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Detection of a fork-like marker of ureaplasmosis in the image of the biological fluid facies

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I.INTRODUCTION

The correctness of diagnosis, that is, the accuracy of determining the type of disease, largely ensures the success of further treatment. Currently, X-rays, ultrasound and other images are widely used in medical diagnostics along with other methods of examining patients. The parameters of biological fluids (blood, lymph, tears, urine, cervical mucus, etc.) are very informative for the diagnosis of many diseases. Recently, the method of studying the state of these liquids by analyzing images of their facies (thin films of dried liquids) has been actively used. As the liquid dries, the substances contained in it crystallize. As a result, the totality of crystals forms characteristic structures (markers). Numerous observations have shown the association of certain types of these markers with some diseases, even in the earliest form, when symptoms are not yet observed.

In this paper, we consider the problem of detecting a marker of ureaplasmosis. This disease is caused by certain types of pathogenic microorganisms (ureaplasmas) and affects the genitourinary system. Recently, this disease, unfortunately, is common. A method for the early (even before the stage of clinical manifestations) diagnosis of urogenital ureaplasmosis based on the image of the urine facies is described. A sign of this disease is the presence of a marker, shaped like a fork. The images used in the paper were provided by the collective of Ulyanovsk State University, where researches in diagnostics by facies of biological fluids are performing under the guidance of Professor L.I. Trubnikova.

II.FORK-LIKE UREAPLASMOSIS MARKER

Figures 1-3 present images of facies with markers characteristic of ureaplasmosis. These markers are shown in red circles in Fig. 4. In shape they resemble a fork. The task is to develop an algorithm and program to detect such markers. Fig. 5 shows an image on which there are no wage markers. Fig. 3 shows the 760x1015-image, on the example of which the algorithm for detecting ureaplasmosis markers will be demonstrated.

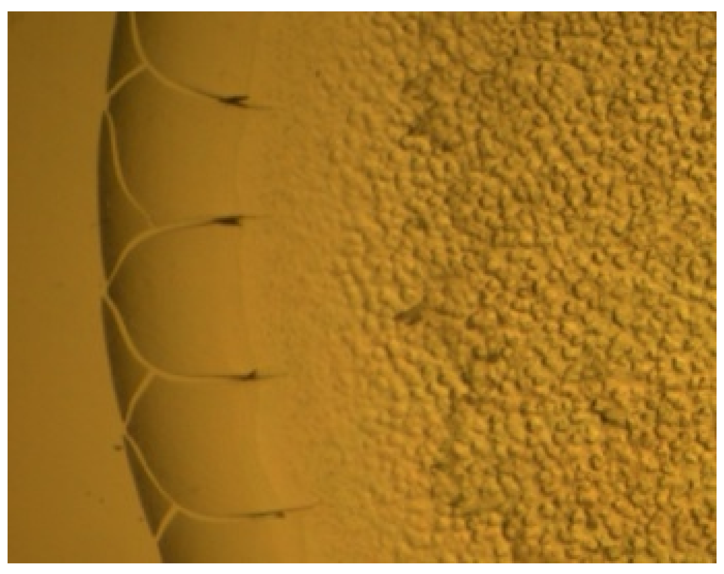

Fig. 1.Image of a facies with three markers

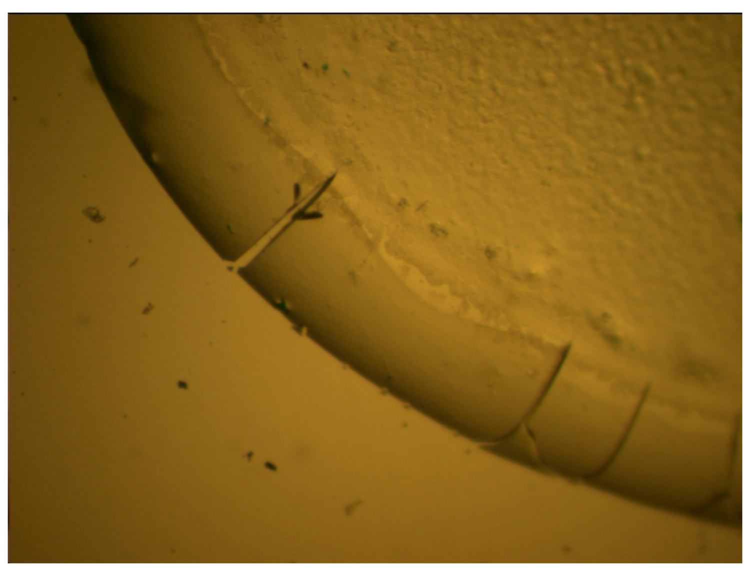

Fig. 2.Image of a facies with one marker

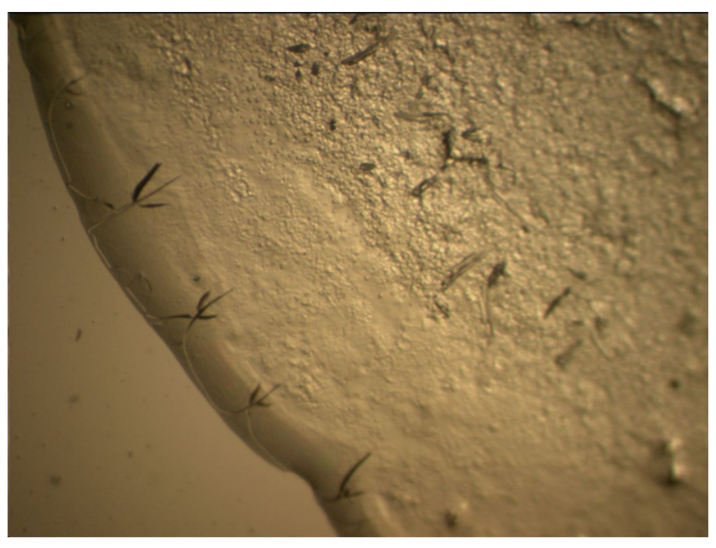

Fig. 3.Original facies image

Fig. 4.Ureaplasmosis markers are marked with circles

Fig. 5. Image of the facies without marker

Fig. 6.Convert to grayscale

III.MARKERS DETECTION

We will detect markers on a facies image converted to grayscale (Fig. 6) by averaging the RGB components of Fig. 3, since the colors in this task do not carry useful information. The resulting image is processed by a median filter to reduce the influence of impulse noise. The facies boundary can be approximated by a circle as it is obtained by drying a round drop of liquid on a glass slide. Image measurements showed that the markers can be located between two circles: the outer radius is equal to the facies radius and the inner radius is 75% of the facies radius. For their construction it is necessary to determine the radius of the facies and its center. There is a brightness jump at the edge of the facies. To detect such points, the variation of brightness (the difference of the maximum and minimum) in a 9x9 sliding window is compared with a threshold (Fig. 7).

Small clusters are removed from the obtained set of points, and the contour of the edge of the facies is formed (Fig. 8). The coordinates of the center of the facies and its radius were found by the method of least square deviations of the radius from the distances between the center and the points of the edge of the facies.

The area of markers location lies between the two circles shown in red on Fig. 9. Areas with brightness above average (shown as white in Fig. 10) are removed from further consideration.The Canny algorithmwith was used to extract the contours. Then, using a pixel-by-pixel traversal of the contour, only borders of sufficient length (at least 50 pixels) are left (Fig. 11). The Hough transform was used to find short, approximately rectilinear lines (Fig. 12).

The decision on the presence of a marker is carried out on the basis of the detection of the intersection of two lines, from among those found at the previous stage. If an intersection of lines at the angle of more than 20 degrees and less than 160 is found on the image, then a decision about the presence of a marker is made (Fig. 4).

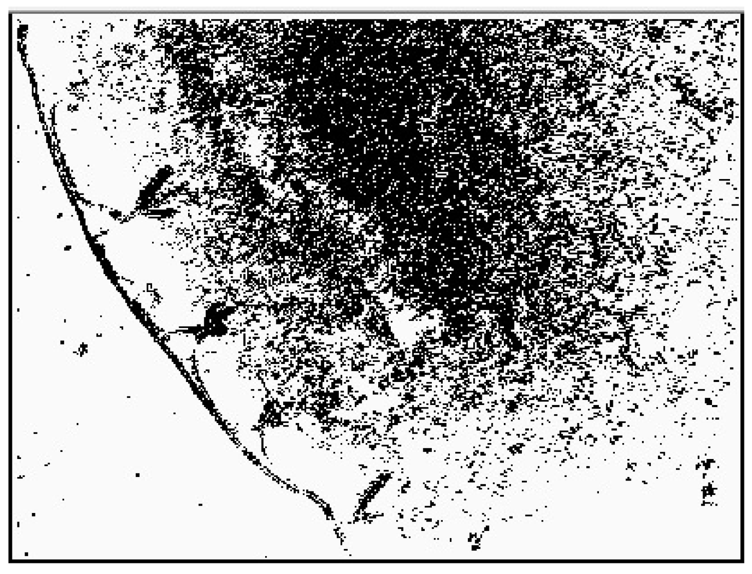

Fig. 7.Points of great variation

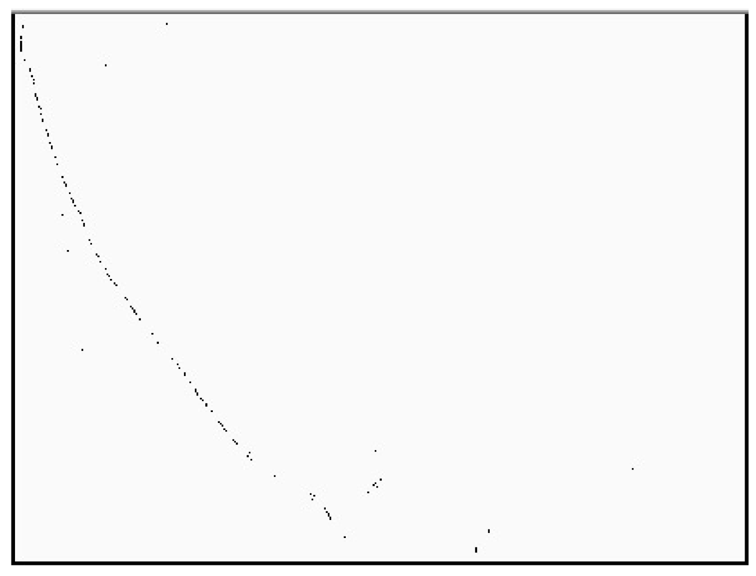

Fig. 8.Facies boundary

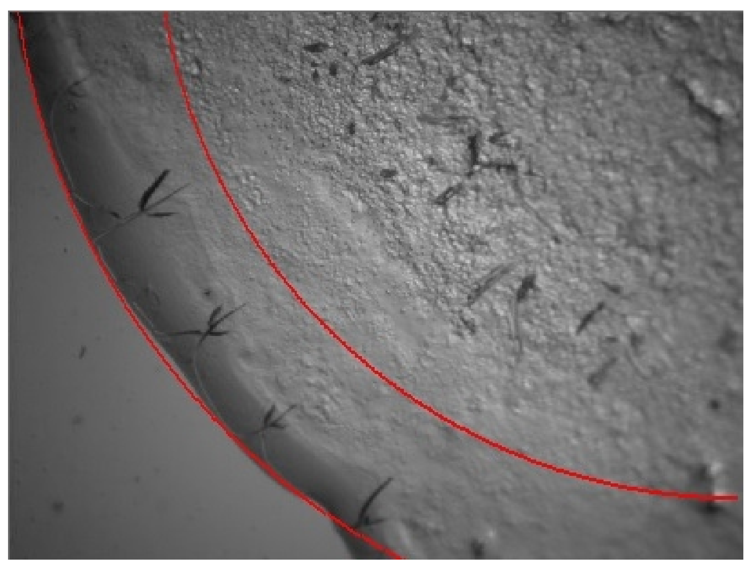

Fig. 9.The area of of markers location

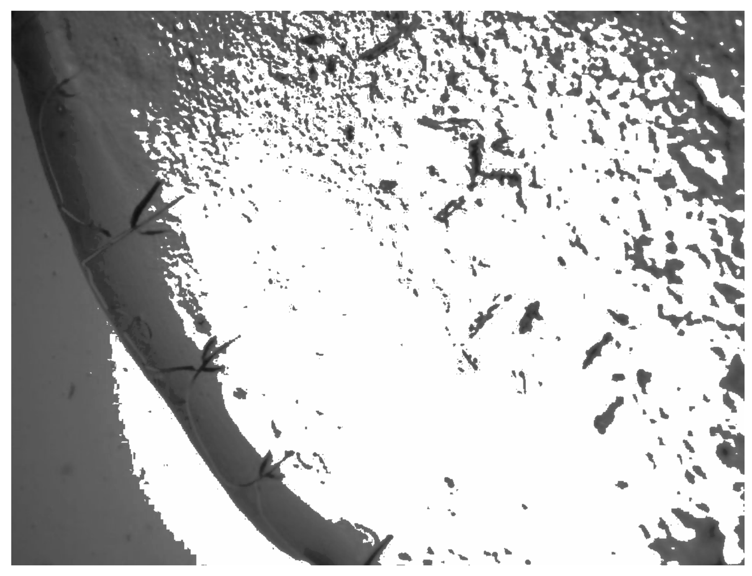

Fig. 10.The threshold section

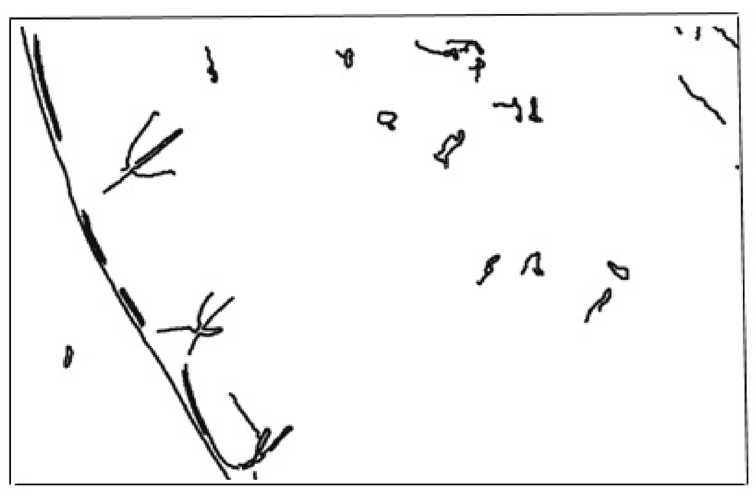

Fig. 11.Selected contours

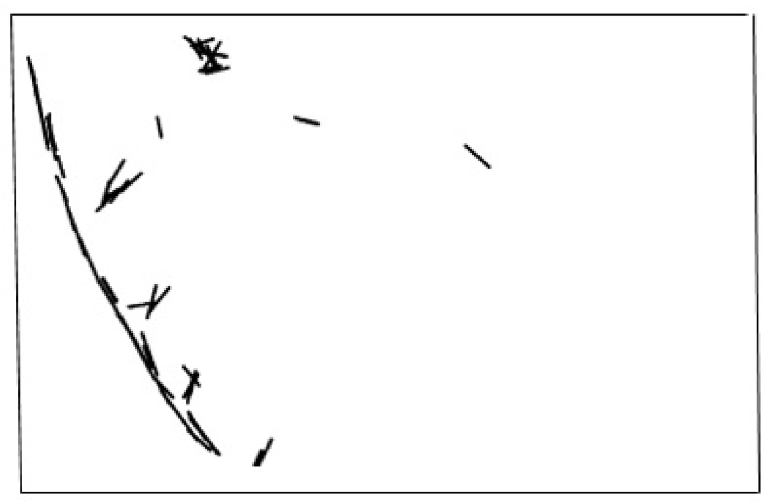

Fig. 12.Selected straight lines

The described algorithm was tested on 154 real facies images. In 10 of these images, there were 27 markers of the considered type, of which 25 were found. In this case, all 10 images were identified as containing markers. Note that the presence of at least one marker on the image is sufficient for diagnosing a disease, that is, it is not necessary to detect all markers. Therefore, in this example, the identification of all 10 images containing markers can be considered a 100% detection, regardless of 2 missing markers out of 27 available.

There were no markers of ureaplasmosis on 144 images, however, on 7 images there were false detections, that is, less than 5%.

IV.CONCLUSION

The problem of detecting a marker of ureaplasmosis in the image of the urine facies is considered. This common disease is caused by certain types of pathogenic microorganisms (ureaplasmas) and affects the genitourinary system. Diagnostics based on facies images does not require expensive laboratory equipment and a long time, therefore it can be used in mass surveys of the population.

The proposed algorithm processes the facies image entered into the computer. The markers are fork-shaped and located near the facies boundary. The algorithm includes finding the border, center and radius of the facies, and the area of possible location of markers. Fragments with characteristic features of the marker are searched for in this area.

The tests carried out on 154 real facies images showed a high efficiency of the proposed algorithm, which makes it suitable for use in medical institutions.

ACKNOWLEDGMENT

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