iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** VIII **Month of publication:** August 2017

DOI: http://doi.org/10.22214/ijraset.2017.8071

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

Cepstrum of Bispectrum for MUAP Estimation from EMG Signals

S.V. Karthik[1]
[1]M.Tech in Communication Engineering and Signal Processing, Velagapudi Ramakrishna Siddhartha Engineering College, Affiliated to JNTU Kakinada, Kanuru, Vijayawada-520007

Abstract: EMG signal gives the information regarding the working of nerves and the muscles. The shape of the MUAP is same until there is a movement in the position of electrode. In mathematically the EMG signal is modeled as the output signal of a filtered impulse process where the neuron firing impulses are assumed to be the input of a system whose transfer function is the motor unit action potential. For obtaining the motor unit action potentials we have to apply some higher order statics based reconstruction algorithm methods. this paper we report the results of applying cepstrum of bispectrum method to different type of EMG signals to characterize the motor unit action potentials in the muscle. In this paper we clearly obtain the shape of MUAP is same for different EMG signals. The characteristics of MUAP is different for the disease having neuropathy and myopathy. The MUAP for these type of diseases we can report in the results.
KeyWords: EMG(Electromyographic signal),MUAP(Motor Unit Action Potential)

I. INTRODUCTION

Electromyography is a diagnostic technique for recording and evaluating the electrical activity in the muscles. EMG signals are directly detected from the muscle or by using skin surface with the help of surface electrodes. For the detection of EMG signal we have two types of electrodes are present. They are surface or indwelling electrode and Needle electrode. For detection of EMG signals we can put surface electrodes on the skin surface and the Needle electrodes will be inserted in the body itself. Mostly for detecting of EMG signals we are using surface electrodes because this process is very easy for detecting EMG signals.
In mathematically the EMG signal [1] –[3]can be modeled as shown in equation.

$$X(n) = \sum_{r=0}^{N-1} h(r)e(n-r) + w(n) \qquad (1)$$

The above equation shows x(n) is a EMG signal, e(n) is a point process(poison random process) represents the firing impulses h(r) represents MUAP and w(n) is a zero mean additive white Gaussian noise. w(n) is independent of e(n).N is the motor unit firings number.

A. MUAP Model

The basis functins for the MUAP model with having Hermit-Rodriguez (HR) series expansion as shown in below,

$$w_n(\alpha,t) = \frac{1}{\sqrt{2^n n!}} H_n(t/\alpha)\frac{1}{\sqrt{\pi}\,\alpha} e^{(-t/\alpha)^2}$$

Here n=1,2,3,...

H_n is the Hermite polynomial of order n

To change the above equation in time scaling for that can put α=1,t=ξ ,then the above equation can be written as

$$v_n(\xi) = w_n(1,\xi) = H_n(\xi)e^{-\xi^2}$$

It can express the MUAP as a series of these basis functions,

$$f(\xi) = \sum_{n=1}^{N} a_i v_n(\xi)$$

Here we can define the inner product of two basis functions as

$\langle v_{1,} v_2 \rangle = \int_{-\infty}^{+\infty} v_1(t)\, v_2(t)$ dt and the norm as $\|v(t)\| = \sqrt{\langle v, v \rangle}$ then finally MUAP can be represented as

$$f(\xi) = \sin(\phi)\,\frac{v_1(\xi)}{\|v1\|} + \cos(\phi)\,\frac{v_2(\xi)}{\|v2\|}$$

Here ϕ is the angle between two vectors

Here we can apply total equations in the equation (1) we can get the EMG equation. Fig 1 represents the mathematical EMG equation.

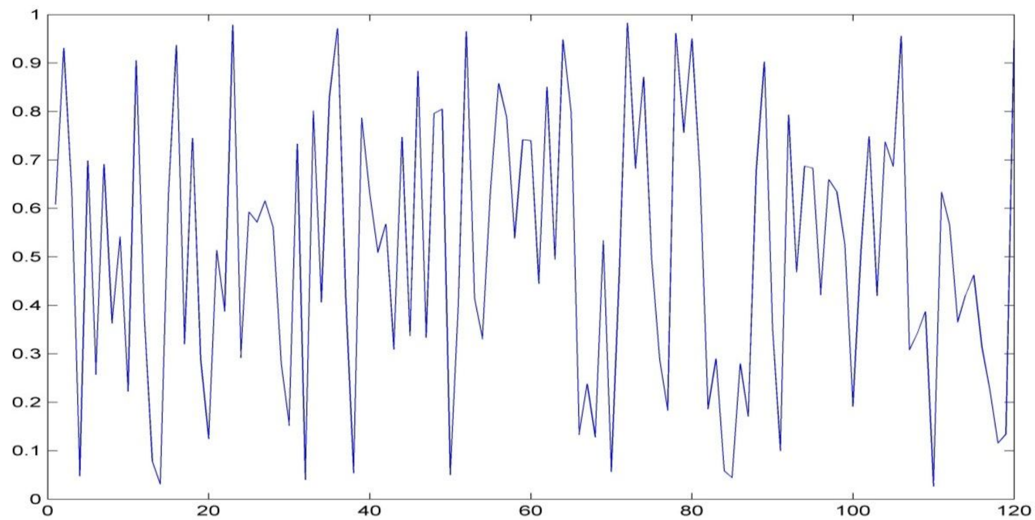

Fig 1: Mathematical EMG signal

In the above diagram shows the EMG signal in mathematical manner. Each EMG signal having different shape. The shape of the EMG depends on the muscle and also the diameter of the muscle also. If the diameter is changed then the shape of the EMG also changed. Fig 2 shows the MUAP signal for the mathematical EMG signal.

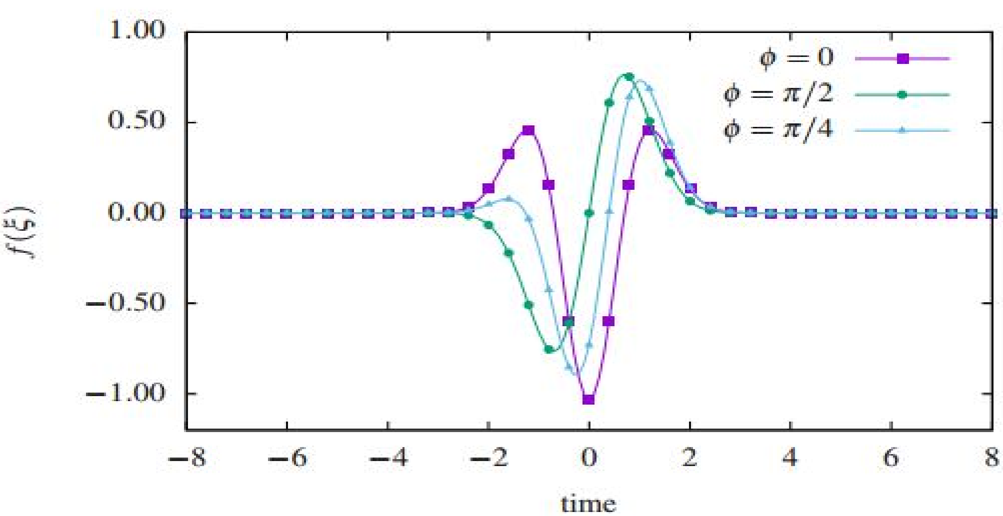

Fig 2: MUAP model for different ϕ values

Fig 2 shows the MUAP's for different ϕ values. The shape of the MUAP is same if the person doesn't having any disease like neural disorders. If the person having any disease specifically in neural department definitely his action potentials releasing is different from the healthy person.

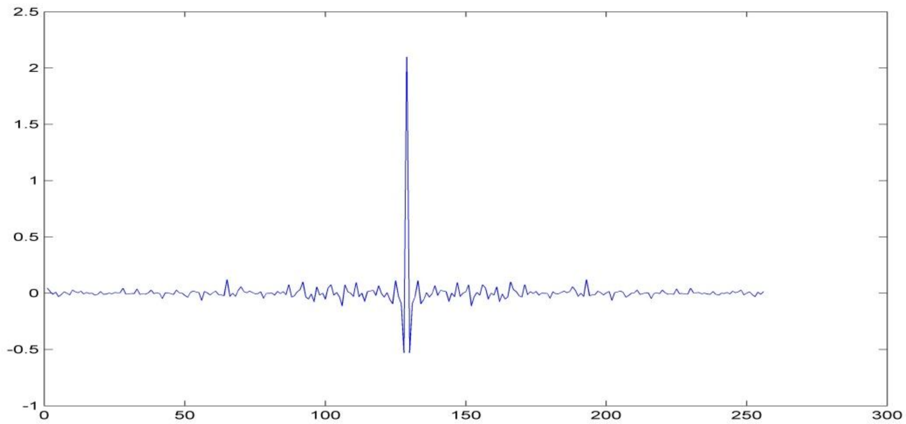

Fig 3: Mathematical MUAP

II. MUAP RECOVERY TECHNIQUE

A. Bispectrum

Bispectrum can be defined as the expectation of three frequency's. In that two direct frequency components and another one is the sum of conjugate of those two frequency's of a random signal[4].The bispectrum can be defined as

$$B_x(k,l) = E\{X(k)X(l)X^*(k+l)\}$$

Here expectation denotes the statistical expectation.k and l are the discrete frequencys.
Here output signal is a non-gaussian signal then the above equation can be written as

$$B_x(k,l) = \gamma_3^e H(k)H(l)H^*(k+l)$$

Where γ_3^e is the skewness of the bispectrum of the input signal e(n) and H(k).

B. Cepstrum of Bispectrum Recovery Technique

The cepstrum of bispectrum can be find that applying of 1-D inverse Fourier transform of logarithm of bispectrum.It can be written as

$$c_{B_x}(k,m)=F^{-1}[logB_x(k,l)]_l$$

Here F^{-1} indicates the 1-D fourier transform on the l and m axis can put $B_x(k,l)$ in the above equation then

$$C_{B_z}(k,m) = F^{-1}[log\gamma_3^e] + F^{-1}[logH(k)]_l + F^{-1}[logH(l)]_l + F^{-1}[logH_\emptyset(k+l)]_l$$
$$= [log\gamma_3^e]\delta(m) + [logH(k)]\delta(m) + F^{-1}[logP_x(l)]_l = [log\gamma_3^e]\delta(m) + [logH(k)]\delta(m) + p_x(m)$$

Here F^{-1} indicates the 1-D inverse Fourier transform to be applied on the frequency axis l and p_x. p_x is the power spectrum and δ indicates the kronecker delta function. In this paper consider only the axis m=0 and the equation can be written as

$$c_{B_x}(k,0) = [log\gamma_3^e] + [logH(k)] + p_x(0) = [logH(k)] + C$$

Here c is constant and the above equation represents a log of a system transfer function and a constant. And the above constant can be removed by normalization because for any blind-deconvoultion method we can only recover a scaling factor [5].Let k=0 and H(0)=1 then it gives C=$c_{B_z}(k,0)$.Then the system transfer function can be written as

$$H(k) = \exp[c_{B_z}(k,0) - c_{B_z}(0,0)]$$

The above H(K) may not always true for estimated phase. For that purpose should apply phase unwrapping technique[6].For this purpose can need to relate integer, true and estimated biphase as below[7].

$$\varphi_t(k,l) = \varphi_x(k,l) + 2\pi n(k,l)$$

Here $\varphi_t(k,l) = \varphi_x(k,l) = B_x(k,l)$ are true and estimated biphase values. $n(k,l)$ is the matrix of integers.

For finding of matrix n(k,l) can use a technique[3] and computed as

$$\varphi_s = A_\emptyset \emptyset_x$$

Here $A_\emptyset$ is the biphase coefficient matrix[6]. φ_s is the shadow biphase.And the elements in the n(k,l) values are rounded to the nearest integer value then the equation can be wtitten as

$$n(k,l) = \frac{\varphi_s - \varphi_x}{2\pi}$$

Finally the better system estimated informatin can be written as

$$H(k) = |H(k)|\exp(j\emptyset_t)$$

III. EMG SIGNAL ACQUISITION AND PROCESSING

EMG signals were recorded for different persons in the laboratory by using some eqipments. In this paper the myopathy and neuropathy data downloaded from the bio-medical processing sites and the MUAP of these data will represented in this paper.

A. Subjects

Different healthy male volunteers were recruited with age of 23-25.For each subject the emg signals were taken at the same time on the same muscle. Here we are taking EMG signals for different persons like healthy, myopathy and neuropathy disease persons.

B. Acquisition of EMG Signals

On each activity three electrodes are used are set up and corresponding EMG signals were recorded. The recorded EMG signal was recorded by using one channel by using LAB-VIEW software. Here we are using a sensor for recording of EMG signals.

C. Technique of MUAP Estimation

The recorded EMG signals were plotted by using MATLAB software. From the plotted EMG signals we observe that the amplitude of the EMG signal is varying on the contraction of muscle or for different activities of muscle. At the same time the raw EMG signals also recorded. The raw EMG signals are always contain some noise due to this it is difficult to estimate good MUAP signal from the EMG signal. By using cepstrum of bispectrum recovery technique we can recover the shape of the EMG signal.

IV. RESULTS

MUAP's were estimated for different EMG signals. In that mainly the healthy person, myopathy and neuropathy disease peoples. Healthy person wants to lift the wait he doesn't lose his actions potentials heavily. At the point of starting he is in normal condition only and he release less action potentials that means he doesn't lose his energy also. The fig 5 show healthy person MUAP.In that he release only some action potentials. Then at the time of lifting he releases more action potentials. And then the reaming is in resting potential.

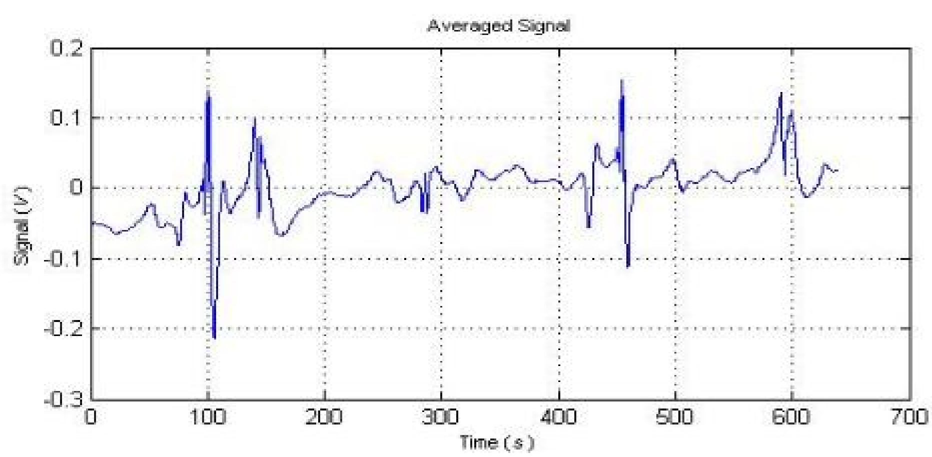

Fig 4:Healthy person EMG signal

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue VIII, August 2017- Available at www.ijraset.com

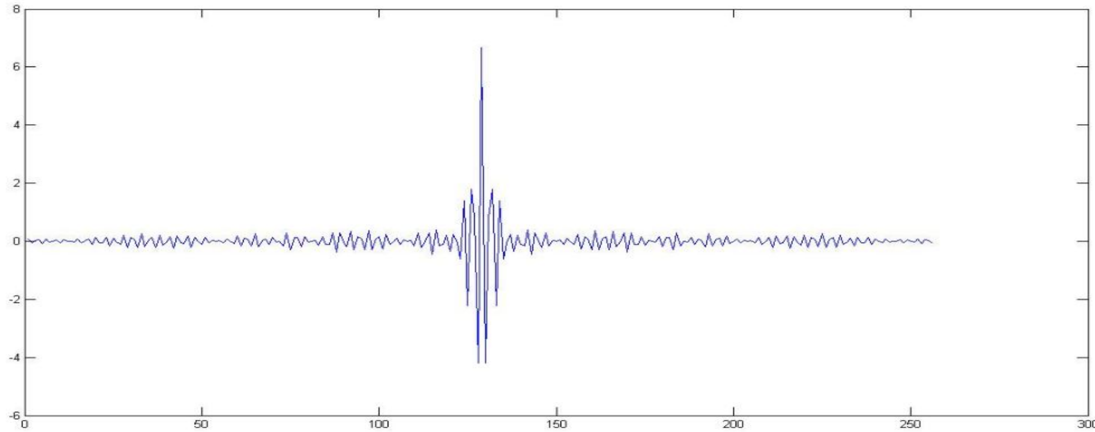

Fig 5: MUAP for healthy person

The fig 6 shows the MUAP for myopathy person. The person having myopathy he loses his action potentials very quickly. At the starting point of lifting also he loses his potentials very highly compared to healthy person. If he wants to lift more wait then he loses more action potentials

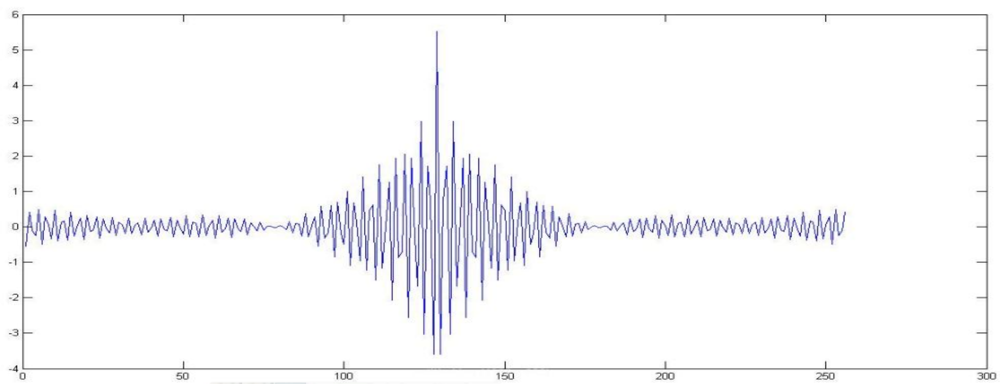

Fig 6: MUAP for myopathy disease person

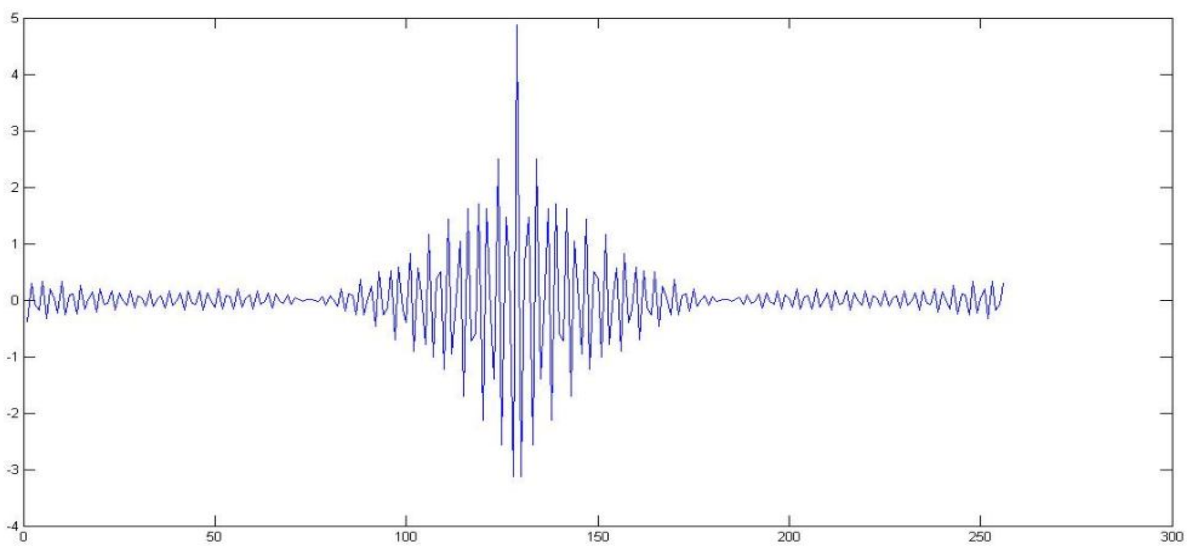

Fig 7: MUAP for Neuropathy disease person

The above figure 7 shows that neuropathy MUAP. Here also due to abnormality of the nerves he can lose more potentials or energy. At the starting point also he will lose more energy and at the time of middle also he will lose more potential.

V. DISCUSSION AND CONCLUSION

Mainly this paper shows and report the results of different persons muap's. Here we conclude that the shape of the MUAP is same for all the peoples but the shape of the EMG is not same. And the person having neural disorders his action potentials are released frequently in body. That means he loses his energy without doing any work. And here we will also complete of mathematical approach also. And the output we are getting MUAP is obtained by the input having non-Gaussian white noise. And we can do this by using real data also. And we can test for different peoples for various diseases also. By knowing this MUAP that means energy we can provide some extra skeletal to the body also. If the person weighing more waits his action potentials also loses very frequently. For those peoples we can provide some extra skeletal.

REFERENCES

[1] C.J.Deluca,"physiology and mathematics of myoelectric signals,"IEEE Transaction on Biomedical Engineering vol.BME-26,no.6,PP.313- 325,1979
[2] D.Stashuk,"EMG signal decomposition: how can it be accomplished and used?", Journal of Electromyography and Kinesiology, vol.11,pp.151-173,2001
[3] P.A.Kaplanis,C.S.Pattichis,L.J.Hadjileontiadis,and S.M.Pans,"Bispectral analysis of surface EMG," in Proc. 10th Mediterranean Electro technical Conference,vol.II.pp.770-773,2000
[4] J.Kollmitzer,G.R.Ebenbichler,and A.Kopf,"Reliability of surface electromyography measurements, "Clinical Neurophysiology,vo.110,pp.725-734,1999
[5] C.L.Nikias and A.P.Petropulu,Higher-Order spectral Analysis: A Nonlinear Signal Processing Framework. Englewo Cliffs,NJ:PTR prentice Hall,1993
[6] M.Rangoussi and G.B.Giannakis,"fir modeling using log-bispectra:Weighted least-squares algorithms and performance analysis,"IEEE Transactions on circuits and Systems,vol.38,no.3,pp.281,1991
[7] J.C.Marro P.P.Sanchez and R.C.Sullivan,"Unwrapping algorithm for least-square recovery from the modulo 2..bispectrum phase,"Opt.soc.Am.A,vol.7,no.1,pp.14-20,jan.1990

.