ANALYSIS OF THE ELECTROCARDIOGRAM BY MEANS OF CHARACTERISTICS OF THE DISPROPORTIONALITY OF NUMERICAL FUNCTIONS

Munther Al Shehab, Safwan Al Salaimeh, Shaker Dwairy, Wa'ed Hatamleh

Aqaba University of Technology, Aqaba, Jordan

Corresponding Author: Safwan Al Salaimeh, safwan670@yahoo.com, ssalaimeh@aut.edu.jo

ABSTRACT: Electrocardiography: this is a method of recording the potential difference between two points in the electric field of the heart during its excitation. The modern technology allow you to record ECG on a long time interval in condition of person normal life(portable cardio); when carrying out functional tasks with doses physical exertion (bicycle ergometer, treadmill) and tests with the introduction of medicament preparations.
To solve the problem, the following non-proportionality can be used: by the first - order derivative, by the value of the first order, as well as the disproportionality for the function y(t) by x(t), given parametrically.
In this paper was an analyzed ECG assistant with the characteristics of the proportionality of numerical functions.
KEYWORDS: ECG, Process, Excitation, Function, Proportionality, Record.

1. INTRODUCTION

Electrocardiography: this is a method of recording the potential difference between two points in the electric field of the heart during its excitation. Figure (1) shows two cycles of a normal electrocardiogram using common notation for the elements of the signal of electrical processes in the heart and phases of electrical processes of the heart when coverage by excitation of the on the electrocardiogram (ECG) arises P.
The complex QRS correspond to the depolarization of the ventricular myocardium. During full coverage by excitation of ventricles, absent and an ISO – electric ST recorded on the ECG. A ward of repolarization of the ventricles – prong T.
The modern technology allow you to record ECG on a long time interval in condition of person normal life(portable cardio); when carrying out functional tasks with doses physical exertion (bicycle ergometer, treadmill) and tests with the introduction of medicament preparations. Amplitude of cardio signal, shot in this patient at different times can slowly change due to, for example, variable resistance current carrying medium (a solution of sodium chloride or electrode paste) between the electrode and the body, changes, connected with unequally adherence of electrodes due to the presence of the hairline of the skin. Besides, with the repeated removal of ECG electrodes are difficult to establish just as they were installed and previous registrations, but how removable Electric Driving Force (EDF), inversely proportional to the square of the distance from the electrode to the heart, then the error in setting the electrodes causes a change in the absolute value of the EDF. The influence of the listed factors leads to the one that being recorded and the value of the potential difference differs from the real EDF of the heart to the scale factors, the value of which is unknown and can change slowly randomly. Decoding ECG includes a selection and analysis of prongs, segments and intervals (P, QRST, RS –T, T, Q -T), it shows the complex process of propagation of the excitation wave over the heart. When analyzing a prongs and their complex are determined by the polarity, duration, amplitude. Qualitative features describe the form: split prongs, broadness, serration, surrounding, horizontal, skewness, canopy, steep, absenteeism and others.
It is required to propose a method, allowing quantities description on changes in the form of prongs or their complex. ECG can be regarded as a piecewise – smooth function of one variable $= f(t)$, specified at a time interval [0,T].
Let there are two numerical function $x(t), t \in [t_{n1}, t_{k1}]$ and $y(t)$, $t \in [t_{n2}, t_{n2}]$, describing the shape of the prongs at different times and recording it at intervals of the same length. When you change the shape of the prongs, the relationship between y(t) and x(t) – proportional that is

$$y(t) = cx(t) \qquad (1)$$

Where c - coefficient of proportionality. Any deviation of the relationship between x(t) and y(t) from proportional evidence of a change in the shape of prongs (distortions y(t) relatively x(t)).
By hypothesis, the coefficient c is unknown. Define it for a relationship $d(t) = \frac{y(t)}{x(t)}$ is it possible only

when prongs registration intervals d(t) = const. Otherwise, d(t) = var and is not known what its value should be taken as a constant coefficient c, to evaluate at what values t the relationship between y(t) and x(t) deviates from proportional and how much.

In this way, formally, the problem reduce to the need for a quantitative description of the deviation of the relationship between y(t) and x(t) from the device is proportional with the unknown value of coefficient c.

Similar problems arise, for example, in estimating the signal distortion y(t) at the output of the device under study (amplifier, converter, telemetry channel) in comparison with the input signal x(t), when comparing two images, functions x(t) and y(t) and others.

2. FORMULATION OF THE PROBLEM

On the set of Ω of real numbers there are given piecewise continues real function x(t) and y(t), having one derivative. Suppose that for $t \in \Omega_1$, where $\Omega_1 \subset \Omega$, the relationship between function is described by expression (1).

It is necessary to find a functional that, regardless of the value of the coefficient c in (1), is zero in the region $t \epsilon\ \Omega_1$.

3. METHOD FOR SOLVING THE PROBLEM

Because the x(t) , y (t) are deterministic, then for a fixed dependence y on x is unambiguous and can be considered as a parametric.

In work [SB06] the developed characteristics of the non- proportionality of numerical functions with respect to derivations (2) and values (3)

$$@d_x^{(n)} y = \frac{i d_x^n}{n! d x_n^n} \tag{2}$$

$$@v_x^{(n)} y = y - \frac{x^n d_y^n}{n! d_x^n} \tag{3}$$

To solve the problem, the following non-proportionality can be used: by the first - order derivative, by the value of the first order, as well as the disproportionality for the function y(t) by x(t), given parametrically.

Disproportionality with respect to the derivative and value of the first order of the function y(t) by x(t), specified parametrically.

$$@d_x^{(t)} y = @d_{\varphi(t)}^{(t)} \Psi(t) = \frac{y}{x}\frac{y_t}{x_i} = \frac{\Psi_{(t)} \varphi_t(t)}{\varphi_{(t)} \varphi_t(t)} \tag{4}$$

$$@v_x^{(t)} = @v_{\varphi(t)}^{(t)} \Psi(t) = \Psi(t) - \varphi(t) \frac{\Psi_t(t)}{\varphi_t(t)} \tag{5}$$

Equal to zero regardless of the value c, if x(t) and y (t) satisfy the condition (1). And, the use of estimates of non-proportionality makes it possible to estimate the difference between the independence of functions from the proportional at each point of the set , on which the function is specified.

Consider ECG changes, emerging with hypotrophy of the atria. The slowing down of the electric pulse in the left atrium leads to a later one, the norm or rate; the end of his excitation and to enhance the synchronous of depolarization of both atria fig (2) .

As a result of ECG a split prongs appears P, the total, and its duration increases fig (4,5) compared to the figure (3).

In order to quantify at what times and how much the shape of the prongs P is distorted it is proposed to use disproportionate (5). Figures (6) and (7) show graphs of the non- proportionality of the function 5, the graphs of which are presented in figures (4,5) in relation to the function, describing distorted prongs P figure (3). It can be seen that a large changes in the shape of the prong correspond to large changes in the estimate (5). And if the functions describing the prong P would differ only in the scale factor, than disproportionality function was equal to zero in the whole range of its task.

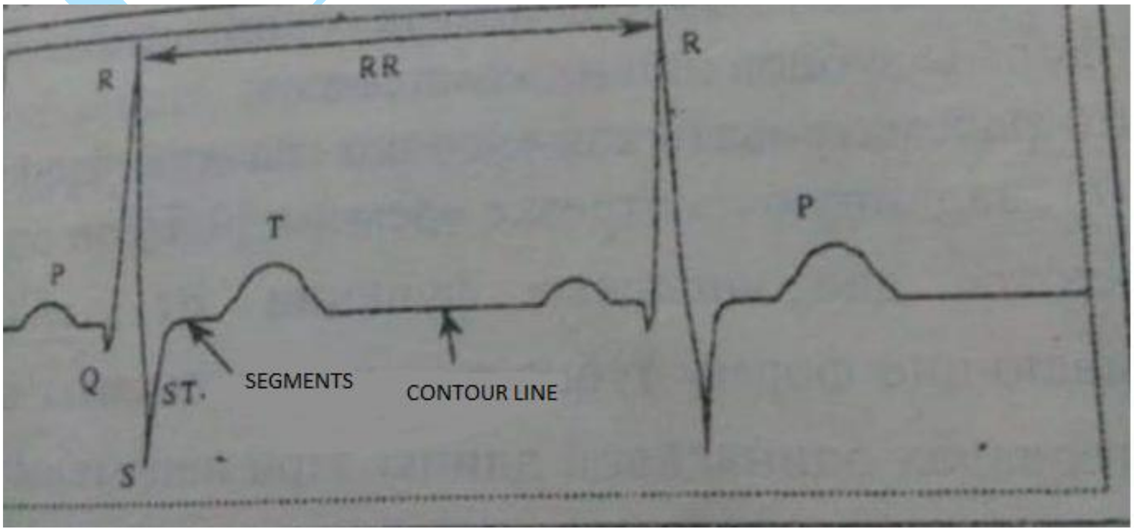

Figure 1: Two cycles of a normal electrocardiogram

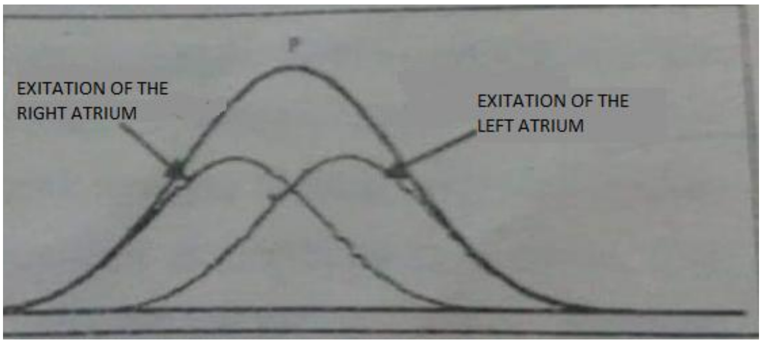

Figure 2: The excitation of the left and right atrium

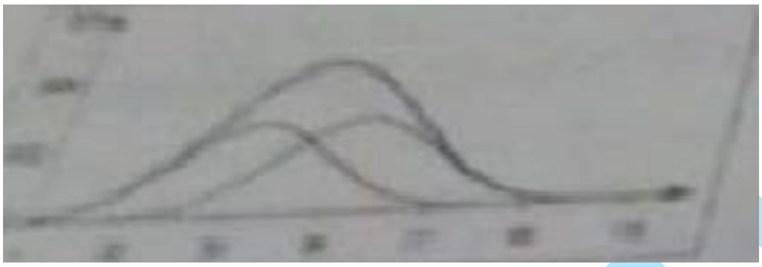

Figure 3: Describing of distorted prongs P

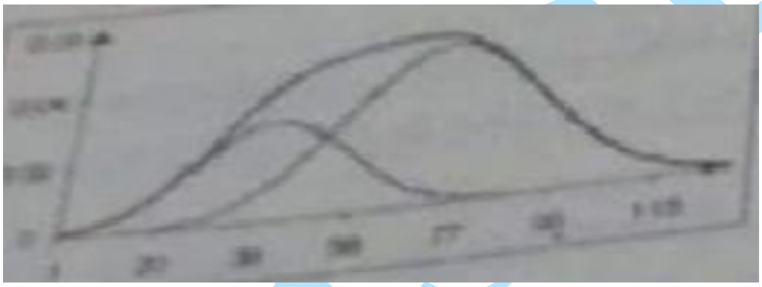

Figure 4: The total of result of ECG, and its duration increases

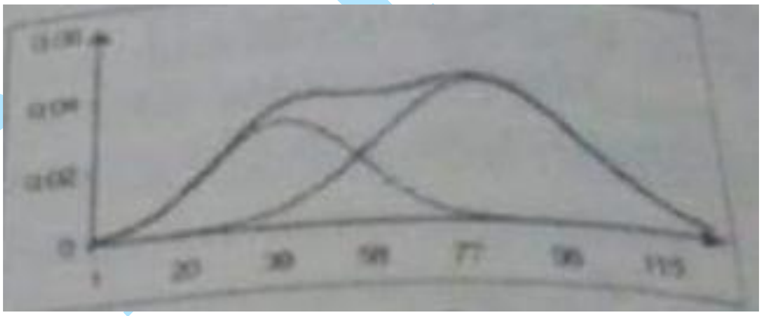

Figure 5: The total of result of ECG, and its duration increases

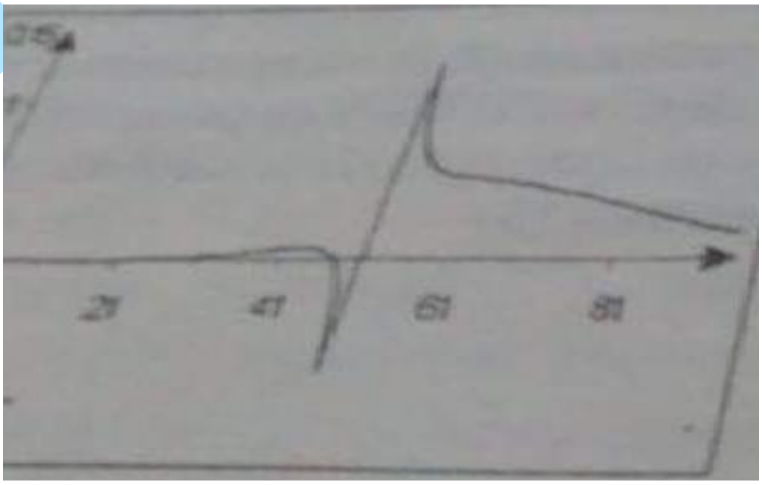

Figure 6: Graph of the non-proportionality of the function 5

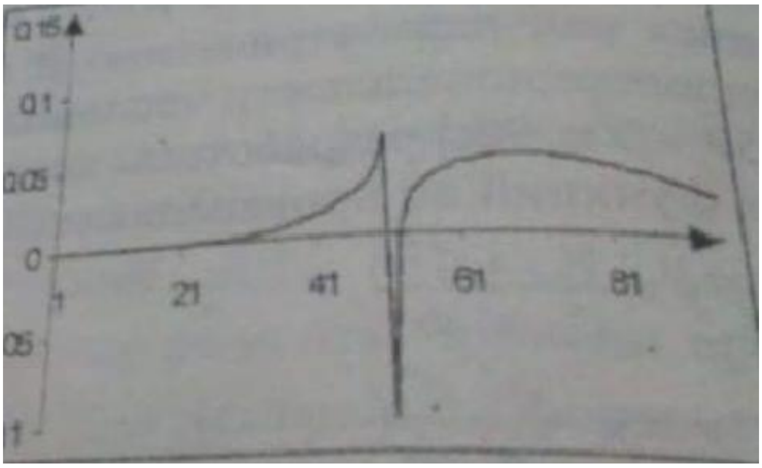

Figure 7: Graph of the non-proportionality of the function 5

4. CONCLUSION

In this way, instead of qualitative evaluation, changes in the shape of the prong and their complex in the application of non-proportionality 5 allows these changes to be described quantitatively at each tome point. Specifically, and for the task of analyzing ECG, its application makes it possible to quantity the effect of treatment or quantitatively describe the process of changing the shape of the prong or their complex in time. It is possible to process and ECG, removal for different gains in the ECG.

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