

Computer-Assisted Electrocardiography

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Opinion

Every heart activity can be observed as one heart action phenomenon which generates appropriate signals. Said signals can be recorded and displayed using certain devices. The biological medical phenomenon of the heart is a synergy of different activities of the heart. In the case of an ECG, the medical phenomenon that is displayed is the electrical activity of the heart. A graphic record of the movement of electrical potentials generated in the heart, i.e. electrocardiogram ECG, is one of the oldest diagnostic tools in cardiology. The ECG is a reliable marker for monitoring heart activity and is therefore an irreplaceable tool in the diagnosis of heart diseases that can threaten the normal rhythm and work of the heart.

ECG recordings of a healthy heart have a characteristic shape. Any irregularity in the heart rhythm or damage to the heart muscle can change the electrical activity of the heart, which leads to a change in the shape of the ECG recording. Interpretation of the ECG signal is the process of recognizing the normal characteristic signal and signal segments of uncharacteristic shapes that indicate a certain irregularity in the heart's functioning. Interpretation of the ECG leads to significant data in the diagnosis of heart diseases. The appearance of a normal ECG is not universal. A multitude of external phenomena that we call noise and artifacts can affect the appearance of the ECG. For this reason, it is not possible to make any diagnosis of heart disease based on the ECG alone. However, if the ECG is observed within the clinical picture of the patient's physical status and other diagnostic tests, the data obtained can be decisive.

The development of digital signal recording and processing technologies has enabled a variety of displays of cardiac and many other biomedical signals. In computer processing of ECG signals, signal processing in the time domain is mainly applied. For diagnostic interpretation of ECG signals, temporal mapping of events of the electrical activity of the heart is essential.

The ECG signal is probably one of the most common biological signals in medical practice. Software detection of QRS complexes is a relatively young scientific discipline and is one of the examples of successful implementation of IT (information technology) in modern medicine. This topic has been relevant for more than half a century, and the best algorithms enable 99% accuracy in detecting QRS complexes. The time intervals of the appearance of QRS complexes and their morphological forms can provide a lot of information about the current state of the heart and indicate problems with the heart and the entire organism. Today's software packages enable automatic determination of a lot of diagnostic cardiological information by processing ECG signals. They can be programmed for automatic determination of heart rhythm but also for more complex diagnoses such as arrhythmias and assessment of the effectiveness of certain drugs and therapies. ECG signal processing software does this job very quickly, thus saving medical staff time, i.e. human work. By monitoring and interpreting data

obtained by processing cardiac signals, doctors gain insight into the functionality of the heart, which is crucial for heart diagnostics.

QRS complexes are the starting points in the diagnostic interpretation of the ECG signal. The time instants of their occurrence, their duration (width), amplitudes and morphological forms are significant data in cardiological diagnostics. The time interval that begins with a QRS complex and ends immediately before the beginning of the next QRS complex represents one cardiac cycle of the heart. It is common to call the cardiac cycle a heartbeat, and since the QRS complex is the most prominent part of the ECG cycle, it is a representative (marker) for one heartbeat. Therefore, the accurate detection of the time locations of the QRS complexes is the basis for the analysis of the heart rhythm. Computer detection of QRS complexes is not a simple procedure because certain problems may arise that complicate the procedure. Many algorithms fail to detect QRS complexes of small amplitudes and longer duration, i.e. larger width. One of the problems is the fact that sometimes the P and T waves can have characteristics similar to a QRS complex.

Heart monitoring is a diagnostic procedure that is automated and/or supported by computer diagnostics. Various experiments have shown that the overall diagnostic effect of the ECG largely depends on the accurate detection and location of the QRS complex in the ECG signal. Therefore, the development of an automatic QRS detector with high reliability is necessary in cardiology diagnostics. However, due to irregular heartbeats, amplitude and morphological non-uniformities of ECG waves and segments, and various noises and artifacts, it is still a challenging task.

Considering the number of people with heart problems, it is normal that electrocardiography plays a significant role in modern medicine. Many heart diseases would be undetectable without

devices that record and record the heart's electrical activity over time. With the technological development and improvement of medical equipment, the diagnosis and treatment of heart diseases is improved. The development of medical equipment began with simple and, for today's conditions, backward devices that were demanding to use and in many cases ineffective. Medical equipment and with it medicine itself experienced the most significant progress with the appearance of the first computers and their development. The development of computers and computer techniques opened the door to the progress of medicine and other sciences. Such development was a prerequisite for the modernization and improvement of electrocardiography. The first heart rate monitors were bulky and unwieldy, and their displays were unclear. However, as the development of electrocardiography began to be followed by sciences such as mathematics, physics, electrical engineering and especially computing, the ECG record (display) became much clearer and more reliable, and the devices were light, portable and practical.

Electrocardiography is one of the most common diagnostic methods used in cardiology and medicine in general. However, the interpretation of ECG signals requires a lot of knowledge and experience that many doctors do not have in medical practice. Timely and reliable ECG diagnostics as we know it today is the result of multidisciplinary cooperation between engineers and doctors. Computer-aided interpretation of ECG signals improves cardiological diagnostics and significantly reduces the possibility of diagnostic errors. Although numerous modern methods have been developed in the diagnosis of cardiovascular diseases, electrocardiography is still irreplaceable and provides much more information than other technologically advanced and expensive methods.