Abstract-- The information the observer needs from the Electrocardiogram (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 to 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 matrix 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.

Index Term-- 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 [2,3,4,5,6]. 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 the waves 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 results in either the time counting or diagnosis. The examination 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 Conversion (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 prodvided 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 discrete 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 processing 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.
Fig. 1. The Hardware designing of the signal tapping

Fig. 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 [1,3,16,17]. In designing the software, referring to figure 3 (lead II), 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:
  -0.02mV≤a₁, a₂, a₃, a₄≤0.01mV
  - calculating the duration of the amplitude on the condition:
    0.01mV> b₁, b₂, b₃, b₄
  - calculating the duration of the amplitude on the condition:
    -0.02mV>c₁, c₂

Based on the segmentation, then:
Segment PR = a_2
Segment ST = a_3
Interval PR = b_1 + a_2
Interval QRS = c_1 + b_2 + c_2
Interval QT = c_1 + b_2 + c_2 + a_3 + b_3
Interval ST = a_3 + b_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 follows:

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

- **Power signal** is obtained from the root of the number quadratic values of the amplitude in each point of time
  \[ v_A = \sqrt{a_1^2 + a_2^2 + a_3^2 + \ldots + a_n^2} \]

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

- **Waves Length** = counting the wave length
  \[ c = \frac{f \lambda}{f} \Rightarrow \lambda = c / f \]

- **Long Line** is \( \Sigma \sqrt{(V_n - V_{n-1})^2 + (0.004)^2} \)

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 valuable information on the bandwidth (the width of the frequency area, range frequency), modulation effect, and false signal generation [1, 8, 9, 10].
Table II

ECG parameter for Measurement itself

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<td>Sabar Sethody/14</td>
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Figure 4 and Figure 5 shows the change in the discrete signal 1 cycle leads II from the time domain to the frequency domain for record 16265 and measurement itself record. Figure 6 show report measurement for record masd-250-1 and srir-250-1.
Fig. 4. Changes discrete signal from the time domain to the frequency domain 1 cycle leads II for to record 16265.

Fig. 5. Changes discrete signal from the time domain to the frequency domain 1 cycle leads II for to record measurement itself.
IV. CONCLUSION
The designing of this tool will result in:
- Facilitating 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 appropriate 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

V. ACKNOWLEDGEMENT
This research was funded by the DP2M Dirjen Dikti in line with the attachment of the Dirlitabmas decision no. 0094/ES.1/PE/2015, under the scheme of Penelitian Hibah Bersaing, with the title of Perancangan Elektrokardiogram 12-lead berbasis computer.

REFERENCE
REPORT MEASUREMENT

Date/time: 4/6/2015 3:47:41 AM

Code/Name: [Redacted]
Sex/Female: Male / Married
Date/place of birth: 17-06-1990 / Bandung
Height/Weight: 70 / 70
Home address: [Redacted]
Blood type: O

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ACTUAL ELECTROCARDIOGRAM

Other Information:

Diagnosis: [Redacted]

Signature: [Redacted]
**REPORT MEASUREMENT**

Date/Time: 5/26/2015 6:44:54 PM

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- **Sex/Sexes:** Female / Unknown
- **Date/Gender:** 03/04/1657 / M/F
- **Height/Weight:** 110 / 00
- **Blood group:** O

**ACTUAL SIGNAL VALUES**

- **Heart Rate:** 110 BPM

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**ACTUAL ELECTROCARDIOGRAM**

**FIG. 6.** Report measurement for record Srir-250-1 and record Masd-250-1

**Other Information:**

Diagnosis: Malang 6/27/2015

Signature: