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THE USE OF COGNITIVE GRAPHICS FOR VISUALIZATION MULTIDIMENSIONAL MEDICAL DATA

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Introduction

Currently accumulated a vast arsenal of tools to analyze multidimensional data. The most complete statement of the approaches we use is considered in [1-6]. In [1], there is a classification of the multivariate data structure analysis main methods:

- data visualization: linear dimension reduction techniques, non-linear mapping, multi-dimensional scaling, space-filling curves;
- automatic grouping: factor and cluster analysis of objects and attributes, hierarchical clustering, the definition of "condensation points."

The main purpose of any information technology is obtaining adequate information that a researcher needs for analysis and making decisions on the basis of this analysis. In this case the information implies data concerning objects, their parameters, properties and states, reducing the degree of uncertainty and incompleteness of knowledge. Adequacy should be expressed in three forms: syntactic, semantic, pragmatic. The way of information representation is considered at the syntactic level. Semantic aspect involves consideration of the meaningful content of the information. Pragmatic adequacy reflects the value (utility) of information received in making a particular decision.

Data visualization is a problem that any researcher faces in his work. The problem of representing the experimental data or the results of theoretical research in visual forms leads to the problem of data visualization. Traditional instruments in this area, charts and graphs, are not efficient in visualization when there is a need to represent more than three interrelated variables. When analyzing the data the researcher is often faced with the multidimensionality of their description. Methods of multidimensional analysis are the most effective tool for quantitative investigation of the processes described by a large number of characteristics.

Modern computer technologies use a wide range of imaging data. Imaging techniques allow researchers to detect features at a glance, identify patterns and anomalies in large volumes of information. The impact of interactive computer graphics has led to the emergence of a new trend in the problems of artificial intelligence called cognitive computer graphics.

Cognitive graphics – a set of methods and techniques of figurative representation, the tasks which allows either immediately see the solution, or get a clue to his whereabouts.

Visualization multidimensional data based on the method "Spectral representations"

The use of cognitive graphics allows the user to make definite conclusions without analyzing a large amount of information. Information may be presented in a cognitive way as a sector, a histogram, a cross, a circle, etc., parts of which are painted in different colors and have a definite meaning.

Cognitive graphics forms a separate area in medicine. Visualization of the current state of the object and its characteristics allows to monitor continually the status of groups of individuals or a certain individual.

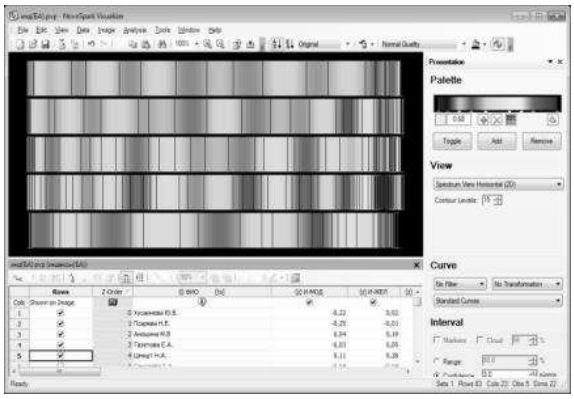
In our opinion the approach to displaying multidimensional objects in a generalized form of graphic images: curves, or "spectra" [7, 8], seems to be of particular interest. "Spectral representations" in this method emphasize the distinctive characteristics of each curve and help to explore their visual properties in more detail. Color palette emphasizes the levels of the curves values changes. Making the imaginary extension of curves along Z-axis and looking down on the result of this operation you can get color bars representing the spectrum of each observation [7].

We have used this approach dealing with the problems of identifying hidden regularity in medical data [8], particularly analyzing the characteristics of various bronchopulmonary diseases [9].

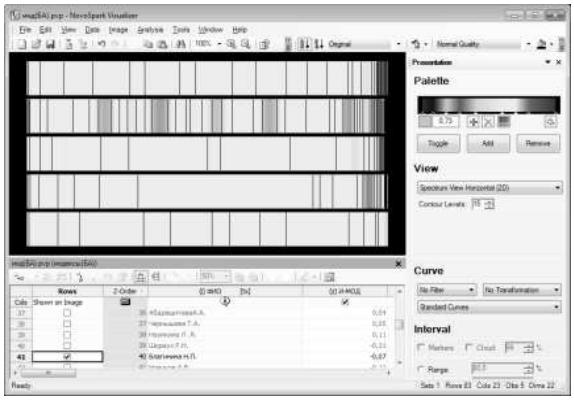
Background information is data of patients with four types of bronchopulmonary diseases:

- Bronchial asthma non-psychogenic (BANP);
- Bronchial asthma somatic psychogenic (BASP);
- Bronchial asthma psychogenic-induced (BAPI);
- Psychogenic dyspnea (PD).

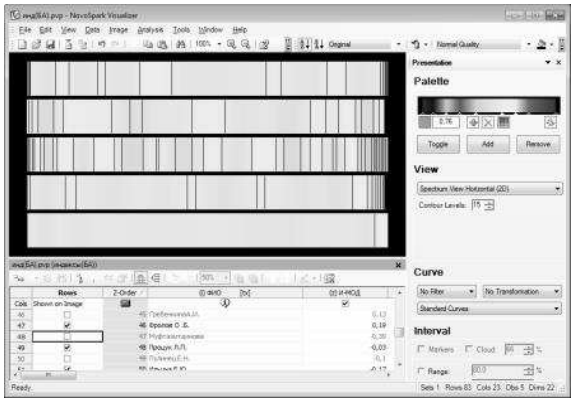
Let us compare the sample data of all 4 forms of the disease on visual closeness of observations spectra.



Pic. 1. The spectral representation of the data on patients diagnosed with BAPI



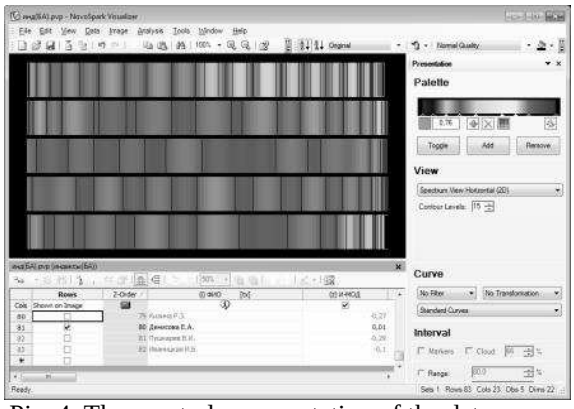
Pic. 2. The spectral representation of the data on patients with a diagnosis of BASP



Pic. 3. The spectral representation of the data on patients diagnosed with BANP

Each color bar in the spectral view corresponds to a certain patient data. In our case in Pictures 1 - 4 each image is represented by five bars, respectively representing five members of a certain group. The color scheme of the patients diagnosed with BAPI and patients with the diagnosis of PD are similar. The same is true for patients with the diagnosis of BASP and BANP.

As it can be seen from the Pictures, people with BASP and PD have the closest figures. The most evident differences can be seen in patients with BAPI.



Pic. 4. The spectral representation of the data on patients diagnosed with PD

Thus, the use of cognitive graphics has revealed some previously unknown regularity of physiological reactions of the bronchopulmonary system in response to the psycho-physiological effects.

The spectral representation of the visual image is more "delicate" tool, which highlights the differences and similarities of images than conventional methods of characterizing these properties at the level of the numerical parameters. This enables the researcher to more gently apply to the differences and highlight the "similarity" in a wide range of properties. You can ignore the overall color differences by switching to a monochromatic representation.

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SOFTWARE SYSTEM TO ASSIST IN RECOVERY OF LOST MEMORY

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Introduction

Nowadays, memory loss is an urgent social problem. Now there are only two recognized methods of memory retrieval: a method of Sigmund Freud and hypnosis. Each of them is very complex and requires special training of specialists and patients.

"Total Recall" is the software solution that was designed to help people, who had lost their memory.

This solution is based on the method of associations. Sometimes, people suffering from amnesia, can get a chance to remember some moments of their lives being in familiar surroundings. People get 90% of the information through their eyes. That's why the represented solution is based on the work of the patient's eyes.

Application session

During the session, a patient is viewing a collection of images that is based on the principle "from general to specific".

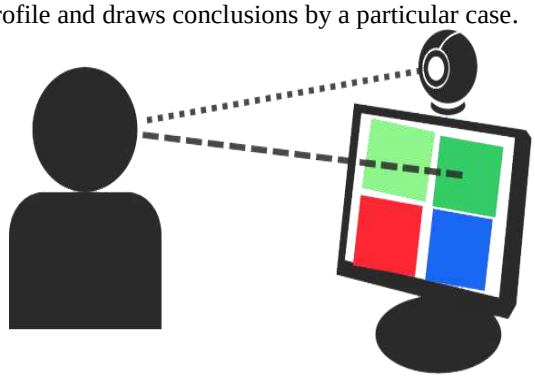
There is a probability that during the session, the patient will see the familiar images and his memory will recover. Ideally, after viewing the collection, the patient will remember a few key points. This will provide invaluable material for psychologists that will significantly reduce the time of rehabilitation of the patient.

Patients should register in the system to start work with the application. Registration is a simple process and does not require a large amount of data about a patient. After logging into account, a patient chooses the category of images. Next, the program synchronizes the local database of images in the Windows Azure cloud and downloads the missing images on a computer. Further, the screen displays multiple images (2 or 4). Webcam tracks which of the images the patient looks at in the first place (Fig. 1).

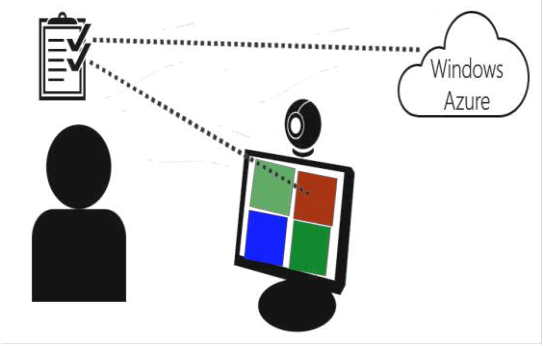
The results are written in a special profile. Thereafter, depending on the previous images selection, the next set of images connected with the common aspects of the previous set will be displayed.

Thus, the overall picture of the object, which the patient is trying to remember, is formed. All selected pictures are included in E-profile. The Profile includes not only images but also short descriptions and a set of keywords for each picture.

When a session is complete, the created E-profile is sent to a psychologist for analyzing (using the cloud Windows Azure – Pic. 2). A Psychologist views the profile and draws conclusions by a particular case.



Pic.1. Tracking of patient's gaze direction with webcams



Pic. 2. Adding images to a form and sending profiles to the Windows Azure cloud

Using technology

The program is a WPF application for Windows platform, implemented by framework NET 4.5 and a library EmguCV 2.4. The basic part of the program is devoted to tracking the direction of the user's gaze. Special libraries help to simplify the task and optimize the structural integrity of the application.

To work with the video of a webcam the EmguCV library based on OpenCV library is used. EmguCV is a cross platform .Net wrapper to the OpenCV image processing library that gives access to OpenCV functions to be called from .NET compatible languages such as C#, VB, VC++, Iron Python etc.

First, face recognition is performed by using the **DetectMultiScale** function. This function recognizes