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VOLUME CHARACTERISTICS DEFINITION FROM DINAMICAL MICROSCOPIC IMAGE[1]

O. Nedzved[2], S. Ablameyko[3,4], A. Belotserkovsky[3], I.Gurevich[5], A. Myagkov[5], V. Yashina[5]

[2] Belurusian State Medical University, Olga_Nedzved@tut.by
[3] United Institute of Informatics Problems of the National Academy of Sciences of Belarus, nedzveda@newman.bas-net.by
[4] Belarusian State University, ablameyko@bsu.by
[5] Computing Centre, Russian Academy of Sciencesv, aem.istranet@gmail.com, werayashina@mail.ru.

In this paper method of dynamical cytological objects analysis is proposed. This method is based on properties of unicellular organisms. Organisms are displaced during the process of acquisition. Each new position of an object can be considered for the construction of three-dimensional model of stereo. However, the methods for obtaining images in optical microscopy lead to difficulties that must be considered.

Introduction

In modern medicine there is a problem of receiving and processing of the three-dimensional images of cell cultures. However, most of the equipment to enter the medical images based on one sensor, that means only one image is the source for the analysis.
There are several methods of sensing an object in optical microscopy for obtain volume characteristics (fig.1)

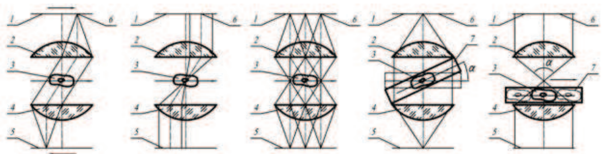


Fig. 1. Scheme sensing an object in microscopy: a-c) with scanning probe light beam relative to a stationary object; d, e) with the motion of the object relative to a fixed beam of probing light way. 1, 5 - front and rear focal plane of the microscope objectives, 2, 4 - microobjectives, 3 - object, 6 - source 7 - holder.

In real life, the optical system of the microscope always has the defect of the optical axis (fig. 1). Optical axis of parts of the system of lighting and imaging system does not match. This defect causes the uneven illumination in the field of view and additional shadow on microscopic objects.
On the other way if the object is not static it is moved into the field of view. This feature allows us to obtain the projections from different angles.

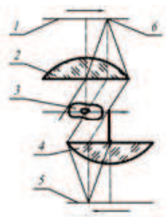


Fig. 2. Scheme sensing an object in microscopy with broken optical axis.

Some method of determination of the correspondence between the points or fragments of two images corresponding to the same elements of the scene underlies of any system stereo reconstruction.
The problem of three-dimensional reconstruction of biological moving object has several features that require specific methods of solution. It is primarily due to the diffuse, low-contrast nature of the borders, as well as with a complicated evolution of the object itself. In addition, this type of scene is dynamic so synchronous stereo is not allows.
Thus, the stereomonitoring of medical objects requires to develop new tools of 3D reconstruction and formulation of requirements for stereo systems on the basis of evaluation of their potential.
In this paper we consider the possibility of medical stereoreconstruction of dynamic biological objects, provided that the displaced image can be used as an additional image in the construction of a stereopair.

Definition characteristics of optical system

3D information is determined on the base of the motion of the object. Usually the movement is reflected by a sequence of images captured at stated intervals. The optical axis of the system is shifted resulting in a complex scheme.

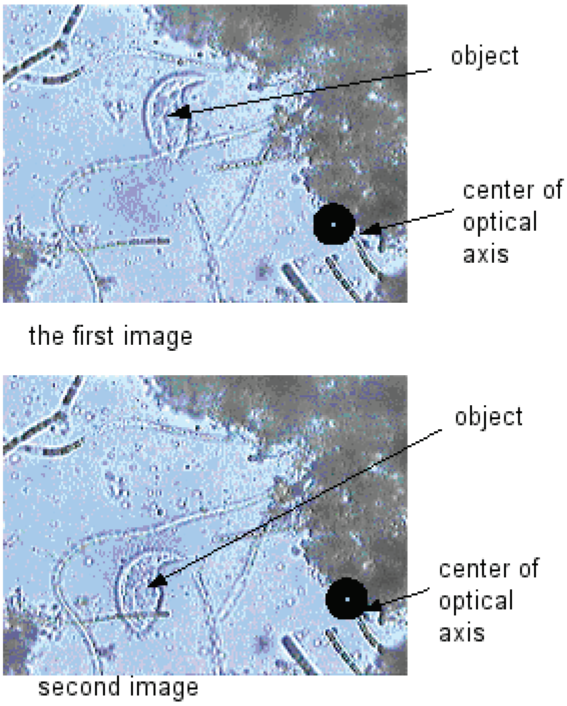


Fig. 3. Important points in the field of view to determine the stereo.

This stereo is not quite usual. Shooting on a camera while the camera is not shifted, but the object itself (fig.4).

As a result, the problem of determining the distance is reduced to a problem for stereo, by defining the optical axis, the exchange of stereo images of places and moving objects segmentation.

For each local region characteristics of the anisotropy of the gradient of brightness are calculated. They represent the general direction of the image formed by shadows in the image (fig. 5).

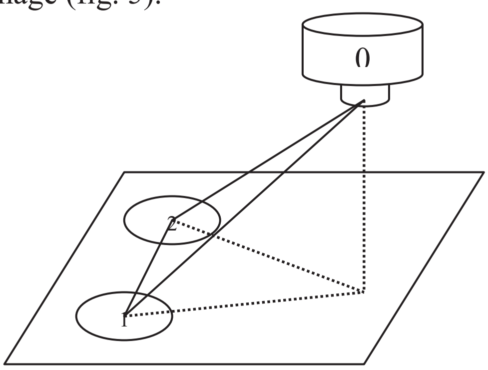


Fig. 4. Determination of triangles and distances for stereo preparing.

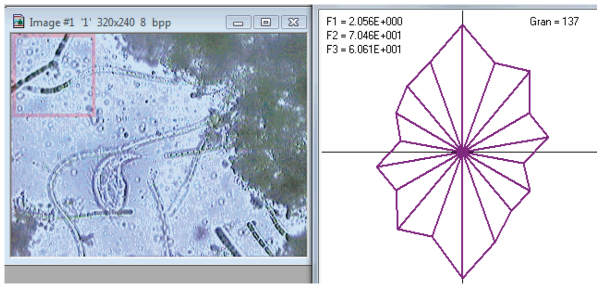


Fig. 5. Scanning local region for pixel, the distribution of the anisotropy for this region.

As a result anisotropy map is created for the whole image. This map has strong smoothing and contrasting for best result. At the point of crossing by optical axis has the minimal value on this map (fig. 6).

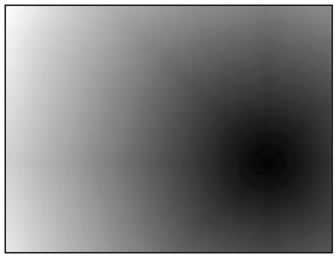


Fig. 6. Map of anisotropy distribution.

Segmentation of dynamic objects and their position

There are many algorithms for dynamic extraction of objects in images. Most of them are based on the determination of the background and its difference with the current image. The easiest way to determine the background is a creation of the histogram for each image pixel (fig. 7).

We can represent a sequence of images as a cube. We then construct a profile of brightness for each pixel along a line across all the image sequence. For these values we construct a histogram, determine the median on it and assigning the median value corresponding pixel. (fig. 7).

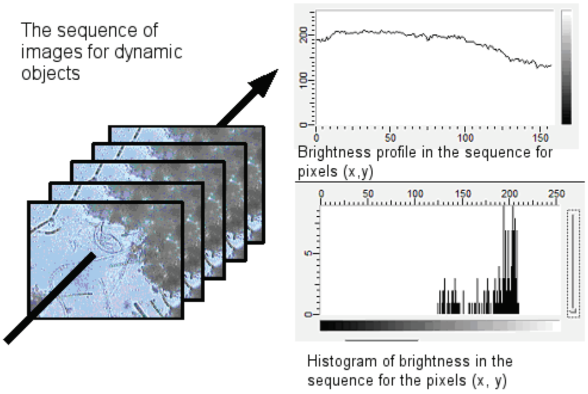


Fig. 7. Steps of detection of the background pixel values.

As a result, a background image. This image has a slight error that occurs when applying the noise the camera to the dynamic changes in the image. These noises are of little value and are removed by median filtering (fig. 8).

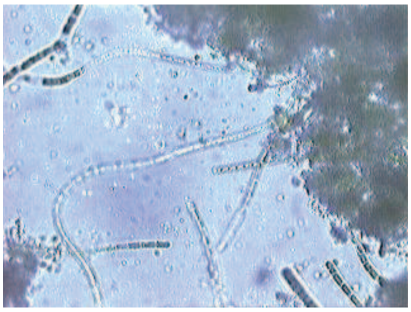


Fig. 8. The synthesized background image.

When the background image is known, it is easy to identify the position of the dynamic objects by calculating the modulus difference between the images.

To determine the position of the object it's necessary to make binarization of this difference. Binarization is performed by the Otsu threshold segmentation. [5]

The aim of this method is to select a threshold that minimizes the ratio of the combined dispersion to the dispersion between classes which defines a partition of the histogram on the thresholds. The result is an image with a large set of multitype objects. Determination of geometrical properties is being for their classification. Objects that fall out of a certain interval of geometric features, are removed. Defects in shape of objects are corrected by morphological operations and filling.

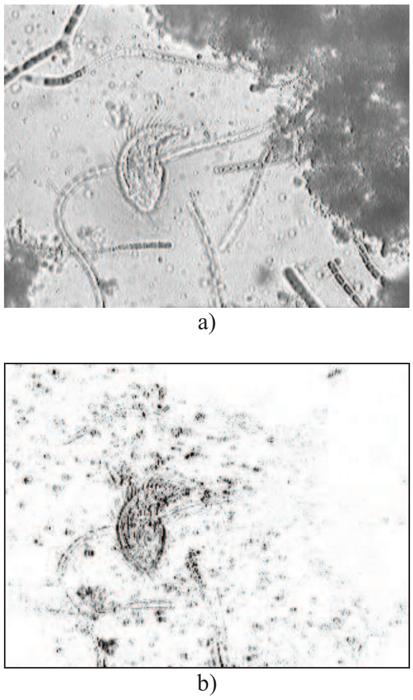


Fig. 9. The original image and the modulus of its difference with the background.

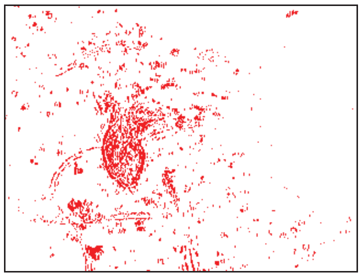


Fig. 10. The binary image after thresholding.

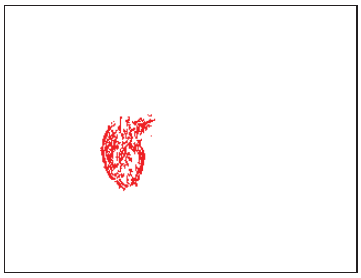


Fig. 11. The binary image after removing small objects.

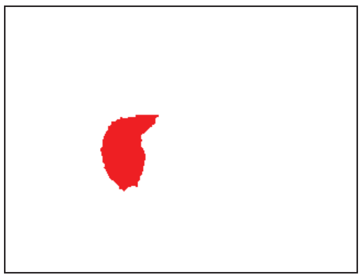


Fig. 12. Shape correction by morphological processing.

A binary image of an object allows determining of the center of mass, the minimum and maximum coordinates, the coordinates of the contour of the object and its square. These characteristics are involved in determining of the parameters of the stereopair (fig.13) which serves for the 3D reconstruction of the object.

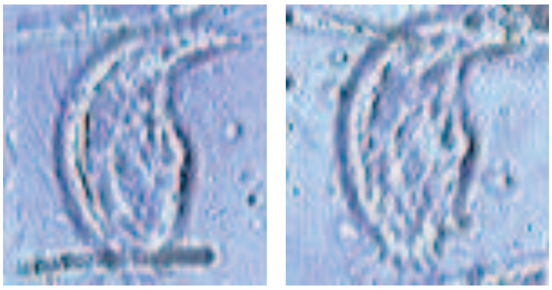
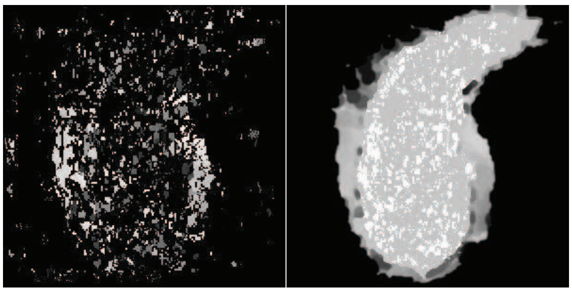


Fig. 13. Resulting stereopair for volume shape reconstruction.

The construction disparity map for such stereopair has many troubles. Problems with optical system of microscope lead to the appearance of shadows and distortions. We solve it by shadows removing. In result draft disparity map is constructed (fig.14a). This map includes separate regions that are corresponding to stable fragment of object. Improvement of the cards carried by the operations of mathematical morphology based on the principles of watershed (fig. 14b)



a) b)

Fig. 14. Disparity map: a)draft map, a) after morphological processing .

Conclusion

The developed algorithm allows to obtain volume object pattern of dynamic medical images. It based on the principle of a stereo pair. Using of additional stereo methods such as the segmentation of dynamic objects, determining the optical axis and correction of the disparity can use this algorithm to work with such complex objects as dynamic objects in the cytology (Fig 15). Using combinations of these principles can quickly and efficiently determine the actual values of the distances, the contour of cells and preserve the value of all source information. Therefore, this algorithm is most effective for use in problems associated with the analysis of dynamical microscopic objects.

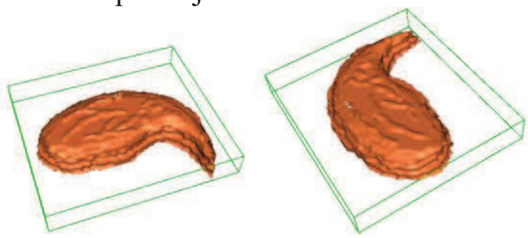


Fig. 13. Cell reconstruction from stereopair.

The results will contribute to the development of analytical software cytological techniques for correct calculation of the data on the dynamics of the evolution of cellular structures. This work is aimed at improving the information content of data dynamic volume objects in medicine and biology, and allows us to obtain new features for a more accurate description.

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