World Journal of Gastroenterology

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DOI: 10.3748/wjg.v2.iSuppl1.118

World J Gastroenterol 1996 September 25; 2(Suppl1): 118-119
ISSN 1007-9327 (print) ISSN 2219-2840 (online)

ABSTRACTS

Neural network based adaptive time frequency analysis of EGG signals

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Author contributions: All authors contributed equally to the work.

Original title: *China National Journal of New Gastroenterology* (1995-1997) renamed *World Journal of Gastroenterology* (1998-).

Received: August 15, 1995
Revised: January 11, 1996
Accepted: August 26, 1996
Published online: September 15, 1996

Abstract

AIM: This abstract introduces our study work on Neural Network based Adaptive Time frequency Analysis of EGG signals, which aims at adaptively extracting time frequency (TF) information of EGG signals by parameters learning algorithm based on Neural network and providing better TF resolution without any cross term interference.

METHODS: Given an EGG signal Egg (*t*) and a base function g(t) $\subset LR^2$ which satisfies ‖g(t)‖ = 1, Egg (t) can be estimated by the following relation,

$$Egg(t) = \sum_{k=0}^{k-1} w\text{—}kg\text{—}Ip(k)(t)$$
$$= \sum_{k=0}^{k-1} w\text{—}k \frac{1}{\sqrt{s(k)}} g\left(\frac{t-u(k)}{s(k)}\right)\cos(\xi(k)t+\theta(k)) \quad (1)$$

Where *IP* (*k*) = {*s* (*k*), *u* (*k*), ξ (*k*), θ (*k*) |*k* = 0, 1, ……*K*|}$\subset LR^+ \times R^3$ is the index parameter set which corresponds to scaling, shifting, center frequency and initial phase. *D* = *g—ip* (*k*), With ‖*g—ip* (*k*)‖ = 1, forms the dictionary of time frequency atoms, which is a very redundant set of function in L^2 (R) that includes window Fourier frames and wavelet frames. W—*k* is the weight parameter set. Given the size of the index set and the weight set, *K*, and the approximation error, ε, we can adjust these two sets by neural network based learning algorithm so that ‖Egg (*t*) - Egg (*t*)‖ < ε.

Defining the least mean square (LMS) energy as

$$E = \frac{1}{2}\sum_{t=0}^{T-1}[Egg(t)\text{-}\dot{E}gg(t)]^2$$

one can learn the parameter sets by gradient algorithm, for example, W^{i+1}—k = W^i—k-α[(∂E)/(∂—k)], S^{i+1}—k = S^i—k—β[(∂E)/(∂—k)]. Where subscript i is the iteration time and α, β are the learning vectors. As soon as the desired estimation estimation of Egg (*t*), Egg(t), is obtained, the next work is to computer the TF energy distribution. Performing Wigner distribution on Egg (*t*) in terms of that

$$Egg(t) = \sum_{k=0}^{\infty} w\text{—}kg\text{—}IP(k) \text{ and } \| Egg(t) \| = \sum_{k=0}^{\infty} |wk|^2$$

We have

$$WEgg(t,\omega) = \sum_{k=0}^{\infty} |w\text{—}k|^2 wg\text{—}Ip(k)(t,\omega) + \sum_{k=0}^{\infty}\sum_{I=0}^{\infty} w\text{—}k\cdot w\text{—}1w[g\text{—}IP(k),\ g\text{—}IP(I)](t,\omega) \quad (2)$$

Because

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} wg\text{—}IP(k)\ (t,\omega)dtd\omega = \| g \|^2 = 1$$

we can define a new TF energy distribution of Egg (*t*) by removing the crossterms of (2) as

$$EEgg(t,\omega) = \frac{1}{2}\sum_{k=0}^{\infty} | w\text{—}k |^2 \cdot \left[wg\left(\frac{t\text{-}U\text{—}k}{S\text{—}k}, S\text{—}k(\omega+\xi\text{—}k)\right) + wg\left(\frac{t\text{-}U\text{—}k}{S\text{—}k}, S\text{—}k(\omega\text{-}\xi\text{—}k)\right)\right]$$

where wg (t, ω) is the Wigner distribution of the base function g (t). The TF energy distribution of Egg (*t*) statisfies

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} EEgg(t,\omega)\ dtd\omega = \| Egg \|^2$$

and its estimation is

$$EEgg(t,\omega) = \frac{1}{2}\sum_{k=0}^{k-1} | w\text{—}k |^2 \cdot \left[wg\left(\frac{t\text{-}U\text{—}k}{S\text{—}k}, S\text{—}k(\omega+\xi\text{—}k)\right) + wg\left(\frac{t\text{-}U\text{—}k}{S\text{—}k}, S\text{—}k(\omega\text{-}\xi\text{—}k)\right)\right]$$

RESULTS: The simulations are performed by taking morlet wavelet base on four typical EGG data, representing normal, Tachygastria, Bradygastria and Arrhythmia respectively, which are provided by the Baptist medical center in United States. The two of the gray images of the TF energy distribution of the four sets of data are shown as

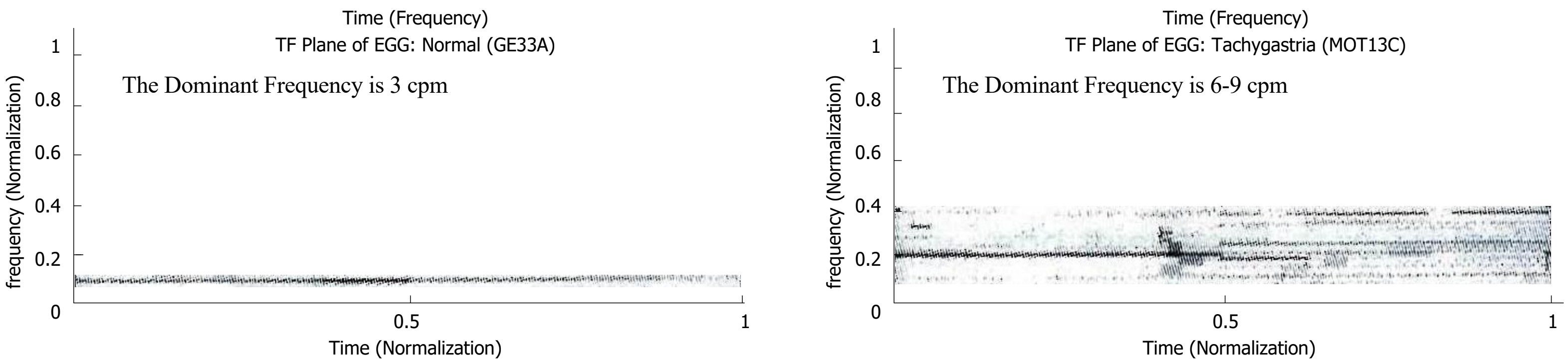

Figure 1 The two of the gray images of the time frequency energy distribution of the four sets of data.

follows (Figure 1).

Wang ZS, Li WH, He ZY, Chen JZ, Liang J, Yang DZ. Neural network based adaptive time frequency analysis of EGG signals. *World J Gastroenterol* 1996; 2(Suppl1): 118-119 Available from: URL: http://www.wjgnet.com/1007-9327/full/v2/iSuppl1/118.htm DOI: http://dx.doi.org/10.3748/wjg.v2.iSuppl1.118

E- Editor: Liu WX

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