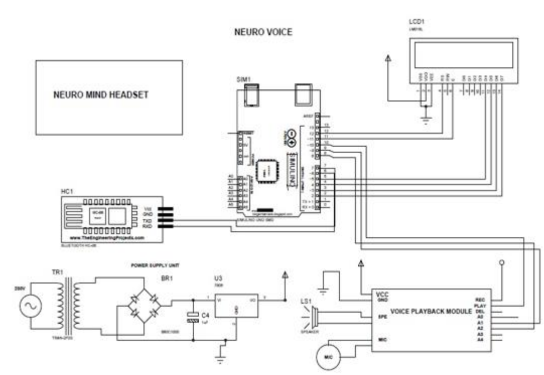

Fig. 4. Circuit diagram

A. Arduino UNO

An open-source electronics platform based on easy-to-use hardware and software. Arduino boards are available commercially in preassembled form or as do-it-yourself (DIY) kits. Arduino board uses a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (For prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers can be programmed using C and C++ programming languages. In addition to using traditional compiler tool chains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project. ATMEGA 328p is the Arduino used here. It is the brain of the project.

ATMEGA 328 is the Arduino used here. The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family (later Microchip Technology acquired Atmel in 2016). It has a modified Harvard architecture 8-bit RISC processor core. The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts. The device achieves throughput approaching 1 MIPS per MHz

B. Neurosky mindwave sensor

Developed by the company NeuroSky, Inc. is a manufacturer of Brain-Computer Interface (BCI) technologies for consumer product. The company adapts electroencephalography (EEG) technology. It is a headset model Flexible rubber sensor arms and rounded forehead sensor tip, T-shaped headband, and wider ear clip contacts make the sensor most comfortable EEG headset. The EEG electrode is on the sensor arm and placed on the forehead above the eye. The Mind Set detects changes in brain-wave patterns via metal sensors at the front and back of the head and at the earlobes. The device uses a mono-polar montage with one active site, and employs a pea-sized (~0.8 mm diameter) electrode clipped to the left earlobe as reference. The device samples data at 512 Hz. The Mind Wave electrodes are made of stainless steel and all connections use shielded cables. Energy is supplied by a single 1.5 V AAA battery.

The manufacturer has rated the device for continuous 8-hour operation on a single battery. Nevertheless, we took the precaution of changing the batteries after every 2 hours of use. A chip digitizes and transmits that information wirelessly via Bluetooth or RFID to a computer, which in turn translates it into commands that go back to the device. Concentrating on an object or thought produces different patterns of brain waves; after the headset calibrates itself to the individual, its algorithms detect those characteristic patterns.

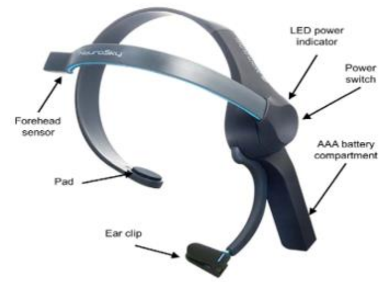

Fig. 5. Neuro sky mindwave sensor

C. Bluetooth Module

It is a Bluetooth device used for wireless communication with Bluetooth enabled devices (like smartphone). It communicates with microcontrollers using serial communication (USART). The Bluetooth module at other end receives the data and send to ardunio through the TX pin of Bluetooth module (RX pin of Arduino). HC-05 is the model used here.

Default settings of HC-05 Bluetooth module can be changed using certain AT commands. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, there is no need to shift TX voltage level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module. It is used to communicate with the hardware.

D. MP3 Module

MP3 (MPEG-1 Audio Layer-3) is a standard technology and format for compressing a sound sequence into a very small file. And there is a speaker connected to the mp3 module to bring the speech output. The DF Mini MP3 Player is a small and low price MP3 module with a simplified output directly to the speaker. The module can be used as a standalone module with attached battery, speaker and push buttons or used in combination with an Arduino or any other with RX/TX capabilities. Specification required are:

- Supported sampling rates (kHz): 8/11.025/12/16/22.05/24/32/44.1/48.
- 24 -bit DAC output, support for dynamic range 90dB, SNR support 85dB.
- Fully supports FAT16, FAT32 file system, maximum support 32G of the TF card, support 32G of U disk, 64M bytes NORFLASH.
- A variety of control modes, I/O control mode, serial mode, AD button control mode.

E. LCD display

The Liquid Crystal library allows you to control LCD displays that are compatible with the Hitachi HD44780 driver.

There are many of them out there, and you can usually tell them by the 16-pin interface. The LCDs have a parallel interface, meaning that the microcontroller has to manipulate several interface pins at once to control the display. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register. Here, it is an add-on feature to display the decoded brain signals.

F. Power Supply

It is provided by an external source. Power supply modules are used to convert AC power into usable DC power so that the system to be powered may operate properly. Also power supplies condition the DC output so that the DC voltage(s) is/are free of noise, spikes, etc. They provide electrical protection in the form of fuses or breakers, may display alarms in the case of abnormal operation and provide a mean to connect the DC output via properly chosen connectors. It is also there for safety reasons so that power grid high voltages are not (usually) present inside an electronic system. The purpose of a power supply is to provide the energy to accomplish whatever the objective of the machine is. If you mean an electronic device; i.e. a computer, radio, mp3 player, camera, etc; it provides the energy directly (battery or solar cells) or indirectly converts it to a usable form (A/C to D/C; mains voltage to device voltage; etc.) from the power outlet.

G. Working

The MindWave has two dry sensor contacts, one that touches your forehead and another that clips onto your left earlobe. Power is provided by a single AAA battery in the rectangular housing that sits behind your left ear and the power switch and power-on light are located on the top surface of the "hub" above your left ear. The entire assembly is reasonably comfortable to wear. The combination of sensors allows the Mind Wave to detect when you are attentive and or meditative (you can be both at once), when you blink (EMG), and activity in a range of EEG frequency bands from 0.5Hz to 50Hz. The determination of attentive and meditative states is done by monitoring several bands at once and is carried out by NeuroSky's proprietary algorithms embedded in the headset's signal processing software.

Essentially the MindWave system creates a serial port in the host system from which you can read the data coming from the headset. This data is a stream of measurements that includes NeuroSky's own proprietary measurements (attentiveness and meditativeness) along with a breakdown of EEG data into various bands that can be interpreted as relating to potential generic mental states (tranquil, anxious, agitation, etc.). This sensor can safely measure, transfer and decode the power spectrum and brain signals. The decoded brain signals includes kinematics and acoustic of speech signals and synthesize them into audio signals.

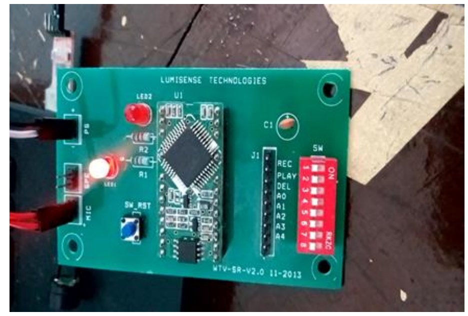

Fig. 6. APR Module

Initially the data from the surroundings is send to the brain and there will be a response for the data collected and Electroencephalogram (EEG) signals will be collected and decoded. The Bluetooth Module used here communicates with the hardware using serial communication (USART). The Bluetooth module at other end receives the data and send to Arduino through the TX pin of Bluetooth module (RX pin of Arduino). HC-05 is the model used here.

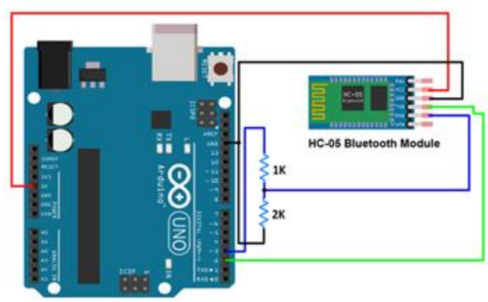

Fig. 7. Bluetooth module interfacing

MP3 (MPEG-1 Audio Layer-3) is a standard technology and format for compressing a sound sequence into a very small file. And there is a speaker connected to the mp3 module to bring the speech output. And there is a speaker connected to the mp3 module to bring the speech output. Then the data collected is proceeding to the audio jack (here we use a small mike attached to the neurosky mindwave headset) and to the LCD display for text message. The display can be enabled (disabled) by the user. We can place this display either as a wrist band or into his mobile phone.

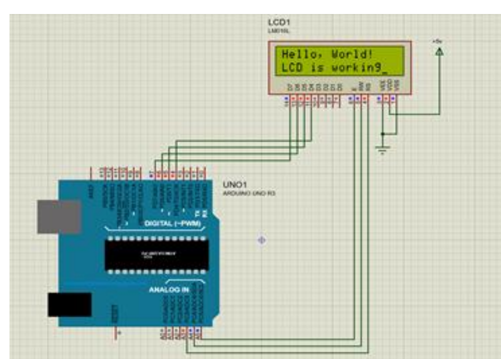

Fig. 8. Schematic of LCD Interfacing

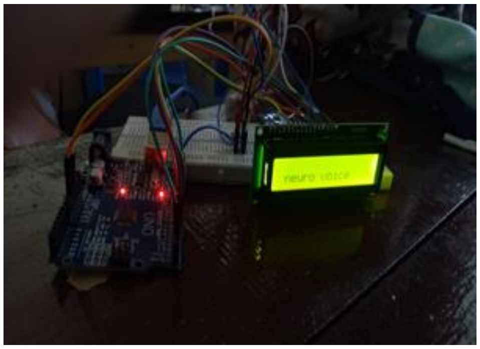
Fig. 9. LCD Interfacing

6. Future scope

Even though the device is light- weight, it appears to be heavier. In the future advancement, the size of the device can be reduced, so that everyone finds it more easy to use and comfortable to use. And for the present system, we cannot program all the languages.

More features can be added on such as a hearing to provide the input the signals to those deaf and also a camera module can be brought in attachment to the speaker to detect the lip movement and produce audio output accordingly. In the advancement of technology in the upcoming years, we can bring up the feature of wide languages and choice can be given to the user. Even though it is cheap compared with the other available equipment's, we can develop more cheap device with the same quality.

7. Conclusion

Measuring EEG activity has traditionally required complex equipment costing thousands of dollars. NeuroSky has unlocked a new world of affordable solutions for health and wellness, education and entertainment. Precisely accurate, portable, and noise filtering, our EEG biosensors collect electrical signals, to translate it into audio and text. This project will provide a better environment to the deaf and dumb people and it also helps the people who have lost their speech ability due to motor speech disorders such as apraxia, dysarthria. It is also applicable for the stuttering people and old age people who finds difficulty in talking. Some people with speech disorders are aware of what they would like to say but unable to articulate their thoughts. This may lead to self-esteem issues and the development. This technology would provide a solution for the above mentioned problems.

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