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KIRLIAN IMAGE PREPROCESSING DIAGNOSTIC SYSTEM

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Abstract: The information technology of Kirlian images preprocessing is developed for decision making support in the telemedicine diagnostic system. Particularly, the image preprocessing includes the selection of objects - fingers emissions in a general image. The algorithms and image processing examples are decrypted.

Keywords: information technology, Kirlian image, preprocessing.

ACM Classification Keywords: J.3 Life and medical sciences – Medical information systems

Introduction

The information technology, processing Kirlian images, are presented to make a decision in the telemedicine diagnostic system. The Kirlian image is discharge gas glow, registered on photo material, arising up near-by the surface of object in the electric field of high tension. Kirlianografy has become widespread in the world as a method of experimental researches. Most interest was caused by researches of biological objects, mainly human kirlianograms. The kirlianograms view depend on the state of human. For example, by the kirlianograms view of hands and feet fingers it is possible to judge about a general level and character of human physiological activity, to estimate the state of his separate systems and to watch after the different influences: preparations, therapies etc. [Pesotskaya,1]

The Kirlian effect is presently the unique instrumental method, allowing on physical and energy information levels to estimate the state of not only an organ or a system, but the entire organism on the whole in interrelation of separate parts with each other.

In a prospect this method is seen as a practical instrument on the table of any doctor. Verifiable and constantly updatable Kirlian images database is needed for development of diagnostics method, using the Kirlian effect. In order to create such database telemedicine information technology is developed.

Telemedicine information technology

The telemedicine information technology apparatus consists of local and server parts, integrated via Internet. Local part includes of device for Kirlian emission registration, scanner. The special software is assigned to preprocess the images in the interactive mode to save the information in the local database and also to transmit and to save the information in the central database in the protected format. The central database is located in the server side, where information is saved being preprocessed in local parts. The general arrangement of the technology is represented at fig.1.

The chosen configuration allows operatively collecting and accumulating in one center information about patients which are far enough from each other. The large volume of preprocessed data creates the possibility to diagnose large quantity of patients by the several highly skilled specialists and, simultaneously, perfect a diagnostic method.

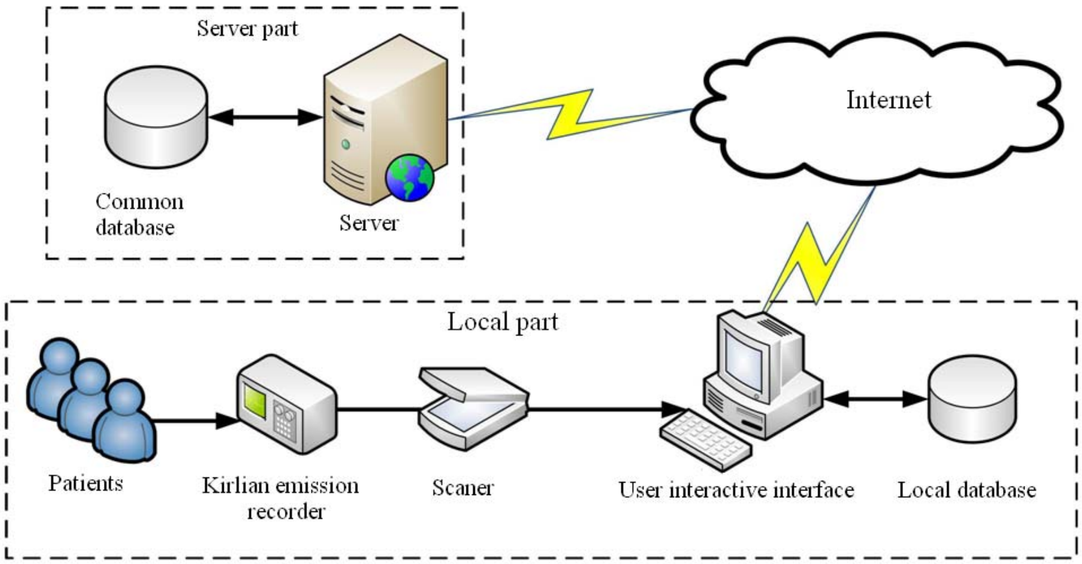

Fig.1.The telemedicine information technology for Kirlian diagnostics

The preprocessing of Kirlian images in the diagnostic system

The Kirlian images are pictures, got on the special film, by the size of A4, on which emissions as objects are fixed from each of five fingers of both hands (fig.2). It should be noted that there are background variations, noises, which contrast and size are comparable with objects, instability of objects form and contrast. Although on diagnostic content at the present time these images must be considered as binary, however, even the task of such images binarization can not be considered as simple, all the more the tasks of further processing, in particular, the recognition of the objects to be used for diagnostics. The image of every finger emission has the appearance of dark halo, framing a light spot, which form is near to the ellipse. The halo width can be different, even for one image. Often a halo has a not continuous, but interrupted form, and also can consist of separate fragments. A light spot into a halo corresponds to the contact place of finger with film and his brightness corresponds the brightness of image background.

Presently for diagnostic aims standard application software is used, supplied together with a device, realizing the Kirlian method [Korotkov,2]. This device is appropriated for the successive process of emission image fixation separately on every finger (fig.3). The software permits to form the general Kirlianogram of patient using the emissions of ten fingers and to make a diagnosis. However in the successive receiption process of every finger image emission the patient state can substantially change, why a final diagnosis can be distorted. So a one moment Kirlianogram reception for all fingers is more preferable. The possibility appears to research the Kirlianogram sequences and their diagnostic possibilities in the case of the patient state rapid change. To utilize the available software, it is necessary to segment such images, to select the image of every finger from a general image and turn him, to correspond to vertical direction of finger.

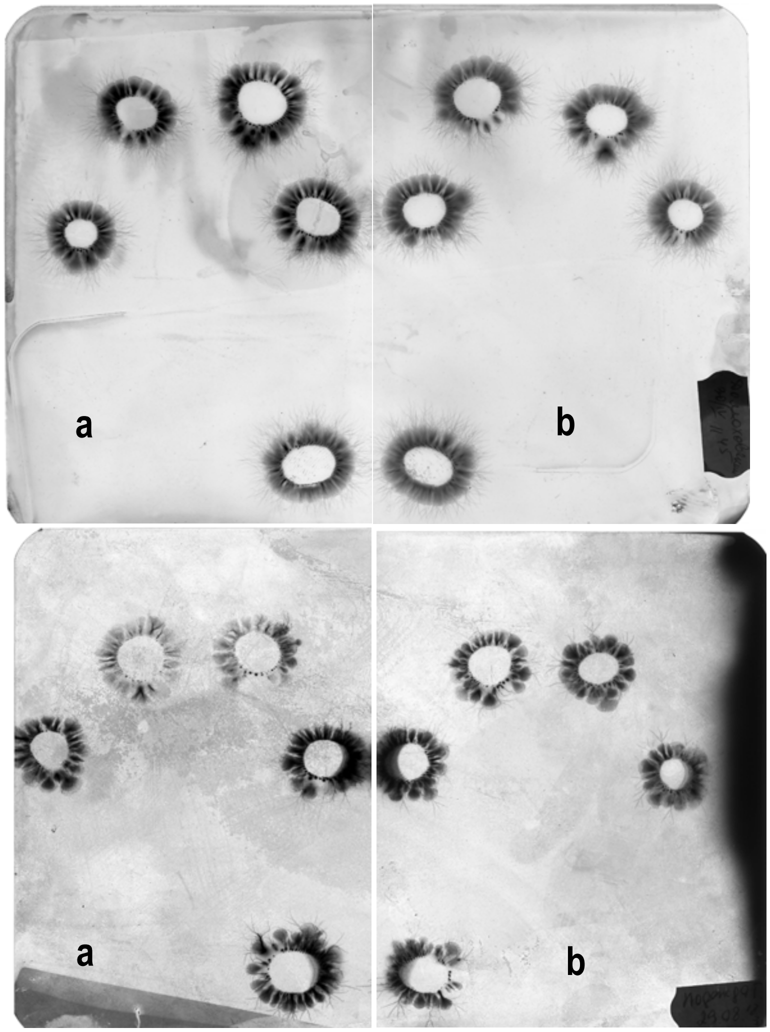

Fig. 2. Kirlian emission images examples:
a - left arm fingers, **b -** right arm fingers

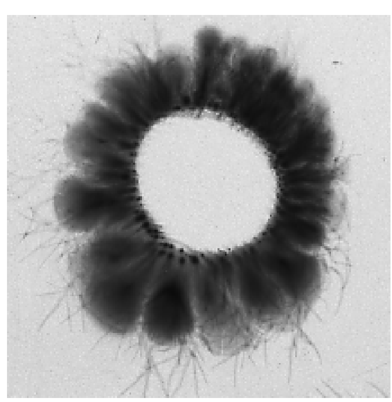

Fig.3. Kirlian emission image of one finger.

Basic functions and algorithms of Kirlian images preprocessing

While Kirlian images preprocessing semi-automatic segmentation is executed on the emission images of every finger separately and corrected the every finger image orientation automatically. The image emission rotation is fulfilled round a conditional center for every finger image.

Software executes the followings functions:

- the emission file opening, view it for a preliminary estimation by an expert and possible adjustment in the interactive mode in order to delete noises;
- interactive determination of fingers emission location by operator pointing the conditional centers;
- appropriation of number for every fingers emission on their mutual location;
- determination of conditional palm center and of corners to be rotated the fingers emission images;
- determination of rectangles, including separate fingers emissions, taking into account the rotation corner;
- rotation of separate fingers images;
- forming the emission files for every finger;
- the results adjustment in interactive mode.

The most important tasks are the determination of accurate location finger emission, emission boundaries and conditional emission center.

On the basis of the general concepts about Kirlian images, it is expedient to approximate the internal finger emission contour as ellipse, and external emission boundary as circumference, to single out the emission of every finger as image object and to determinate its parameters. The parameters of ellipse are co-ordinates of its center; semi axes sizes and slope angle of large axe. The parameters of circumference, described round the emission of every finger, are a center and diameter. The ellipse and circumference centers coincide. A circumference must envelope all emission (dark halo), on possibility except peripheral striolas - «dendrites». It is assumed that a palm center is on the line segment middle, connecting the centers of the first and fifth fingers emission. The palm center is connected with the all emission centers to determinate the rotation corner of every finger in relation to a vertical line. We will consider that every finger emission image will be a square, described round a circumference that enveloped emission, and rotated on the slope angle of line connecting the center of palm with the center of this emission.

The initial information is a preliminary co-ordinates list of emission centers *of x1l*, *y1l*, *l* =1,5 - five fingers for every palm.

The output information is a parameters list of five circumferences, bounded emissions, parameters list of five ellipses, bounded the emission interior.

The optimization algorithms are used, realizing the gradient descent method to search the parameters of circumferences and ellipses.

For circumferences the optimization parameters are center co-ordinates *of* $x_ц, y_ц$ and radius magnitude *of r*. Objective function

$$c = \max_{x_ц, y_ц, r} S_{окр}, \text{ при } \sum_{(x-x_ц)^2+(y-y_ц)^2<r^2} \nu(x,y) > \theta \cdot \Psi \quad (1)$$

where $\theta \approx 0.9$ is some threshold, determined experimentally,

$\nu(x,y)$ is a optical density value of pixel with the co-ordinates *of x,y*;

$\Psi = \sum_{(i-x_ц)^2+(j-y_ц)^2<r_{\max}} \nu(i,j)$ – optical density accumulative value within the circle of maximal radius enveloped emission *of* r_{max} with the center co-ordinates *of* $x_ц, y_ц$

i,j are integer co-ordinates of pixel.

For ellipses the optimization parameters are center co-ordinates of $x_ц, y_ц$, big a and small b semiaxes magnitude and rotation corner of α. Objective function

$$c = \max_{x_ц, y_ц, a, b, \alpha} S_{эл}, \text{ при } \sum_{\frac{(x-x_ц)^2}{a^2}+\frac{(y-y_ц)^2}{b^2}<1} \nu(x,y) < (1-\theta)\cdot\Psi \qquad (2)$$

The system functioning algorithm consists in the following (fig.4).

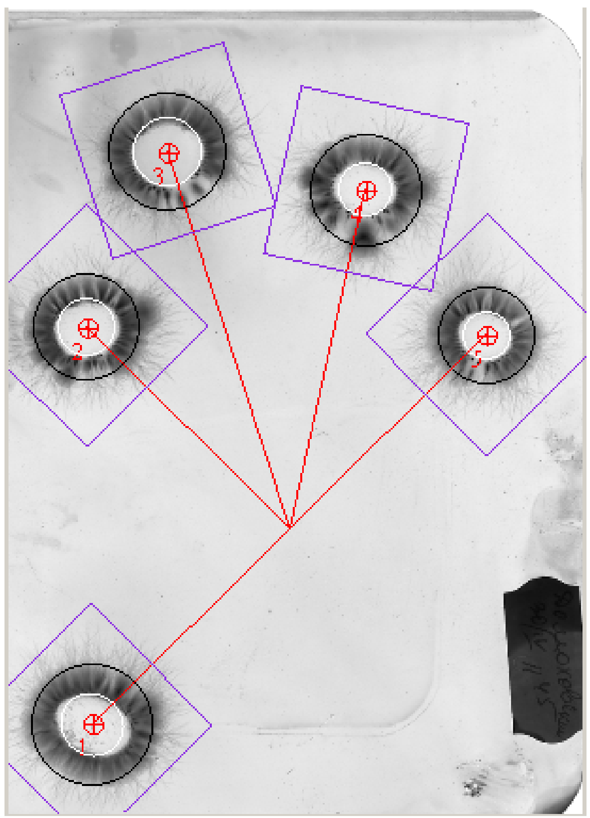

Fig.4 Kirlian image and selected emission images of separate fingers.

1. An operator specifies a cursor on the monitor screen exemplary place of center location for image of every finger. The center location can be indicated approximately, but necessarily must be within the bounds of light spot. The system stores the co-ordinates of the indicated centers.

2. On the indicated co-ordinates the parameters of ellipse and circumference are automatically determined for the image of every finger. If necessary an operator can correct the finger image center, the parameters of ellipse and circumference will be recalculated automatically.

3. The co-ordinates of palm center, values of images rotation corners and parameters of the described squares, boundary the images of separate fingers, are automatically determined.

4. The images of fingers are written down in separate raster files (fig.5.).

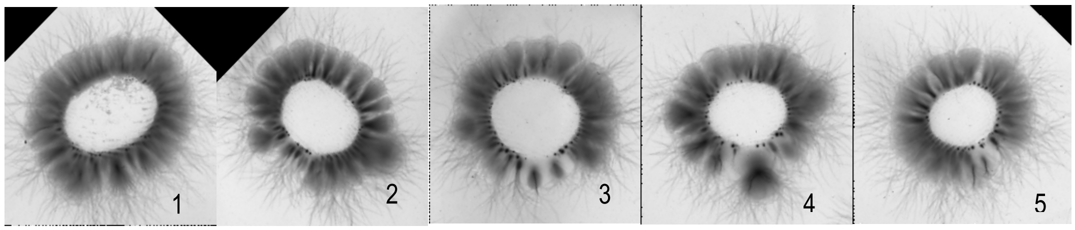

Fig. 5. Separate fingers emission images were selected from the general Kirlian image and formed as separate files.

The ellipse and circumference parameters determination algorithm for every finger consists of the following:

1. The background brightness in the place of every finger emission location is determined. As a background brightness a middle brightness in a square 10×10 pixels is assumed, the square center coincides with the center of finger image.

2. The ellipse parameters of maximal area is determined at the limitations (2), using the gradient descent method.

2.1. In a zero approaching the ellipse center co-ordinates is used, got in the interactive mode, the rotating corner is equal to the zero of degrees in relation to a vertical line.

2.2. Changing the values of parameters *of* $x_ц$, $y_ц$, a, b, α, determine their values, maximizing the area of ellipse at the limitations (2).

3. The diameter of the enveloped circumference is determined. The center circumference co-ordinates coincide with the co-ordinates of ellipse center.

3.1. As a zero approaching the radius of circumference, equal to the greater semi axe of ellipse, is choose.

3.2. Changing the radius values of r, its value, maximizing the circumference area, is determined, using the limitations (1).

Conclusion

1. The laboratory tests demonstrated the efficiency of the created technology to process the Kirlian images for support a decision in the diagnostic systems.

2. One moment Kirlian images reception allows to make a decision in the diagnostic systems at the rapid changes of the patient organism state, and also to research the possibility of using the Kirlianogram sequences in diagnostic aims.

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