

**Proposals  
for cooperation  
of  
Department of Computer Engineering  
and Programming of NTU «KhPI»**

# Department of Computer Engineering and Programming

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## Specialties

- ❖ Bachelor      6.050102 «Computer Engineering»
- ❖ Master        8.05010201 «Computer Systems and Networks»  
                    8.05010202 «System Programming»  
                    8.05010203 «Specialized Computer Systems»

## Subjects of research

- ❖ Methods and informational technologies of building of intelligent computer decision support systems during diagnostic and therapeutic measures (ICDSS-DThM) based on complex optimization of steps of diagnosis and treatment in order to ensure the required level of reliability of computer diagnosis and efficiency of therapeutic treatments terms of analysis of dependent heterogeneous features, including the analysis of biological signals and medical images.

# Authors

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# Participation in Projects

## State Budget Topics

- ❖ № 0104U003361 «**Development of the theory and methods of structural identification in the design of computer systems for medical diagnostics**», *from 2004 to 2006*
- ❖ № 0107U000599 «**Development of the theory and methods of building of intelligent medical systems based on structural identification**», *from 2007 to 2009*
- ❖ № 0113U000449 «**Development of intelligent decision support systems for the diagnosis, management and optimization of technical and biotechnical objects**», *from 2013 to 2015*

## Self-Financing Topic

№ 0115U001307 «**The software module of morphological analysis of mammograms based on nonlinear filtering of digital grayscale image**», *2015*

## Innovative Project

- ❖ «**Decision Support System in medicine based on the combined decision rule**»  
- 3rd place in the competition of innovative projects "IT-Kharkiv" in nomination "The best project in the field of IT-Health" - 2013

# Developments

**Developing promising class of intelligent computer decision support systems for diagnostic and therapeutic measures (ICDSS-DThM) based on a complex optimization of steps of diagnosis and treatment to ensure the required level of reliability of computer diagnosis, efficacy of therapeutic treatments and risk minimization of negative consequences of errors in decision-making in each of these stages.**

# Developments

**Morphological analysis of one- and two-dimensional biomedical signals with a locally focused features, i.e. the selection of the structural elements of considered diagnostic signals whose parameters are used to calculate the diagnostic features. Development of formalized method of morphological analysis of one- and two-dimensional biomedical signal based on the selection of the useful signal models and synthesis of the multi-channel nonlinear digital filter which provides for detection, segmentation and classification of the structural elements whose parameters are used to calculate the diagnostic features.**

# Developments

**Development of combined diagnostic decision rule that combines probabilistic logic and fuzzy logic of expert assessments of symptom structures.**

The structural and parametric optimization of diagnostic feature space and synthesis of binary decision tree is performed for a decision rule implementation. The transition from diagnostic feature space to pharmacological action space in order to minimize the negative consequences of the wrong therapeutic means, which are caused by errors in the diagnostic step, are invited to perform in contrast to the classical approach of a decision tree building with the criterion of minimum error of diagnostic step.

# Developments

**Development of the system of formation of complex medicinal preparations at a given diagnosis taking into account the necessary therapeutic effect, patient intolerance to certain medications, incompatibility of preparations, multi-criteria comparisons of preparations-analogs based on artificial neural network structure development (INS) and the learning algorithm of ANN weight ratios.**



# Protected Thesis on the Subject of Research

- ❖ *Povoroznyuk A. I.* **Information technology decision support in medical diagnosis based on the synthesis of structured models.** – Manuscript.  
Dissertation for Doctor of Technical Sciences scientific degree, speciality 05.13.06 – Information technologies. – National Technical University "Kharkiv Polytechnic Institute", Kharkiv, 2011.
- ❖ *Filatova A.E.* **Structural identification signals in cardiological systems.** – Manuscript.  
The dissertation for scientific degree candidate of technical sciences on speciality 05.11.17 – medical devices and systems. – The Kharkiv National University of Radioelectronics, Kharkiv, 2001.
- ❖ *Maksyuta N. V.* **System analysis of results hemorheological studies based on hierarchical clustering diagnostic features.** – Manuscript.  
The dissertation for scientific degree candidate of technical sciences on speciality 05.11.17 – biological and medical devices and systems. – The Kharkiv National University of Radioelectronics, Kharkiv, 2007.

# Protected Thesis on the Subject of Research

- ❖ *Povoroznyuk O.A.* **Biotechnical system of prescribing medical preparates in dermatology.** – Manuscript.  
The dissertation for scientific degree candidate of technical sciences on speciality 05.11.17 – biological and medical devices and systems. – The Kharkiv National University of Radioelectronics, Kharkiv, 2010.
- ❖ *Antonova I.V.* **System of estimation of the professionally conditioned diseases development risk based on fuzzy logic.** – Manuscript.  
Dissertation for the degree of the candidate of technical sciences, speciality 05.11.17 – biological and medical devices and systems. – Kharkiv National University of Radio Electronics, Kharkiv, 2011.
- ❖ *Burtsev M.V.* **Decision Support System in the diagnosis of therapy disease based on the combined decision rule.** – Manuscript.  
Dissertation for the philosophy doctor degree in the technical sciences area for specialty 05.11.17 – Biological and Medical Devices and Systems – Kharkov National University of Radio Electronics Kharkov, 2014.

# Publications in Scopus

1. Povoroznyuk A. **Generalized method of nonlinear filtering of biomedical signals with locally concentrated signs** / A. Povoroznyuk, A. Filatova // Modern Problems of Radio Engineering, Telecommunications and Computer Science – Proceedings of the 11th International Conference, TCSET'2012 – Slavske, Ukraine february 21–24, 2012, p.131
2. **Design of decision support system when undertaking medical-diagnostic action** / Povoroznyuk A.I., Filatova A.E., Surtel W., Burlibay A., Zhassandykyzy M. // Proc. SPIE 9816, Optical Fibers and Their Applications 2015, 98161O (December 18, 2015); doi:10.1117/12.2229295 – 7P. [Electronic resource  
<http://proceedings.spiedigitallibrary.org/volume.aspx?conferenceid=3608&volumeid=17461>]
3. Povoroznyuk A., **Development of alternative diagnostic feature system in the cardiology decision support systems** / Povoroznyuk A., Filatova A. // Eastern European Journal of Enterprise Technologies – 2016 – 3/9 (81) pp. 39-45.
4. Povoroznyuk A. **Design of non-linear filter in the problem of structural identification of biomedical signals with locally concentrated properties** / A. Povoroznyuk, A. Filatova, Y. Myrghorod // International Journal of Circuits, Systems and Signal Processing. – Vol. 2, No. 3, 2013, pp. 85-92.

# Proposals for joint research

**1. The development of information technology of integrated assessment of steps of diagnostic and therapeutic interventions in defined area of medicine in order to improve their effectiveness and risk minimization of medical errors.**

## **Scientific novelty**

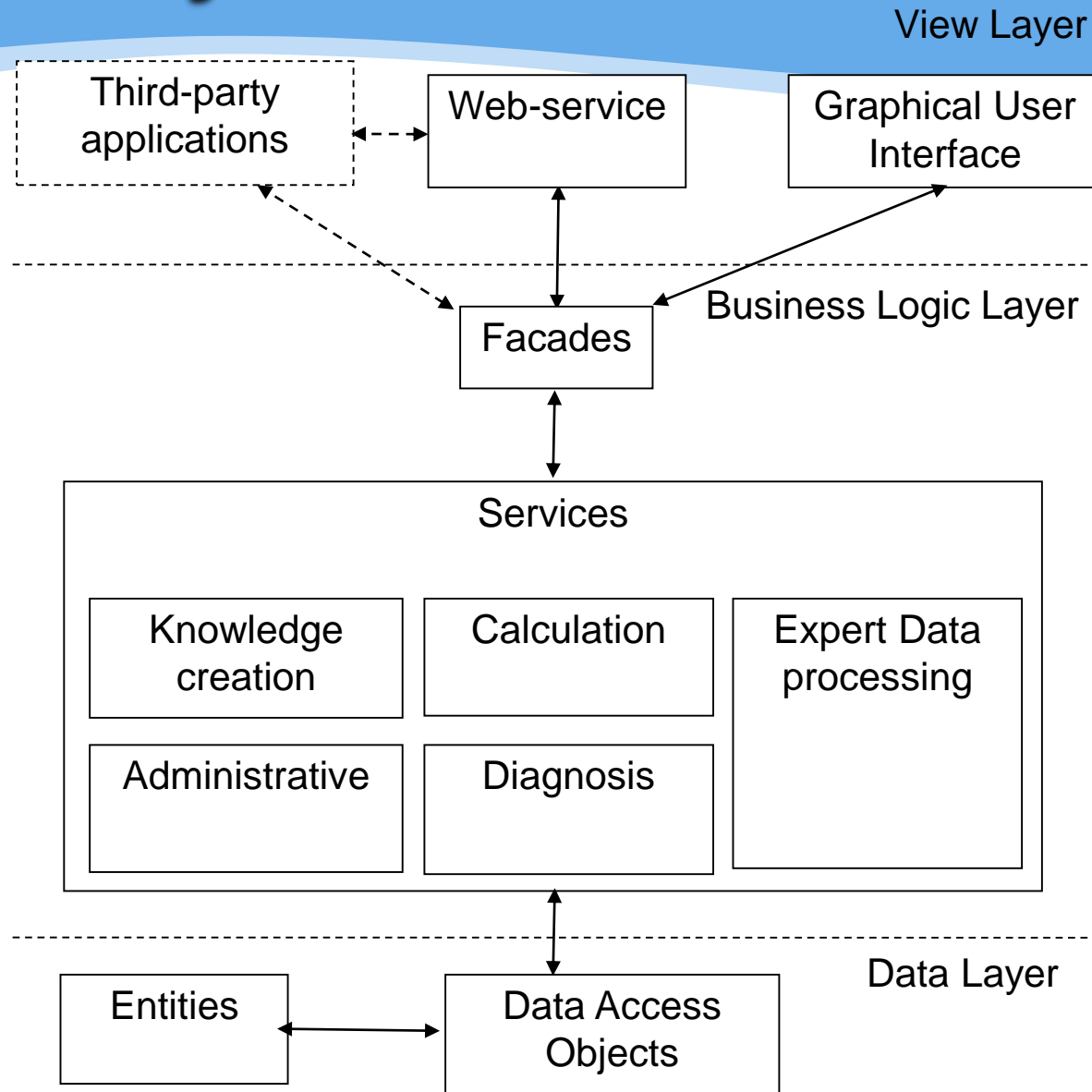
For the first time, a complex optimization of the diagnostic and treatment steps is performed. The transition from the traditional feature space into the space of medical actions is carried out to achieve the goal that helped to solve the following tasks:

- ❖ to minimize the risks of wrong decision at the diagnostic step, taking into account their impact on the step of medical actions at the tree synthesis solutions;
- ❖ to develop a correction method of uncertainty interval boundaries in the diagnostic decision rule.

## **The practical usefulness of the results**

It is software implementation of the system and its testing on real medical databases. System software architecture makes it easy to adapt to different subject areas of medicine.

# System Architecture



# Proposals for joint research

## **2. The development of information technologies of selection of the structural elements of one- and two-dimensional biomedical signals.**

### **Scientific novelty**

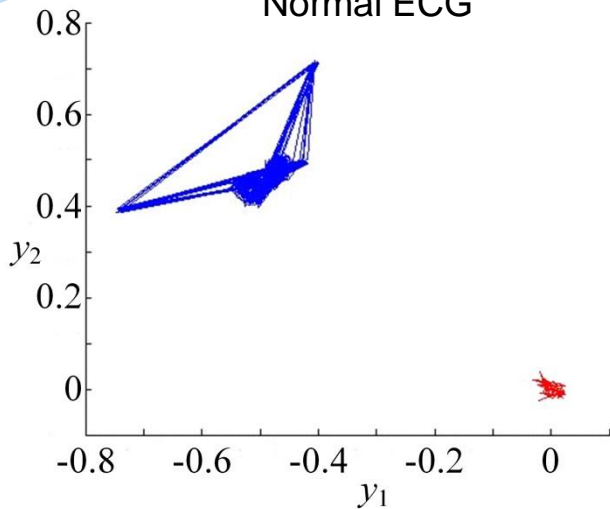
For the first time, the selection method of the structural elements of one- and two-dimensional biomedical signal with a locally concentrated features based on the selection of the useful signal models and synthesis of the multi-channel nonlinear digital filter which provides for detection, segmentation and classification of the structural elements is designed to allow the use formalized approach at identify different types of structural elements including atypical forms for different types of signals, eventually increases the probability of identification.

### **The practical usefulness of the results**

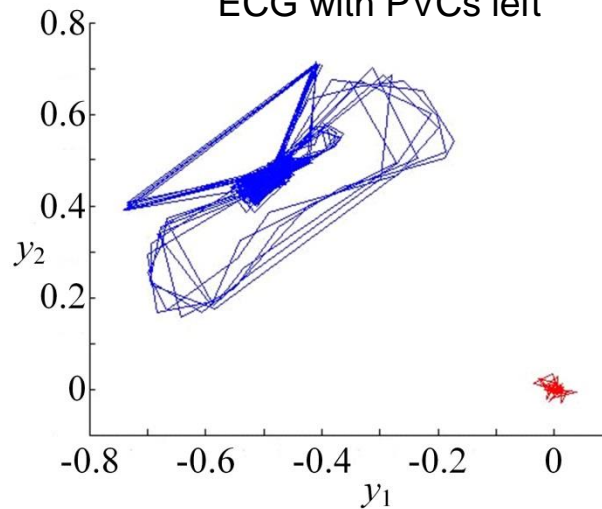
It is the software module as a DLL module with an interface that allows you to integrate it into the software of digital devices of registration of biomedical signals (a cardiograph, a rheograph, etc.)

# System Works Illustration (ECG–hodograph)

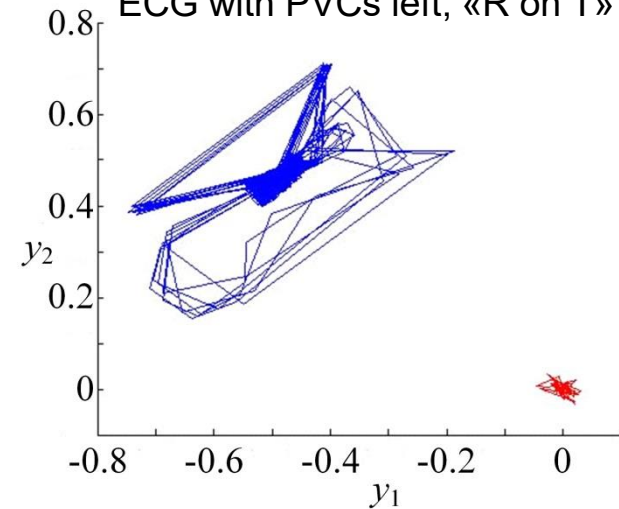
Normal ECG



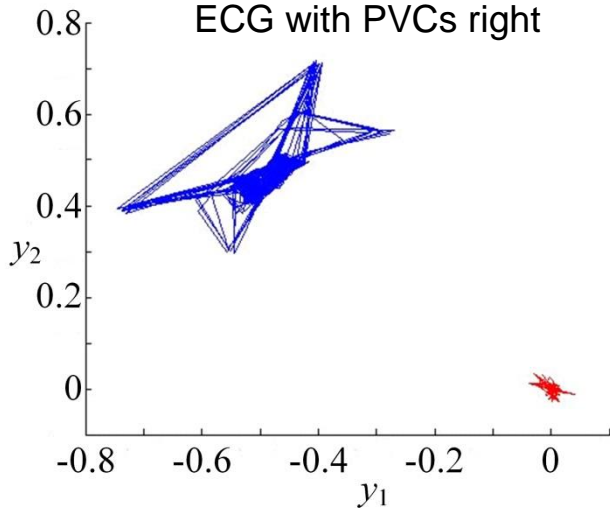
ECG with PVCs left



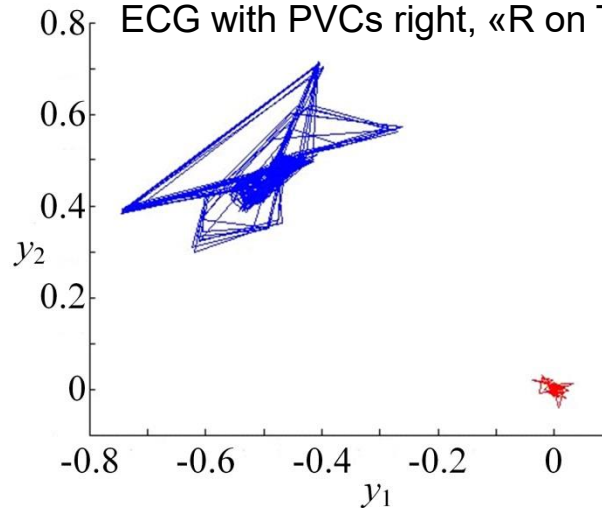
ECG with PVCs left, «R on T»



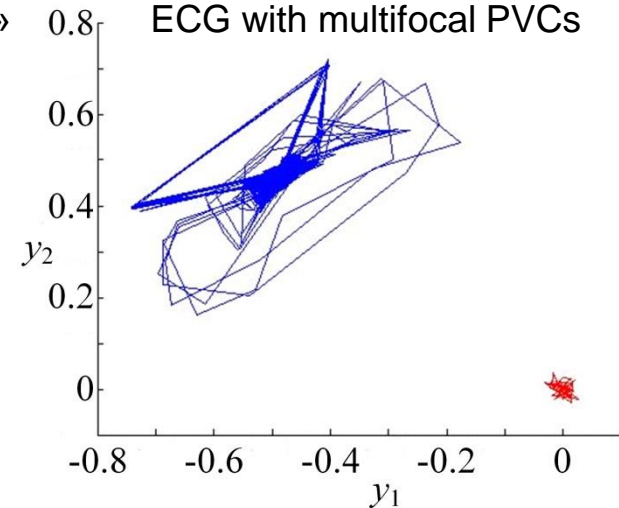
ECG with PVCs right



ECG with PVCs right, «R on T»



ECG with multifocal PVCs





# Proposals for joint research

## **3. Development of decision support systems in medical diagnosis (in a given subject area of medicine).**

### **Scientific novelty**

For the first time, the method of synthesis of the combined diagnostic decision rule based on an analysis of a priori conditional probabilities, their uncertainties and expert assessments of symptom structures, which implements the optimal scheme of the analysis of diagnostic features and provides a minimum of diagnostic errors, is developed.

### **The practical usefulness of the results**

It is software implementation of the system and its testing on real medical databases.



# Proposals for joint research

## **4. Development of a formation system of the medicinal preparations complex at given diagnosis.**

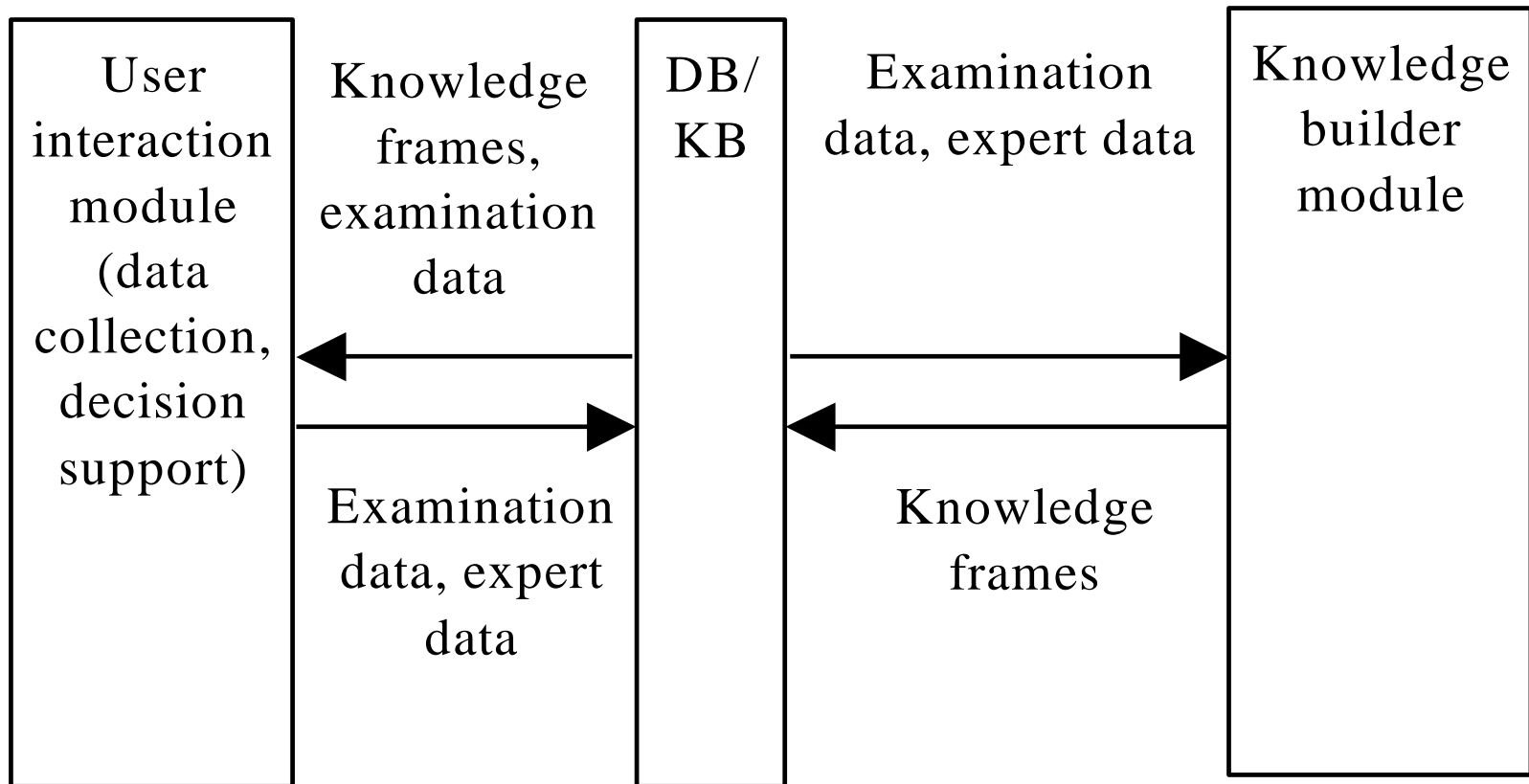
### **Scientific novelty**

For the first time, the formation method of complexes of medicinal preparations based on artificial neural network with multicriterial evaluation of preparations-analogues on the training step, which takes into account not only a detailed diagnosis of the patient, but also their individual characteristics, as well as statistics of management solutions, improves the efficiency of the process of rehabilitation patients is designed.

### **The practical usefulness of the results**

It is software implementation of the system and its testing on real medical databases.

# System Software Implementation



# Proposals for joint research

## **5. The development of information technology of morphological analysis of mammograms based on nonlinear filtering of digital grayscale images..**

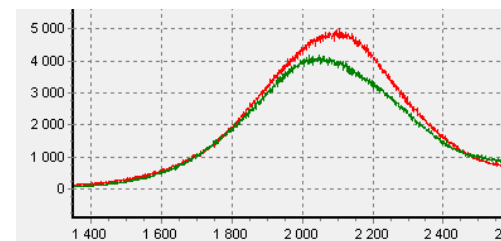
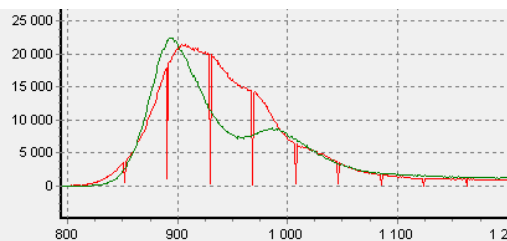
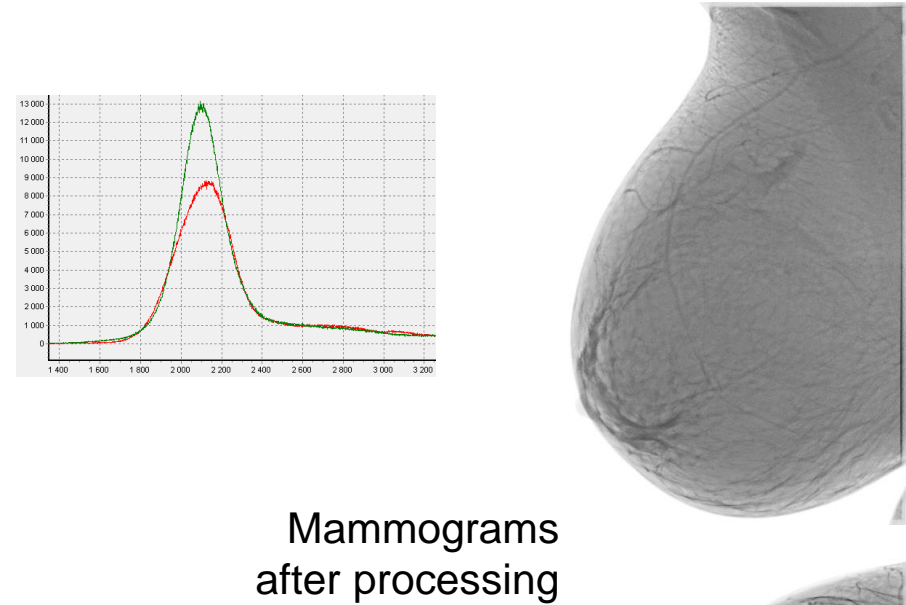
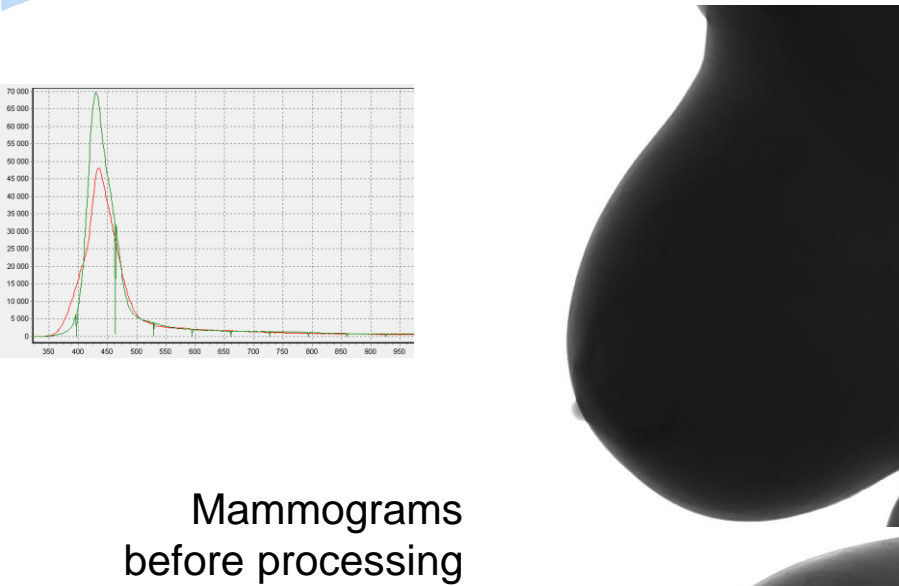
### **Scientific novelty**

For the first time, a mathematical model of the image the breast on a mammogram, which takes into account the properties of the recorded images is proposed, as well as a method of improving the visualization of mammograms based on the proposed model and existing methods of digital processing of grayscale images is designed.

### **The practical usefulness of the results**

It is the software module as a DLL module with an interface that allows to integrate it into the software of digital X-ray mammography systems.

# System Works Illustration (IMRI-MAM) Improvement of X-ray image



**Thank for attention!**