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Design of a Supportive System for Patients with ALS (Amyotrophic Lateral Sclerosis) with the help of Eyebrow sensing & Easy Talk Module

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Abstract

Eyebrow sensing and easy talk modules together help the patients with ALS (Amyotrophic Lateral Sclerosis) to communicate with others at the time of need. This paper also includes the design of the modules and also showcases the implementation process. This design actually helps those who actually find it difficult while communicating with others.

Keywords: Eyebrow Sensing, Surface EMG electrodes, Instrumentation Amplifier, ALS (Amyotrophic Lateral Sclerosis), Easy Talk.

Introduction

The design of Eyebrow Communication is used to communicate by picking up the electrical activity in eyebrow muscle through EMG Surface electrodes and giving it as click to the Easy Talk through which the person can communicate his needs. The version 1 of this design has the output through software named “Handi Talk” installed in a net book/laptop. In Developing Countries, Laptops and Net books are not affordable. Easy Talk is the solution which can affordable by any person in the Country. This design is useful for ALS patients.

Amyotrophic Lateral Sclerosis (ALS) [1-2] is a disease which can begin from a small part of body like- a small finger of hand and start spreading to other parts .The muscle movement of such patients deteriorates continuously affecting the entire body .Hence gradually the patient looses the ability to talk and move .The last preserved movement in these cases is eyebrow movement [10] The idea is to design a medical product [10] that can assist such patients to communicate with the outer world to meet their daily needs. Eyebrow Communication is designed to facilitate the patient to communicate. Easy Talk is a low cost device with which the patients can express their needs and call at the time of help.

Firstly, the capturing of Electromyography (EMG) [3-4] signal from the eyebrow is done. This signal is processed and converted into the binary format that can resemble the clicking mechanism of normal mouse [5]. Many applications and the operating system of a tablet PC can be programmed to respond in different ways to different gestures created by the EMG signal in binary format.

Then the eyebrow sensing module is connected to Easy Talk that has a click-to-sound converting module. Standardized patients’ needs and queries are implemented in our document software, and the sound output has various options like-“water” ,”help ”,”pain” ,”food”, ”sleep”, ”medicine” and other daily needs. The basic practical implementation for Eyebrow Communication is characterized and picturized in a clear way in the below diagram. The Instrumentation Amplifier should be in that range.

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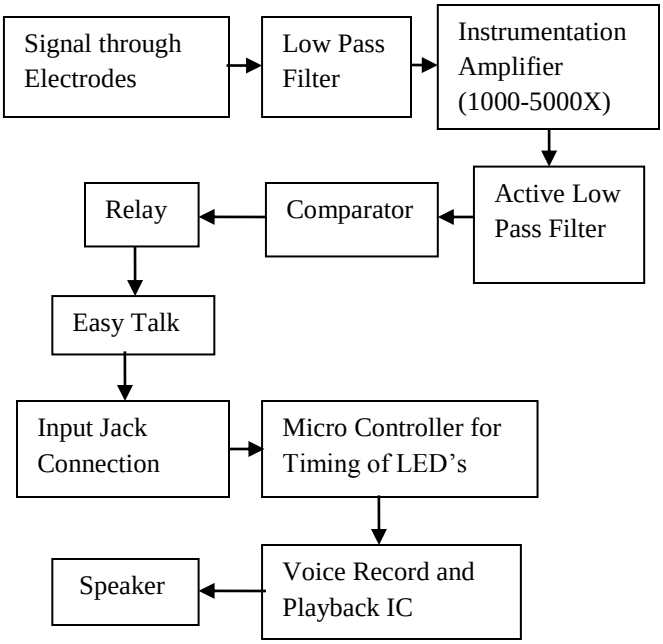
Eyebrow Sensing Module



The surface EMG electrodes [6]are placed on the eyebrow muscles. The movement of muscles is captured by the electrodes and transmitted to the circuit .The signal has minute amplitude (in mV or μV) and is not in a usable form. It is amplified with 10,000 gains in first level and 20,000 gains in second level .The amplified signal is filtered using an active low pass filter[9] to attenuate the high frequency noise that comes from subcutaneous muscle movements [8]. Then by using a comparator and relay circuit, a switching control signal is generated. This signal is sent as an input to a Relay and the signal sent to netbook through a USB connecting wire. The signal is processed and is sent as a click to the Easy Talk module which contains icons for communication. A Easy Talk consists of icons with LED's blinking one after the other. As the click is received through the EMG surface electrodes, then LED's starts blinking from one icon to another and the required icon can be clicked by raising the eyebrow. This application helps the ALS patients for producing different sounds based on daily basic needs and improves the quality of care by effective patiCrence in the concentrations and ionic composition across the plasma membrane. A potential difference exists between the intra-cellular and extra –cellular fluids of cell in response to stimulus from the neuron, a muscle fiber depolarizes as the signal propagates along it's surface. This depolarization accompanied by a moment of ions, generates an electrical field near each muscle fiber. And finally muscles generate a voltage of amplitude ranging from mV to a few micro volts. It contains frequencies of higher or lower than 10Hz.The EMG bioelectrical signals are typically very-very small in amplitude and so, amplifier circuit is required to accurately record, display and analyze the EMG. A typical EMG waveform measured during a brief muscle contraction is shown in Fig. 2.

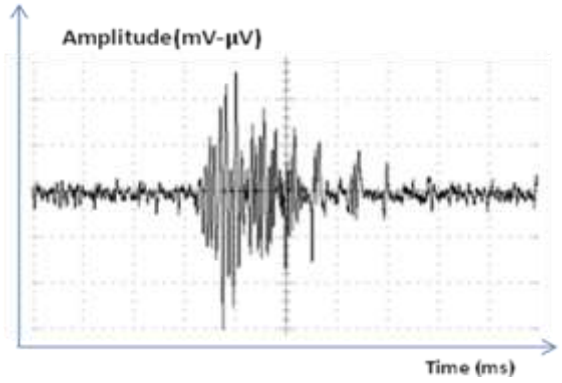


Fig. 2: Typical EMG waveform during a brief muscle contraction

The EMG signal recorded during voluntary dynamic contraction [13] may be consider as a zero. Mean Gaussian process $\boldsymbol{s(t) \in N(0, \sigma_s)}$ Modulated by the muscle activity and corrupted by a zero-mean Gaussian additive noise$\boldsymbol{n(t) \in N(0, \sigma_s)}$. If the probability of detection is $\boldsymbol{p_d}$.Then the double-threshold method is by equation:-

$$\mathbf{P_d} = \sum_{K=r_0}^{m} \binom{m}{k} P_{dk}{}^{k}(1 - P_{dk})^{m-k}$$

Where $\boldsymbol{P_{dk}}$ is probability of detection in single

Threshold method= $\boldsymbol{exp\left(\frac{\ln P_y}{1+10^{SNR/10}}\right).P_y}$ is probability of noise sample above the threshold 'y'. $\boldsymbol{r_0}$ Is the threshold parameters, and 'm' is the length of the observation window.

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Instrumentation Amplifier

The instrumentation amplifier is a closed-loop adjustable gain block that allows the amplification of low-level signals in the presence of common-mode error and noise. Most common op-amps such as 386BD JRC and TDA7052A as input device. This leads to input current of 100-500nA with very high gain. This Amplifier takes the input signal and works upon it.

Low pass filter

To attenuate the high frequency noise that comes from subcutaneous muscle movements. In a simple resistive/ capacitive low pass filter the cutoff frequency is given as:-

$$f_{cutoff} = \frac{1}{2\pi RC}$$

R:Resistance
C:Capacitance

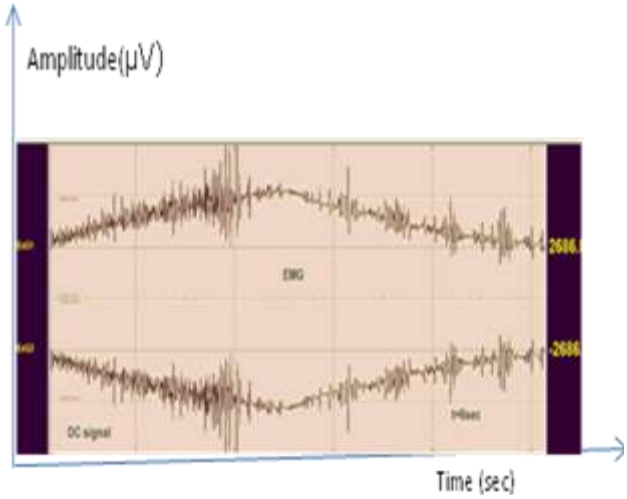

Fig 3: Output electrical signal by two different surfaces EMG Electrodes

The signal is picked up at the electrode and amplified typically; a differential amplifier is used as a first stage amplifier. Then the signal can be processed to eliminate low frequency or high frequency noise or other possible artifacts. This process is done by using a filter circuit and final output from filter circuit.

Easy talk

The Easy Talk contains the icons and LED'S above the icons. The LED's blinks from one icon to another and when the icon is to be clicked, the eyebrow should be raised. It records and plays up to 42 messages. Simply slide in the interchangeable picture icons to enhance expressive and receptive language. The bottom right switch is the level changer with a level announcing message. Device has 300 seconds of total record time and stores up to 48-six second messages including the level announcing records.

This easy talk device modulates the speech and sends it to the speaker for listening

Conclusion

Amyotrophic Lateral sclerosis (ALS) patients will not be able to express their needs due to the non-functioning of vocal cords and arms. The Eyebrow Comunication aids such patients to be able to communicate. An Eyebrow Communication performs click operation on the Easy Talk module. Easy Talk consists of icons with LED's blinking one after the other. As the click is received through the EMG surface electrodes, then LED's starts blinking from one icon to another and the required icon can be clicked by raising the eyebrow and the corresponding sound comes out which alerts the other people of the patient's needs. An Eyebrow Communication helps in communication for ALS patients. It can be used by any patient who unable to move, speak provided some part of their body has little movements.In future Improvement of necessary software like Handi talk in the version 1, Easy talk can be replaced with a tablet PC which can be made more portable and easy to access, where the person can play games, listen to music, home automation, send e-mails etc.

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