

# Self-Control of Heart Rhythmdisorders

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## Abstract

**The broken rhythm of the heart activity of a person can lead to fatal consequences if it is not detected at an early stage. The article described a device for counting and indicating the number of violations of rhythm of cardiac activity. The device is intended for home use and does not require medical knowledge. If the patient will notice a trend towards the increasing number of arrhythmias, he must seek for cardiology advice.**

## Keywords

**Heart Activity, Cardiac Arrhythmia, Number of Arrhythmias**

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## 1. Introduction

One of the more common signs diseases of the vascular system is disturbance of the rhythm of the heart, known under the name of arrhythmia when appears extrasystoles or falls of the next QRS complex and other. This disease is diagnosed when a doctor's visit and its initial period, usually overlooked by health professionals. Rare and irregular visits by the patient's physician can cause the disease detected at the stage, threatening to human health. Therefore, it is necessary arrangement for regular self-examination by the patient at home without recourse to the assistance of medical personnel. Objective assessment of the number of violations of the rhythm of the heart in the home will allow the patient to pay attention to the change in the normal activity of the heart and to go to the doctor, which may lead to the detection of diseases at an early stage. In the clinic, objective assessment of the number of arrhythmias will allow the doctor to increase the effectiveness of the strategy and tactics of treatment.

The task of measurement and predict of arrhythmias has a big history [1]-[3]. However, these and many other technical solutions to this problem do not provide for personal use due to the patients without medical education at home.

## 2. Technical Base

The device relates to medical equipment and, in particular, to devices for individual control of cardiac activity. The device is a compact unit with self-contained battery-AAA class and contains 4 Sensor electrocardiosignals S1, ..., S4, blocks of analog electronics and digital processing with alphanumeric single-line display. The device has a minimum of arm controls: one button start-up. The generalized block diagram of the device is shown in **Figure 1**.

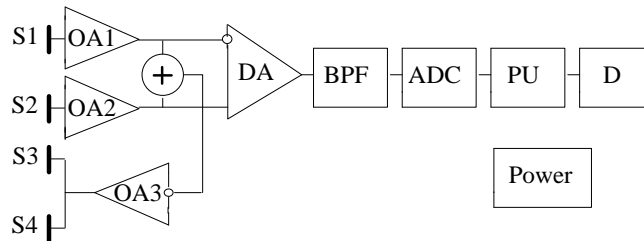
The device consist 4 sensors S1, ..., S4, the adder, denoted by the symbol +, the OA is Operational Amplifier, the DA-Differential Amplifier, the BPF-Band Pass Filter, the ADC-Analog Digital Converter, the PU-Processing Unit, the D-Display. The sensor S1, ..., S2 provides an electro-mechanical contact with the skin of the patient and converts the electrical activity of the heart in electro cardio signals. The sensors S3, S4, the adder and OA3 implements the reduction of interference from the industrial power frequency.

The unit of analog electronics provides of filtering, amplification and ADC of electrocardiosignals. In the digital processing unit produces the first operation pulse-forming binding to a characteristic point of the QRS complex, as a rule, to the maximum QRS. Then we performed the operation of removing the drift isoelectric line in accordance with [4]. The essence of this technical solution consists in determining the parameters of the drift in the interval between points T and P of adjacent QRS complexes and noise compensation on the basis of this information.

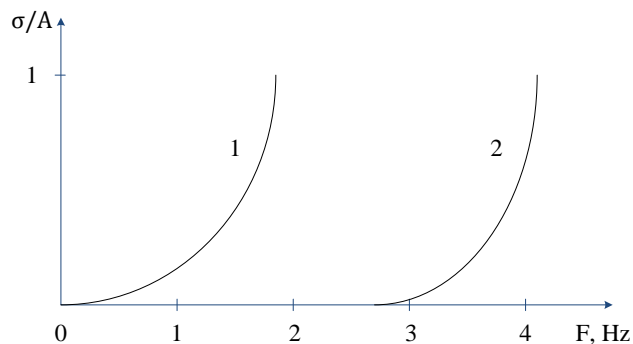
When forming the compensating signal is used spline approximation. In the process of modeling frequency interference drift varied from 0.1 to 6 Hz (the maximum possible value of heart rate of man). Efficiency was estimated as the average squared difference  $\sigma$  between the original signal and the signal obtained by compensation. The simulation results in software LabWiev of the filtering process is shown in **Figure 2**.

Later in PU of length of each RR interval measured, and  $RR_i$  is formed an array with dimension  $N$ ,  $0 < i < N$ . The length of each of the current RR interval is converted in the usual heart rate, beats per minute. The measurement time is near 1 minute. The measurement time  $T_m$  is synchronized with the RR intervals and equal to the total duration of the whole number of RR intervals according to the formula:

$$T_m = \left( \sum_{i=0}^N RR_i \right) \geq 1 \text{ min.}$$



**Figure 1.** The generalized block diagram of the device.



**Figure 2.** Efficiency adjustment contours using the spline approximation. 1: linear spline, 2: cubic. A is the maximum value of the R-wave.

Here the symbol  $\geq$  is to be understood as the nearest larger or equal 1 min.

If time of measurement synchronization to an integer number RR intervals not producing, there can be a large error caused by the lack of an integer ratio of the duration of RR intervals and 1 minute. Then an average value  $\overline{RR}$  is calculated is in units of beats per minute is the rate of the heart RH and checks the length of each  $RR_i$  interval on the deviation from the average  $\Delta R = \overline{RR} - RR_i$ . If  $\Delta R > 10\%$ , in the counter of arrhythmias is added 1. The threshold value of 10% or other should appoint an experienced cardiologist. The algorithm of detection of QRS complex is tested on the signals from an electronic database of MIT-BIH [5] and showed an average probability of correct detection 99.56% and the average probability of false detection of 0.27%.

### 3. The Method of Using the Device

The patient himself applies the device sensors to a body in the area of the left breast roughly in the area of the heart and press a button “Start”. At the end time of the measurement the display shows the value of the heart rate and then the number of violations of rhythm. Changing screens is performed with a period of 20 s with a total duration of display 2 minutes.

For early detection of measurement according to the described technology must be made several times a week. If the patient has noticed a trend to increase the number of arrhythmias or other unusual symptoms, he should immediately consult a cardiologist.

### 4. Design of Device

**Figure 3** shows an external view of the instrument (a-external, b-back side). The display left the familiarity is a symbol of the regime. Shown by the letter in Russian transcription, it indicates the word “pulse”, the right number of beats per minute. The button “start” is located to the right of the display. Compact loudspeaker beeps and disposed within the housing for three holes on the front panel.



(a)



(b)

**Figure 3.** (a). Outer side. (b). External side.

## 5. The Procedure of Compression Electrocardiosignals

It is generally useful to save the flash card of electronic records of electrocardiosignals on the basis of which was detected arrhythmia with aim to analyse records of cardiologist. This leads to compression of the initial information. This problem was solved by many researchers and here is analyzes statistical approach.

The technical nature of this decision, the compression of ECS can show by example that uses the Database records of the MIT-BIH Arrhythmia Database [5]. If you build a histogram of the distribution of HR for 100 records... 104, it is easy to see that for all records there is the heart rate distributed according to the law, somewhat resembling normal, with different mathematical expectations. For example, to record 100 the maximum of the histogram falls on the bin of the histogram, corresponding to 76 BPM and 286 appearances in HR periods of RR intervals with such HR. **Table 1** shows the maximum number of RR intervals in the record, the number of which is indicated in the top row. The value of the heart rate corresponding to the maximum if the number of intervals, indicated in the bottom row.

**Table 1.** Maximums of histograms for different records and the corresponding beats of the heart.

№ record	100	101	102	103	104
max	286	230	368	269	320
HR	76	60	72	69	73

This leads to thought about how to convey the need discrete digital counts only one RR interval, and not all 286 caught in the specified bin. In addition, you must pass the number of periods of the RR intervals within the ECG. Similarly, should be done with the transmission of RR intervals and their numbers in the continuous numbering accumulated in all else bunkers. This will significantly reduce the amount of transmitted ECG and adequately restore the ECG on the receiving end of the transmission channel ECG from patient to doctor.

Experimental experience has shown higher efficacy of procedures statistical compression with respect to the best known methods [6]. Naturally, the effectiveness of the procedure statistical compression will depend on the health of the patient.

## 6. Conclusions

Experimental experience shows that patients are willing to use the device in a domestic environment with the aim of self-control in the number of arrhythmias. This allows more flexibility to implement therapy prescribed by cardiologists. Cardiologists also are willing to use information on the number of arrhythmias recorded by the patient in the process of performance of medical procedures.

The described technologies may be implemented in the iPad, iPhone and others in full.

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