irradiation with helium ions as a basic possibility of obtaining maximum grafting of styrene monomer in the fluoropolymer PVDF samples with thicknesses from 10 to 180 microns. Thus fixed styrene monomer in the polymer that is the dopant, in the subsequent sulfonation imparts proton conducting properties on the polymer matrix. It should also be noted that by changing the energy of ion irradiation, we can create a controlled in depth and thickness layer with free radicals.

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Heart condition imaging with the help of hardware and software complex based on the cardiographic equipment on nanosensors

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Modern functional diagnostics provides the most variable instrumental methods of examination both invasive and noninvasive. The most widespread and available methods of heart examination is electrocardiography (ECG). In spite of prior use in cardiology it is also successfully used for examination of patients with diseases of lungs, kidneys, liver, endocrine glands, and blood system and also in pediatrics, geriatrics, oncology, sports medicine, etc. Using ECG it is possible to detect heart rate and as a result to identify any heart rhythms disturbances; to detect the disturbances of heart electrical conduction which may lead to decrease of its pumping ability and even to its complete cessation; to detect defects or damages of heart muscle caused by chronic or acute disease.

In spite of availability and informational content under real conditions ECG records are affected by internal and external disturbances which disrupt the given informational fragments and as a result cause additional problems in the process of generation of ECG analysis and interpretation computer systems. Even the solution of supposedly absolutely simple problem of ECG division into separate cardiac cycles (RR intervals) requires using quite difficult detection algorithms of QRS-complexes.

Voltage is significantly influenced by correct recording technique and also the distance from explorative electrode to current source. The size of ECG waves is inversely related to squared distance from electrode to current source. It means that the farther electrode is located from current source the less voltage of electrocardiogram complexes is. Therefore after removal of electrodes more than 12 sm from heart further change of voltage appears to be insignificant.

To solve boundary problems for Laplace equation methods of integral equations of potential theory in English-language literature more known as boundary element methods are widely used. The given methods particularly provide the presentation of heart and torso surfaces in the form of polygonal surfaces that is the division of boundary surfaces into multiple triangular elements.

The closest to the represented method (prototype) is the method of Noninvasive Electrocardiographic Mapping (Noninvasive Electrocardiographic Imaging, ECGI) where the superficial mapping is performed using 224 unipolar electrodes placed on a special waistcoat which patients wear during the examination. Surfaces of torso and heart are determined on the basis of computed or MR-tomography of the chest. Algorithm of reconstruction is based on the solution of electrocardiography inverse problem by the method of boundary elements. Heart and torso surfaces are represented in the form of polygonal surfaces. System of matrix-vector equations which is by the way of elementary transformations amounts to simultaneous linear algebraic equations is used for solution of inverse ECG problem. The method was used for determination of localization of accessory conduction pathways in WPW symptomatic syndrome, ectopic sources in ventricular extrasystole and tachycardia, reconstruction of dynamics of myocardial activation in atrial flutter.

A significant drawback of the analyzed method is the use of chest model with fixed factor of specific electrical conduction. Specific electrical conduction of different organs and tissues of the chest significantly differs. Floating factor of electrical conduction of biological tissues significantly influences electrical field of the heart in the chest that is confirmed by the data of experimental examinations. The difference between electrical conduction of lungs and surrounding soft tissues (4-5 times) plays the greatest role. Potentials of cardiac electrical field of model sources calculated for homogenous and inhomogenous models of the chest differ by 15%-20%. Therefore, ignoring of electrical inhomogeneity of the chest tissues leads to large deviations in reconstruction of cardiac electrical field [1]. To solve the inverse ECG problem method of regularization by A.N.Tikhonov [2] is used. It fundamentally includes the following claims:

1. Heart condition determines its electrical activity.
2. The amount, position and choice of heart model points assume maximum resolution for examination of electrical processes taking place in the heart.
3. Heart model points of the patient are elementary heart dipoles each of which in the system of heart coordinates has location, direction and behavior in time of its value, and define electrical activity of a patient.
4. According to electrocardiographic presentation potential value generated by the heart and recorded on the torso of a patient (direct task of electrocardiography) is determined from the formula including the value of electrical potential in j-point of standard lead ($j = 1, \ldots, 12$); average specific electrical resistance of torso and proportionality factor based on the characteristics of electrical activity of the region on the surface of patient's heart model surface [3].

The solution of electrocardiography inverse problem was firstly introduced already in 70s of the last century (B.Taccardi, R.Barr, R.Plonsey). The first efficient algorithm of electrocardiography inverse problem solution was developed in 1981 by V.V. Shakin. The first clinical tests of noninvasive electrophysiological method based on the solution of ECG inverse problem were performed in1985-87 at Scientific Center of Cardiovascular surgery named after A.N. Bakulev (L.A. Bokeria, V.V. Shakin, G.V. Mirskiy, A.Sh. Revishvili, I.P. Polyakova). Results of clinical tests showed potential perspective of this method, however the level of computing and medical equipment development at that time did not allow its full introducing into clinical practice. For the first time all stages of noninvasive epicardial mapping method was realized by research team headed by prof. W.Rudy (USA) who in 2004 suggested method variant called by the authors as Noninvasive Electrocardiographic Imaging which provides besides superficial ECG mapping computer tomography or MRI of the chest and heart. In 2006 at the premises of tachyarrhythmia surgical treatment department at Scientific Center of Cardiovascular surgery named after A.N. Bakulev under supervision of A.Sh. Revishvili modern software and hardware appliance for noninvasive electrophysiological heart examination was developed; it was based on the solution of electrocardiography inverse problem. Calculative noninvasive activation mapping included several stages:

1. Performance of multichannel electrocardiogram recording from the chest surface in 80 or 240 unipolar leads using different systems of superficial ECG-mapping.
2. Patients with already placed superficial electrodes underwent helical computed tomography of the chest with intravenous contrast. Different helices pitch distance was used: 5-7mm for the whole chest scanning and 3 mm helices pitch distance for heart region scanning.
3. Computed tomography data determined the boundaries of the chest surfaces, epicardial and endocardial heart surfaces, and helped to build realistic tree-D voxel models of torso and heart [4].

Such projects are also very important due to development of interventional and surgical methods of heart rhythm disturbances treatment. For example noninvasive activation heart mapping allows performing electrophysiological and topical diagnostics of heart rhythm disturbances with accuracy which was earlier achieved only on the basis of direct electrocardiographic measurements on the myocardial surface under conditions of surgical intervention.

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