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An ECG-representing Concept in the Numerical and Spectral Forms Using Discrete data

Sabar Setiawidayat[1], M.Rasjad Indra[2], Djanggan Sargowo[2], Setyawan Sakti[2]
[1] Widyagama University of Malang, [2] Brawijaya University of Malang

Abstract

Up to now, an Electrocardiography tool has still be showing information on the heart condition in the form of waves called electrocardiogram (ECG). The information the observer needs from the ECG is principally used to understand the peak value of the PQRST amplitude existing in the boxes in the sheet specific for ECG or in the monitor screen. Based on the counted values of the waves, the observer will be able do diagnose the heart condition.

This paper is proposing an ECG-representing concept in the numerical and frequency spectral forms for showing information on the amplitude, segment or interval. From the application of a sampling method from the results of the biosignal tapping, a discrete signal of the amplitude strain versus time duration was obtained. And the filtering of maximal and minimal values of the amplitude from the discrete data in a cycle would result in values from the peak amplitude, meanwhile the time transition method would produce segmental and interval values. The matrice operations and the application of the Fast Fourier Transform (FFT) on the discrete data, the values of signal range and spectrum frequency would be obtained

The ECG presentation in the numerical form will make the results of a diagnosis faster because the calculation is made by a software so that the observer merely sees the results of the calculation. The ECG presentation in the spectral form will result in the normality level or the stadium level of the Arrhythmia.

Key word : spectrum, numerical, discrete, sampling, ECG

I. INTRODUCTION

Electrocardiogram (ECG) is an image of the record of the electrical activities of the heart in the form of waves produced by an electronic tool called Electrocardiography [1,2,4,19]. But up to now, this electrocardiography tool has been still showing information in the wave form as a time function. The observer should count the peak values of the amplitude, the segment or the intervals of thewaves through boxes in a piece of sheet special for the ECG or in the monitor screen. Based on the observation through the wave, each observer will have different resuts in either the time counting or diagnosis. The exmination will be quicker if the waves presentation of the peak amplitude, segment and the interval is changed into the numerical and spectral forms.

II. METHOD

1. The Hardware Design

The discrete data of the ECG are taken by sampling the analogous biosignal tapping of the ECG [1,5,6]. The Biosignal data were obtained from the signal tapping in the surface of the body skin using Jely AgCl and an electrode sensors. A series of protection will protect the sign from any interference and the surrounding magnetic field. A low pass filter (LPF) would filter the sign from any unintended noises. An amplifier serves as the signal-gain amplifying tool for the adaptation to the inputs analog to the Digital Convertion (ADC). The ADC will sample the analogous signals into discrete ones [8,9,10]. The achievement of the discrete signals may be realized by designing a signal-tapping hardware. The hardware may be connected to a computer through a microcontroller prodived with an interface rs232. Picture 1 shows a block of diagram of the hardware design to obtain discrete signals form the biosignal.

2. The Software Design

The outputs of the dicrete signals from the hardware through the ADC with the sampling frequency of 1 kHz, result in strain discrete signals (mV) as the time function (ms). The ADC outputs through the interface rs232 may be accommodated and stored in the database designed for the purpose in the computer. The programming with the Delphi may be made to produce files of data from each lead consisting discrete data from the amplitude as the time function. Based on the data in the files, a software for proccessing the signal is created to result in the ECG parameters, signal numbers, ECG graphic, matrices and frequency spectrum. The flowchart of the software design is presented in Picture 2.

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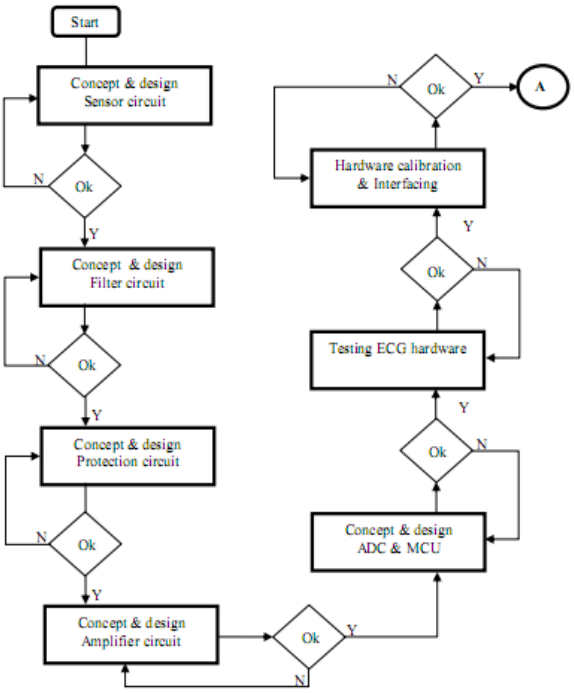

Figure 1. The Hardware designing of the signal tapping

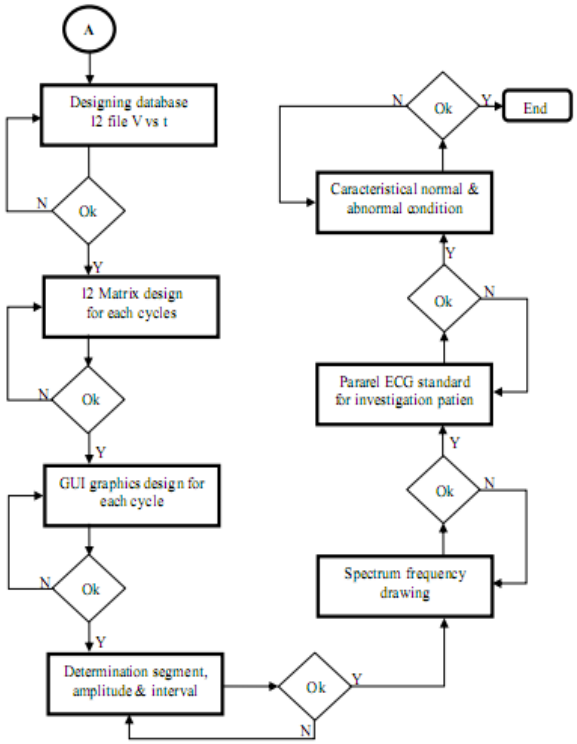

Figure 2. The software designing of the the data storage and signals processing

3. Determining the ECG Parameters

The informations needed from the ECG are the values of the peak amplitude, segmental and interval duration [2,3,15,16]. In designing the software, referring to figure 3 (lead II) and 4, for another may be determined based on the values of the amplitudes as follows :

Point P : obtaining the first maximal positive value

Point Q: obtaining the first minimal value

Point R: obtaining the second maximal positive value

Point S : obtaining the second minimal value

Point T : obtaining the third maximal value

While for the segmental and interval values, a sign is segmented as follow :

-calculating the duration of the amplitude on the condition:

$-0.5mV \leq a_1, a_2, a_3, a_4 \leq 0.5mV$

-calculating the duration of the amplitude on the condition : $0.5mV > b_1, b_2, b_3, b_4$

-calculating the duration of the amplitude on the condition:

$-0.5mV > c_1, c_2$

Based on the segmentation,then :

Segment PR = a_2

Segment ST = a_3

Interval PR = b_1+a_2

Interval QRS = c_1+b2+c_2

Interval QT = $c_1+b_2+c_2+a_3+b_3$

Interval ST = a_3+b_3

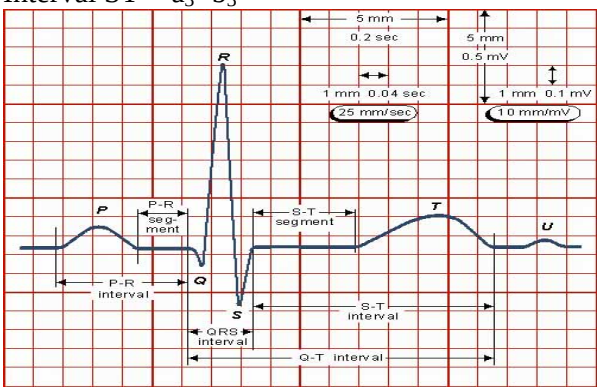

Figure 3. One cycle wave in the ECG sheet.[5]

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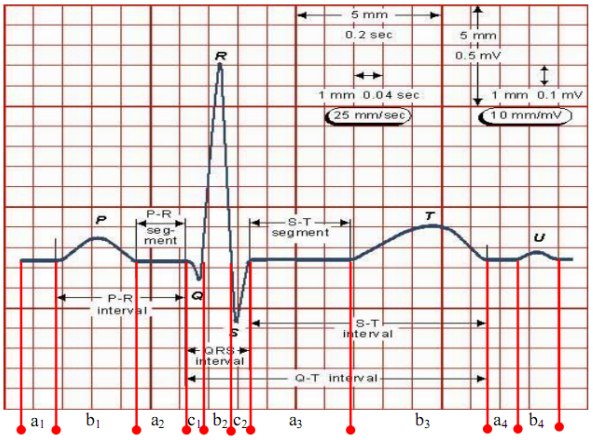

Figure 4. Wave Segmentation from Figure 3

4. Determining the Values of the Signals

The values of the signals are the those of the length of the signal length, of power signals, of signal energy, of dot product and value of the vector of the signal amplitude. The values obtained as s follows [4,7,11,13,15]:

- **Waves Length**= counting the wave length $c = f.\lambda \Rightarrow \lambda = c/f$

- **Signal Energy** is obtained from the root of the number quadratic values of the amplitude in each point of time
  The value of the signal energy :
  $vA = \sqrt{a1^2 + a2^2 + a3^2 + ...+ an^2}$

- **Signal Dot product** (Dp) is the number of multiplication between the values of the amplitude and of the duration. Dp = the row vector (amplitude) * the column vector (duration)

- **Peak Vector of P,Q,R,S,T** in the Cartesian Coordinat is conversed into the polar form so they have a magnitude and phase angle of fasa $Mag.P = \sqrt{A^2 + t^2}$
  $\phi P = \tan^{-1}(A/t)$

5. Determining the Spectrum Frequency

The frequency spectrum is obtained from the application of the FFT method in the first-cycle signal data. From the observation, very valueable information on the bandwith (the width of the frequency area, range frequency), modulation effect, and false signal generation [1,8,9,10].

III. RESULT

Based on the strained discrete data as the time function, the followings are obtained :
- ECG waves appropriate with one cycle
- Values of the heart rate in one cycle
- Values of peak amplitude of P, Q, R, S dan T in one cycle
- Values of the internal duration of PR, QRS, ST dan QT in one cycle
- Values of the duration of the segments of PR and ST in one cycle
- Values of the wave length in one cycle
- Values of the signal power in one cycle
- Values of the signal energy in one cycle
- Bandwidth of each signal in one cycle

IV. CONCLUSION

The designing of this tool will result in:
- faciliting the observer because he will be quicker in getting the ECG information due to the fact that he will not make some calculation anymore
- each variation of signal will be able to be distinguished base done ppropriate values of the signals and spectrum
- facilitating the maintenance of the tool because the hardware and software are separated.
- no dependency happens on the ECG sheet because the results may be printed in ordinary sheet (HVS folio, HVS kwarto,etc) with any printers
- facilities of the history of the patient's examination are available because of the existing data storage
- the general practitioners or patients may interprete the results because the information is in the numerical form
- the price of the ECG tool is lower than the existing ECG

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VI. REFFERENCE

1. David Prutchi, Michael Norris. 2005. *Design and Development of Medical Electronic Instrument*. A John Wiley & Sons, Inc., Publication
2. Guyton. Arthur & Hall.E , 2008, *Textbook of Medical Physiology*, 11th edition, Elsevier, Singapore
3. GA. Stoufer. 2009. *Practical ECG Interpretation*. Wiley-Blackwell. A John Wiley & Sons, Ltd, Publication
4. John R.Cameron, James G. Skofronick, Roderick M.Grant, 2006. *Physics of the Body*, 2th, University of Wisconsin-Madison
5. John R Hampton, 2003. *ECG made Easy*. Churchill Livingstone
6. Myer Kutz. 2009, *Biomedical Engineering and Desain Handbook*. 2th, Vol.1, McGrawHill, ISBN: 978-0-07-170472-4
7. Narayana KVL, *Noise Removal using adaptive noise canceling, analysis of ECG using Matlab*, International Journal of Engineering Science and Technology (IJEST),ISSN:0975-5462, vol.3, no. 4 April 2011
8. PA Otubu, *For the Realisation of the design of Electrocardiogram for the Monitoring of the Physiology of Human Heart*, Journal of Engineering and Applied Sciences 3(11):856-860, 2008. ISSN:1816-949X,@Medwell Journals, 2008
9. Ramesh Kumar S, *The Deterministic Chaos in Heart Rate Variability signal and analysis Techniques*, International Journal of Computer Applications (0975-8887), vol.35, no.7, December 2011
10. Sachin Singh, Netaji Gandhi, *Pattern analysis of different ECG signal using Pan-Tompkin's algorithm*, International Journal on Computer Science and Engineering (IJCSE), vol.02, no.07, 2010, 2502-2505
11. Sarika Tale, *Time and Frequency domain analysis of Heart rate variability signal in prognosis of type 2 diabetic autonomic neuropathy*, International Journal of Engineering Science and technology (IJEST), ISSN:0975-5462, vol.3, no.4 April 2011
12. Stevan Silbernagl, Florian Lang. 2000, *Color atlas of Pathophysiology*, Thieme, Stuttgart-New York
13. S.Karpagachelvi, Arthanari, *Classification of Electrocardiogram signals with Support vector machine and relevance vector machine*, International Journal of Engineering cience and Technology, vol.2(11), 2010, 6511-6520
14. Shirley A John. 2008. *ECG Success, Exercises in ECG Interpretation.* F.A. Davis Company. Philadelphia
15. Webster J.G. 2004. *Electrical Measurement, Signal Processing and Display*. CRS Press LLC