User Manual

The personal cardiovascular monitoring and analysis system is designed for pulse wave recording, heart rate variability parameter analysis, and result visualization. It utilizes the user's personal Android smartphone with installed software.

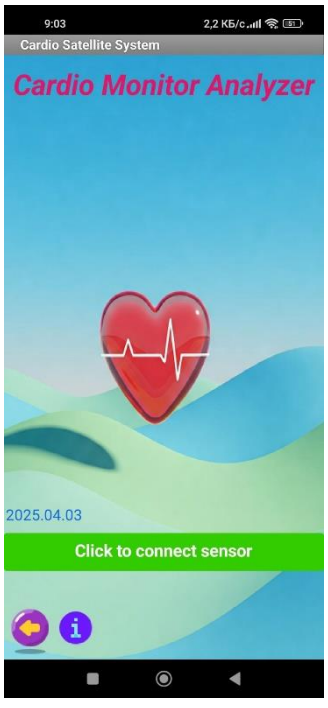
The kit consists of a pulse sensor, a USB-C connection cable, and the CardioSatellite mobile application. The mobile application can be downloaded from the developer's link.

The pulse sensor is designed as a clip that attaches to the first phalanx of any finger. For additional fixation of the connecting cable, you can use the ring included in the kit.

The sensor has a connector for attaching a cable. The other end of the cable connects to the user's smartphone. After connecting the sensor to the smartphone, an operation permission request will appear. You must grant it.

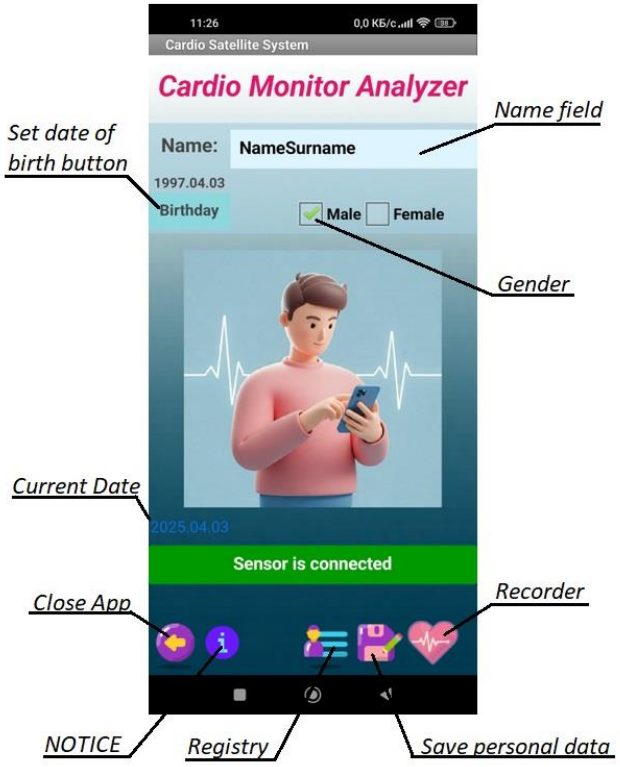
During application operation, data is exchanged between the sensor and the smartphone. When the application starts, the sensor is identified, which serves as a key to open the system and ensure its coordinated operation.

Each time the application is launched, you must press the "TURN ON SENSOR" button and activate the sensor. Then, a message similar to this will appear: "Allow 'Cardio Satellite' to access Seed XIAO MO device?" You must allow this. After that, immediately press the "Click to Connect Sensor" button, and the application's working window will open. If you delay pressing for more than 5 seconds, the connection will not be established. Screenshots are shown below

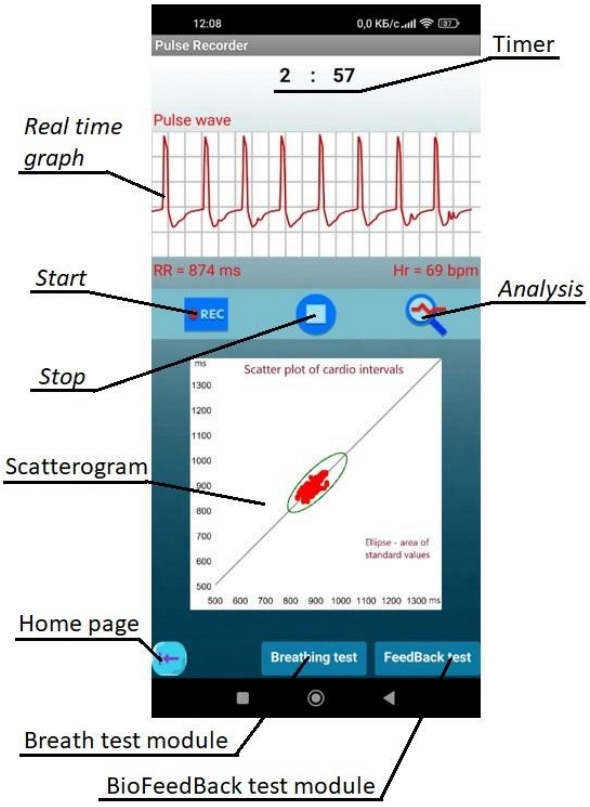


In the application's working window, you must enter the data: Name, Date of birth, and specify Gender. After that, press the Save button. Then, the system will be fully ready for operation.

Control element designations:



Pressing the Recorder button opens the module for recording pulse waves.



This initiates sensor setup, and the word "Ready" appears below the graphical field.

The Recorder module is equipped with a timer, set by default to 5 minutes. The five-minute recording is used in accordance with the recommendations established by the working group of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology.

To conduct the recording, attach the pulse sensor to your finger and press the "Start" button. This will start the timer, and the pulse wave graph will appear in the graphical field in real time.

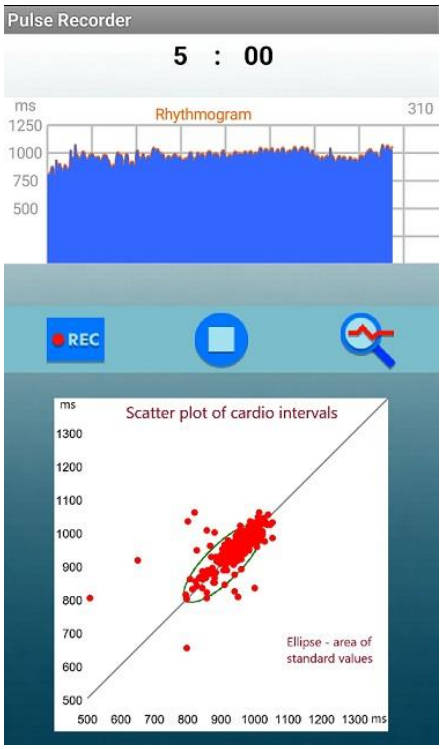
Please ensure that:

- the pulse wave graph is displayed clearly and without distortions;
- the signal is stable and uninterrupted;
- the sensor is firmly attached to your finger to avoid interference;
- you are in a calm state, without sudden movements;
- your body position remains unchanged during the recording;
- the ambient conditions are stable (room temperature, absence of strong sunlight);

- you have rested for a few minutes before starting the recording to stabilize your pulse

You can stop the recording by pressing the Stop button if necessary and restart it. During the recording, the sensor sends data to display the graph, calculates each cardiointerval and heart rate. Simultaneously, in real-time, a scattergram is built – a cloud of points corresponding to each heartbeat. This allows you to observe all heartbeats on one graphical field relative to the standard value range.

After the set time of 5 minutes, the recording automatically stops, a musical signal is produced, and a full Rhythmogram is additionally displayed.

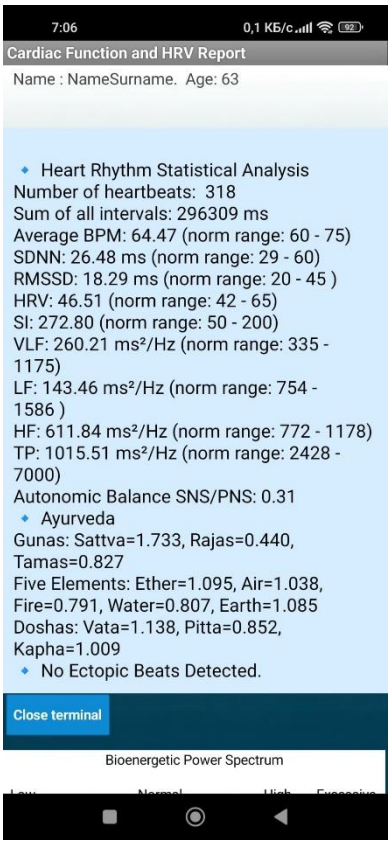


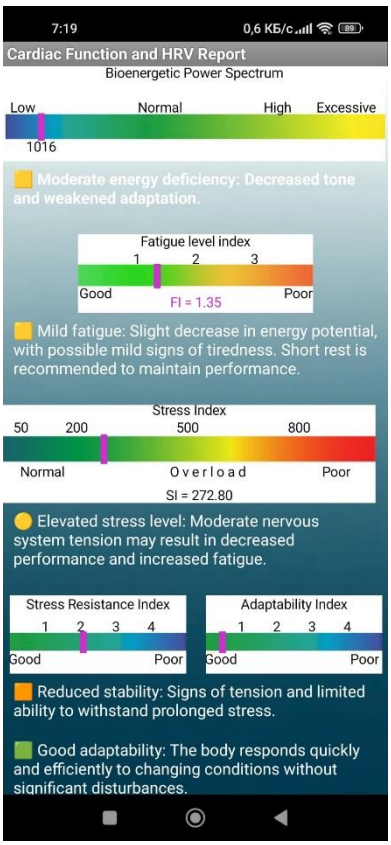
To analyze the obtained data, you need to press the Analyze button. This will transfer the data from the smartphone to the sensor's microprocessor for rhythmogram processing and necessary calculations. As a result of data processing, the rhythmogram is 'cleaned' from possible recording artifacts and potential extrasystoles. However, information about the presence or absence of extrasystoles is preserved.

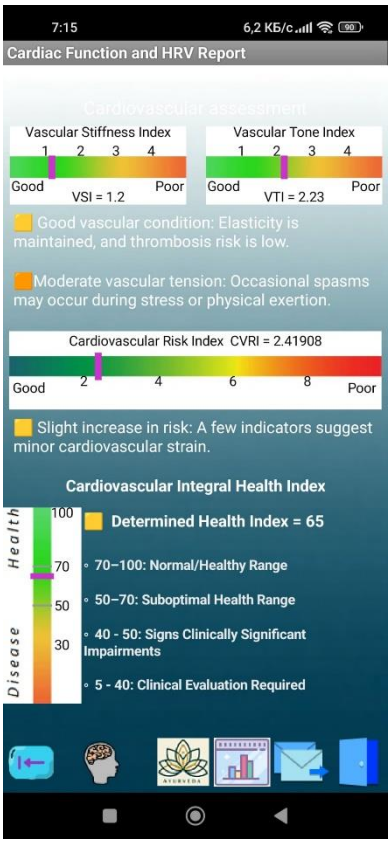
After the computational processing of data and mutual information exchange, the Analysis window opens, presenting the results as a report on cardiac function and pulse variability.

In the upper part of the Analysis window, numerical information on the main results of pulse variability assessment is presented in the Terminal. Below this block, a report on the main parameters of the cardiovascular system's condition is presented in the form of graphical scales with comments.

Below are screenshots of an example of a cardiovascular assessment report.







- Bioenergetic spectral power
- Cardiovascular system fatigue level
- Stress tension index
- Stress resistance index
- Level of adaptive reserve depletion
- Arterial stiffness index
- Vascular tension index
- Cardiovascular risk level/degree
- Integrated cardiovascular health index

The Analysis window contains a menu for activating other program modules.:

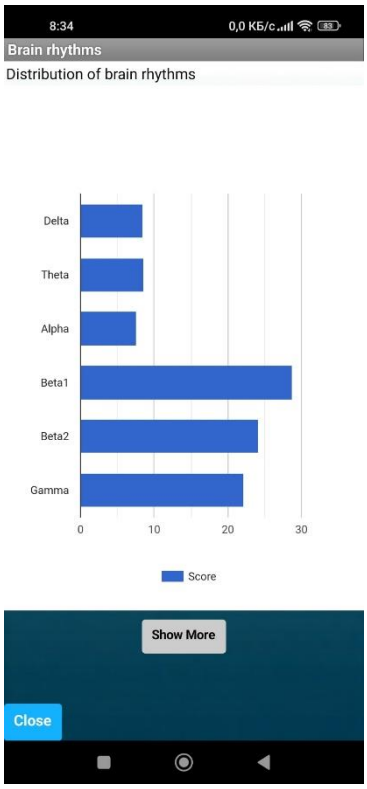
The Brain Rhythms module shows the percentage ratio of the calculated brain rhythms and a description.

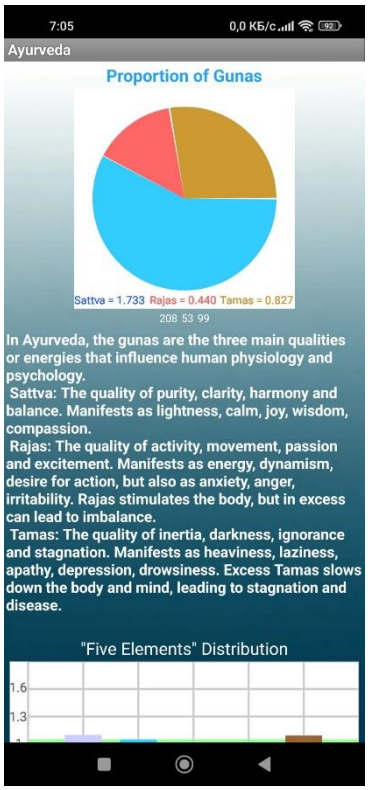
The Ayurveda module shows the interpretation of the results of the pulse variability assessment from the point of view of Eastern Medicine in terms of Ayurveda -

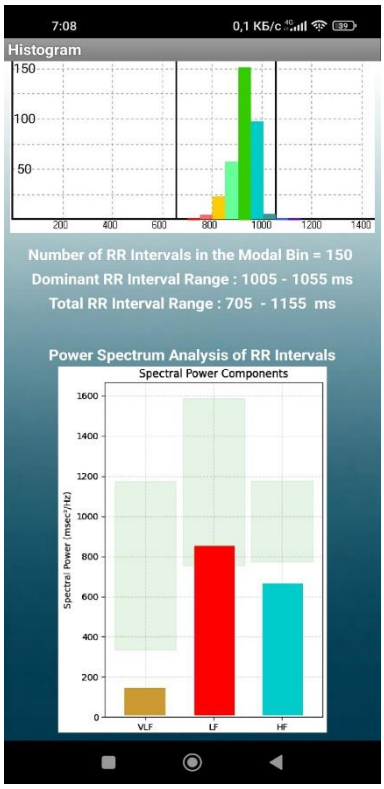
Guna distribution diagram, the ratio of the Five Elements and Dosha.

The Histogram module shows a histogram of the distribution of cardiointervals and a histogram of the results of the spectral analysis of the pulse wave with explanations.

Screenshots of the modules Brain Rhythms, Ayurveda, Histograms are presented below







In the Histograms module, a color circular diagram of cardiointervals is additionally presented – an individual pattern created by the heart's activity.

This diagram visualizes the sequence of cardiointervals (time intervals between heartbeats) in the form of a circular graph. Each cardiointerval is represented by a specific color and sector of the diagram, creating a unique 'heart pattern' that reflects its rhythmic activity.

Thanks to color coding and the circular form, the diagram allows for a quick and clear assessment of the heart rhythm's nature. Different patterns on the diagram can indicate various heart conditions.

Correspondence of heart rate to normal:

Even distribution of colors and sectors on the diagram indicates a normal sinus rhythm. Unevenness or the presence of repeating patterns may indicate rhythm disturbances.

Rhythm Variability:

The variety of colors and sector sizes reflects heart rate variability. High variability generally indicates good cardiovascular system adaptation. Low variability, conversely, may suggest the opposite.

Presence or Absence of Extrasystoles:

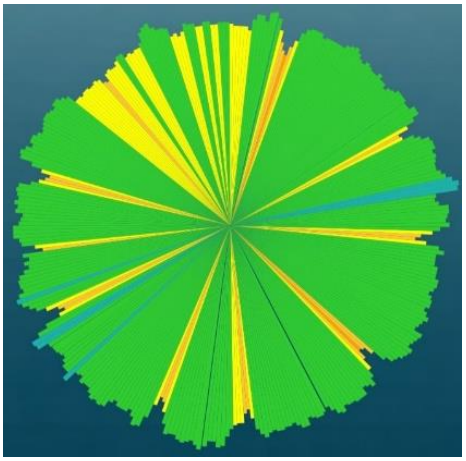
Extrasystoles (premature heart contractions) can be visually identified on the diagram as sharp changes in color or sector size. They can also be noticed as specific repeating patterns.

Advantages:

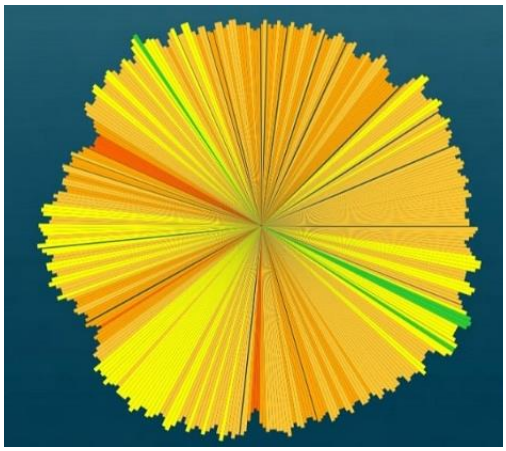
- **Intuitive Visualization:** The circular diagram provides an intuitive visualization of heart rhythm. This simplifies data analysis, even for individuals without medical training.
- **Rapid Analysis:** A glance at the diagram allows for an immediate general understanding of the heart rhythm's state. This is particularly useful for quickly assessing a patient's condition.
- **Individual Pattern:** Each study generates a unique pattern on the circular cardiointerval diagram.

Examples of obtained patterns

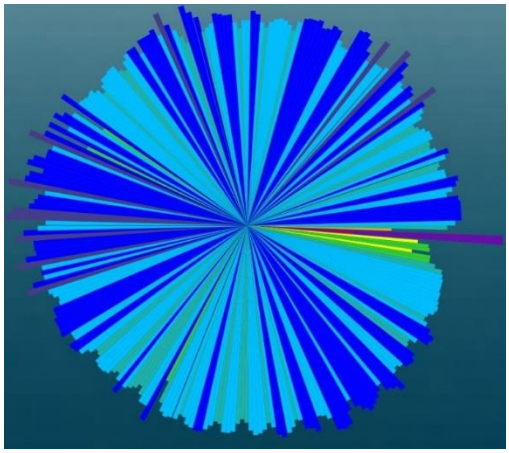
Stable active state



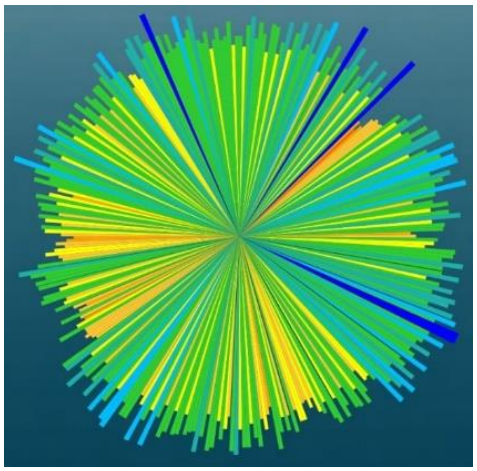
Rapid heart rate



Slow heart rate

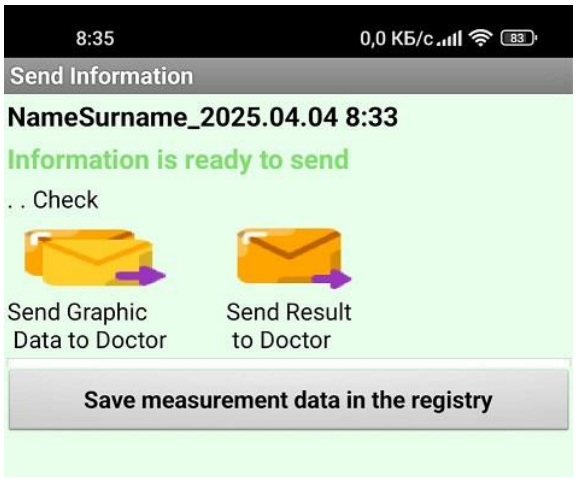


High rhythm variability

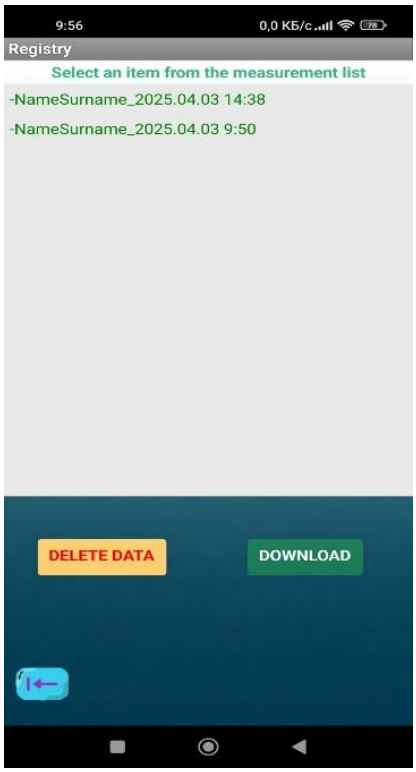


Save/Send Data Module

This module is designed to send information for analysis to a specialist. You can send personal data, primary numerical data of the pulse wave and analysis results by pressing the appropriate buttons. In addition, you can save all the data of the conducted study in the Registry. The saved data can be used for further analysis, comparison of results and identification of the dynamics of changes.



To view data from previous studies, click on the Registration button on the application's home page.

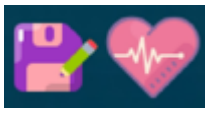


Then the Registry module window will open. The entire list of previously saved data is located here.

To delete data, select an item from the list of studies and click the "Delete data" button.

Procedure for viewing results.

1. To view the results of the study, select an item from the list and click the "DownLoad" button. Then click the "Exit" button.



2. In the opened application start window, click the “Save” and “Recorder” buttons in sequence.

3. In the Recorder window, click the Stop and Analyze buttons in sequence.

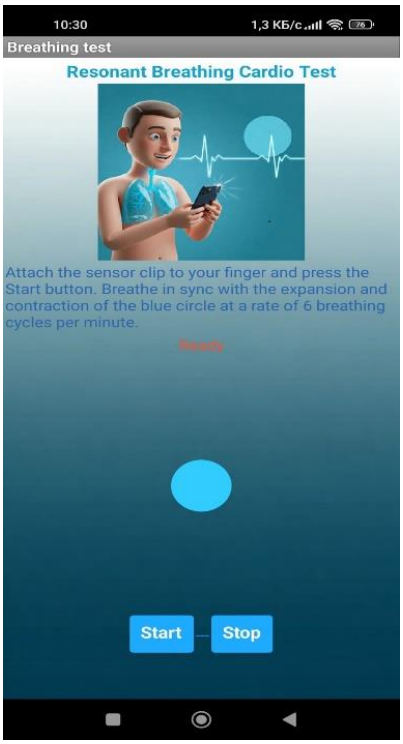
Additional Test Modules

Before testing, you need to activate the Recorder module. Attach the pulse sensor to your finger and check the quality of the pulse wave graph. To do this, press the Start button, watch the pulse wave graph, and then press the Stop button.

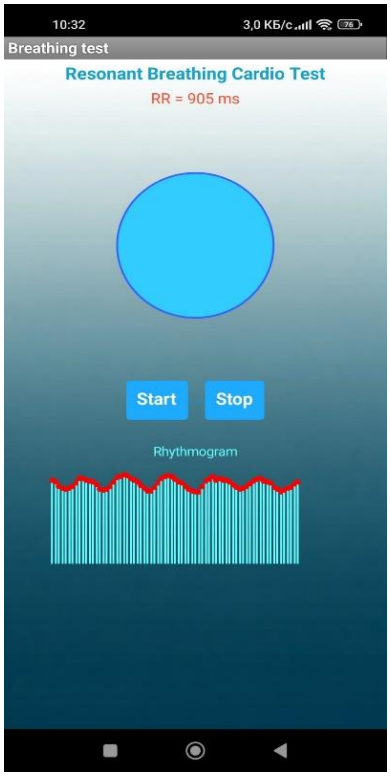
Resonance Breathing Test

Breathing test

To conduct the test, press the button in the Recorder module without removing the pulse sensor from your finger.



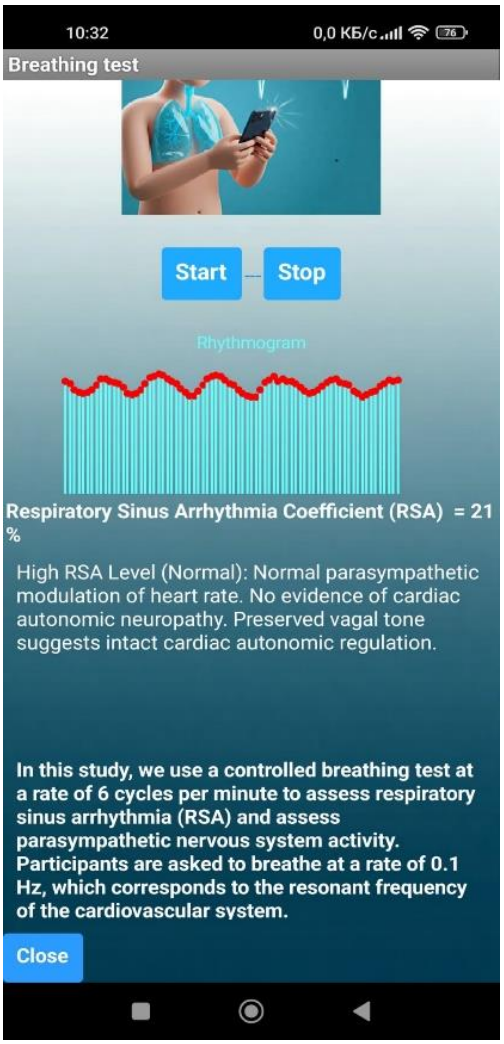
The Breathing Test is a mobile app feature that allows you to assess your cardiovascular system's condition using resonant breathing. Resonant breathing is a technique in which a person breathes at a rate of about 6 cycles per minute. This rate corresponds to the natural resonance of the cardiovascular system. This breathing ensures maximum synchronization between breathing and heart rate, which is reflected in an increase in heart rate variability. To begin the test, press the "Start" button and breathe synchronously with the slowly pulsating blue circle for 1 minute.



During the test, the application will build a rhythmogram that shows how the cardio intervals change.

The rhythmogram is displayed in real time, i.e. changes can be observed directly during breathing.

If extrasystoles or other rhythm disturbances occur during the test, the system will visually warn you about this and offer to repeat the test. Since rhythm disturbances can distort the results.



After 1 minute. The module will analyze the received data, calculate the respiratory sinus arrhythmia coefficient and evaluate the results.

Respiratory sinus arrhythmia (RSA) is a natural change in the heart rate associated with breathing.

The coefficient RSA reflects the degree of this dependence.

A high coefficient (more than 12%) indicates a good state of the autonomic nervous system and the body's ability to adapt to stress. A low respiratory sinus arrhythmia coefficient may indicate the opposite.

The system will determine whether signs of cardiac autonomic neuropathy are present or absent.

Cardiac autonomic neuropathy (CAN) is a lesion of the nerves that regulate the heart.

It can be caused by various diseases, such as diabetes, and can lead to serious heart problems.

The analysis can help identify signs of CAN, since this disease often has a decrease in heart rate variability.

The results of the analysis can be useful for identifying potential health problems.

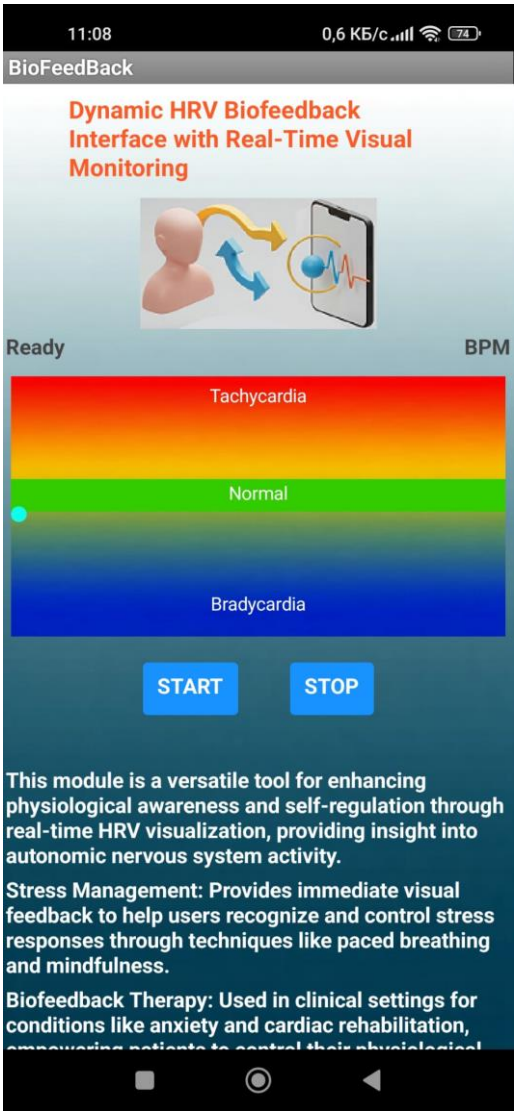
Biofeedback module

FeedBack test To conduct the test, press the button in the Recorder module without removing the pulse sensor from your finger.

The module is designed to visualize and control the heart rate. The pulse sensor reads heart rate data in real time and converts it into a clear graphic form displayed on the smartphone screen. The graphic field is divided into zones corresponding to normal, increased and decreased heart rate.

To start a biofeedback session, click the "Start" button.

The system will then begin reading cardio intervals in real time and displaying them as a ball movement.



The ball, which displays the current pulse, moves across the graphic field, changing speed and position depending on the change in heart rate.

Watch the ball move:

Watch carefully as the ball moves across the graphic field.

Notice how the speed and position of the ball change depending on your heart rate.

Control your breathing:

Try controlling your breathing to influence the movement of the ball.

Slow and deep breathing can help lower your heart rate and move the ball into a normal rhythm zone.

Creating an Internal Image:

Imagine a calm and safe place where you feel relaxed and comfortable.

This could be a quiet beach, a forest clearing, a cozy room, or any other place that evokes a sense of peace within you.

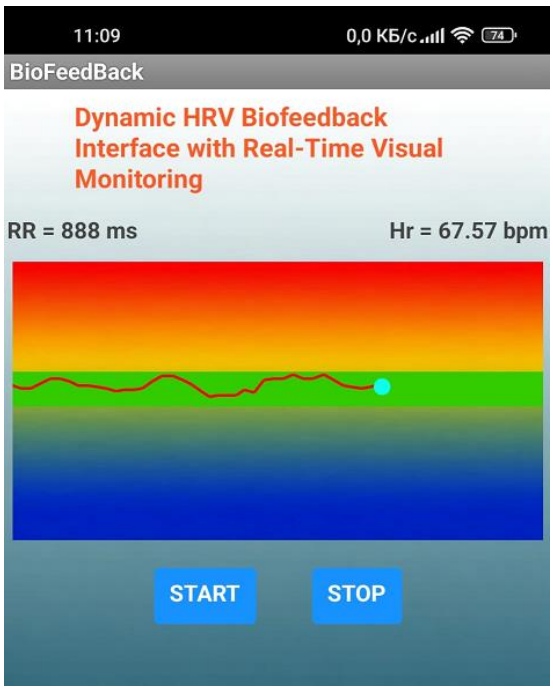
Try to detail this image as much as possible: picture the sounds, smells, and sensations.

Interacting with the Image:

Imagine that you are in this place and allow yourself to fully immerse in the atmosphere of tranquility.

Visualize your body relaxing and your breathing becoming slow and deep.

Picture your heart rate slowing down, and the ball on the screen starting to move more smoothly and slowly.



Controlling the Ball:

Use your internal image to mentally influence the movement of the ball.

Imagine gently guiding the ball into the normal rhythm zone.

Focus on the feeling of control and confidence.

Internal Psychological Attitudes:

Positive Thinking:

Use positive affirmations to set yourself up for success.

For example, say to yourself: "I am calm," "I am in control of my rhythm," "I feel good."

Positive attitudes help reduce anxiety and improve well-being.

Focusing on Breathing:

Concentrate on your breath to distract yourself from anxious thoughts.

Pay attention to each inhale and exhale, feeling the air filling and leaving your lungs.

Breathing is a powerful tool for controlling your state.

Muscle Relaxation:

Gradually relax the muscles in your body, starting from your toes and ending with the muscles in your face.

Muscle tension can increase anxiety and accelerate your heart rate.

Muscle relaxation helps reduce stress levels and calm down.

Internal Dialogue:

Engage in a calm and friendly internal dialogue with yourself.

Encourage yourself, remind yourself of your abilities and achievements.

Avoid self-criticism and negative thoughts.

Practice:

Regular practice will help you learn to better control your heart rate.

Gradually, you will be able to learn to lower your heart rate and maintain it within the normal range.

Conclusion

The personal monitoring and cardiovascular activity analysis system presented in this manual combines modern technologies with intuitive interfaces, making health assessment accessible to all users. The device not only records heart rhythm parameters but also performs in-depth data analysis, including heart rate variability assessment, spectral characteristics, and methods inspired by Eastern medicine.

Interactive modules such as breathing tests, biofeedback, and rhythmic activity visualization make the use of the system not only beneficial but also engaging. Thanks to flexible data storage and transmission capabilities, the system can be effectively used both for individual monitoring and in professional consultations with healthcare specialists.

All tests and measurements are recommended to be conducted in a calm, relaxed state, without the influence of stimulants such as caffeine or nicotine. For the most accurate results, it is advisable to avoid physical exertion immediately before testing and to maintain a consistent testing environment.

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