

# Processing of Electrocardiogram File in Mobile Phones on Symbian Operating System

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**Abstract**— This paper has been devoted to finding pulse processing electrocardiogram file and the description of electrocardiogram in the phone.

**Keywords**— ECG (electrocardiogram); pulse; mobile phone; Symbian

## I. INTRODUCTION

As it is known, Electrocardiography is an interpretation of the electrical activity of the heart over a period of time, as detected by electrodes attached to the outer surface of the skin and recorded by a device external to the body. The recording is called electrocardiogram (ECG). Having ECG analysis one could get detailed information on the heart. ECG is used to measure the rate and regularity of heartbeats, as well as the size and position of the chambers, the presence of any damage to the heart, and the effects of drugs or devices used to regulate the heart, such as a pacemaker [1]. Normal ECG has 3 waves called *P*, *QRS* and *T* and there are three straight lines among them. The changes in these waves and lines show usual changes beyond. Typical ECG signal may be displayed in the flowing figure.

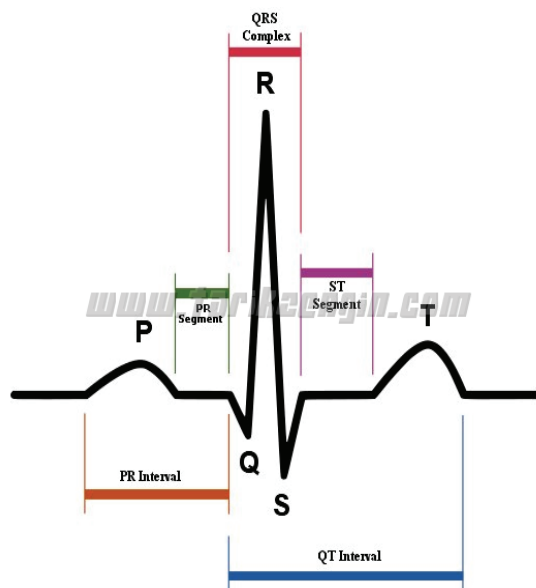


Figure 1. Schematic representation of normal ECG

Pulse is a dance of arterial walls with regard to blood circulation in heart. In details, when saying a pulse one understands any changes in blood vascular system with regard to heart's activity. The following pulse types are usually classified: arterial, venous and capillary pulse. Pulse shows heart beating. So, depending on person's condition the number of pulse sometimes increase or decrease. Person's pulse number changes depending on his/her age, sex, excitement, temperature and activity. As a rule, during illness changes happen in person's pulse number and pressure.

Pulse is measured with several means. Usually it is measured at the wrist, at the neck also with pulse measuring watches, digital blood pressure tools or with other tools. They measure the pulse in online mode. It is clear that pulse can be found with electrocardiogram reflecting the heart activity. If taken electrocardiogram is saved as a file, this work can be automated. We worked out displaying ECG graphic and pulse measuring program from taken electrocardiogram files in mobile phones on Symbian operating system. Symbian is one of the operating systems used in mobile phones. Modern information technologies allow to take a picture of a paper electrocardiogram and to send far distance. Note that our program has been written in *QT* ("cute", or unofficially as *Q-T cue-tee*) environment [2]. *QT* library developed by Trolltech Company supports Symbian platform.

## II. PROBLEM STATEMENT

File on ECG signals is provided. The issue before us is finding pulse processing electrocardiogram file and the description of electrocardiogram in the phone. Patient's electrocardiogram is taken by means of portative tool, is saved as a file, and is send to mobile phone.

## III. SOLUTION

See the algorithm work of the program.

### A. Template to recognize the characteristic parts of cardiogram

To make a template we take electrocardiogram file of a healthy person with a frequency of 1000 Hz. For use of visual aids we first of all move the numbers in text file to Microsoft Excel. Taking into account that the coordinate system on the phone screen is the right-hand oriented the numbers in Microsoft Excel are multiplied by -1. We build the schedule of electrocardiogram on the obtained numbers.

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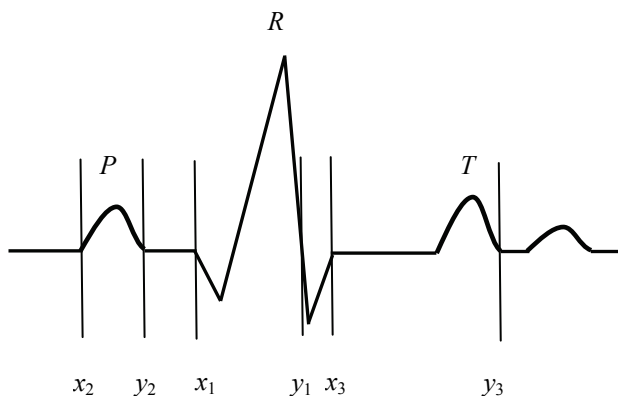


Figure 2. Separating characteristic parts of ECG

We determine and separate characteristic parts. For example, we marked the place of QR interval of electrocardiogram  $[x_1, y_1]$ , the place of P wave  $[x_2, y_2]$ , the place of T wave  $[x_3, y_3]$  [3, p.70]. After this we create the file named Template01 with the following structure.

- 1 - The number of file
  - 1000 - The frequency with which the electrocardiogram was taken (Hz)
  - N - Number of figures in one period
  - $x_1 y_1$
  - $x_2 y_2$
  - $x_3 y_4$
  - $a_1$
  - $a_2$
  - .
  - .
  - $a_N$
- } Numbers in one period

### B. Processing the electrocardiogram

In order to process text-type electrocardiogram file included in mobile phone we use template file. We collect the numbers in text file to float type x array. And we collect the value of the part of the template file from  $x_i$  point to  $y_i$  point to Sh array. In order to find suitable place to  $[x_i, y_i]$ , ( $i=1,2,3$ ) part of the template we use the following correlation function:

$$K(\tau) = \int_0^{(y_i-x_i)} Sh(t) \cdot x(t+\tau) dt, (\tau=0,1,\dots,N-1)$$

Here,  $K(\tau)$  is correlation coefficient,  $t$  is time,  $N$  is number of figure. Sh and x are written above.

We found maximum according to  $\tau$  in accordance with  $K(\tau)$  and assigned to  $R_1, R_2, \dots, R_n$  variables. This allows us to measure pulse. To note that numbers are given in millisecond according to frequency of electrocardiogram. In order to find period between two consecutive QR interval we must multiply the difference of  $R_{i+1}-R_i$  to 1000. The following formula is used to find approximate pulse according to heart beat in  $N$  quantity:

$$\text{Pulse} = \frac{60 * 1000 * (n - 1)}{R_n - R_1}$$

Here,  $n$  is a number of figure in array.  $R$  is written above.

As a result of program work in the screen of mobile phone pulse value, graphic image of electrocardiogram is displayed (Figure. 3).



Figure 3. Description of the graphic in Nokia mobile phone

### IV. CONCLUSION

We make program on Symbian operating system in mobile phone. This program provides measuring pulse and displaying graphic in the phone using given electrocardiogram file.

### REFERENCES

- [1] <http://en.wikipedia.org/wiki/Electrocardiography>
- [2] <http://qt.nokia.com>
- [3] V.N. Orlov. Guidelines for electrocardiography. Medicine, Moscow, 1983, 220 p. (in Russian)