Automatic Identification of Human Sperms from Noisy Microscopic Images
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Abstract- Sperm morphology is assessed consistently as part of fundamental lab analysis in diagnosing human male infertility. Nowadays, analyses of sperm morphology are primarily done based upon subjective requirements. To avoid subjectivity, countless studies that integrate image evaluation techniques in the analysis of sperm morphology have been proposed. The primary process of all these techniques is the segmentation of sperm's parts. This paper has proposed an efficient method for detecting sperm's Acrosome, Core, Mid-piece and identifying sperm's tail with some points put on the sperm's tail, correctly, especially from noisy microscopic images. Sperm morphology, as an indication of fertility, is an essential tool in sperm evaluation. In this research study, the proposed system that completely automates the sperm morphological analysis is presented to remove undesirable human elements. The recommended hybrid system includes two progressive steps: automatic segmentation of feasible sperm shapes and normal/abnormal sperms classification.

Keywords- Sperm, CAD, Segmentation, Arduino, E-health Shield, Andriod Applications.

1. INTRODUCTION

In human sperm mobility analysis, sperm segmentation plays an essential duty to figure out the place of several sperms. Typically, a hands-on sperm analysis is often executed in a laboratory by andrology's professionals. This approach is claimed to be excessively reliant on the experience of specialists, procedures, and also human errors. For that reason, computer-assisted system evaluation (CASA) systems have actually been introduced. CASA has come to be prominent in sperm motility analysis because this system facilitates rapid assessments of sperm mobility, velocity, and various other descriptors [1]. Several industrial and non-commercial versions of the CASA systems are presently offered in the marketplace. However, a study [2] stated that each of these systems has unique attributes that fit various research applications. Hence, different results are gotten when the same sperm example was evaluated using various systems. This issue has motivated researchers to recommend significantly durable as well as accurate image handling strategies for sperm division and classification. Numerous researches that are related to photo segmentation techniques, such as thresholding, unclear c-mean (FCM), area expanding, split-and-merge as well as clustering, have been reported in the literary works [1,3–6] However, none of them are substantially accurate as well as exact, particularly in medical photo division. The sperm division formulas revealed good lead to segmenting the sperm head. Nonetheless, these algorithms still have the following drawbacks [3-5]:
1) The acquired sperm form can not be appropriately identified since this form has been taken care of in specific measurements (i.e. ellipse form or morphological operation).
2) The agglutinated two or even more sperms can not be set apart in a particular frame due to unforeseen sperm mix.
3) The existing techniques are sensitive to noise. In the worst instance circumstances, each noise in an image can be misidentified as the sperm head.
4) The existing methods are not entirely automated.
5) These techniques still need human involvement to start the process of detecting sperm.

In this paper, a sperm detection technique based upon morphological operators and info distance between the initial and processed image, complied with by the recommended segmentation method, exists. In the suggested approach, to start with, the co-occurrence matrix was computed, which has details on the distribution of grey level transition regularity. Using aspects of this matrix, the degeneration of changes throughout borders of picture components was computed, which shows some regions of the acquired image as main "prospects" for sperms. Ultimately, an algorithm based on watershed segmentation was put on determining complete sperms from the above prospects. Unlike the existing techniques, the proposed algorithm extracts a lot more exact morphology for sperms in high-density sperm specimens. This benefit occurs from the ability of the recommended algorithm to remove the background of other details.

2. LITERATURE SURVEY

It is familiar that the seminal fluid of men with impaired fertility has fewer sperms than the semen of males with normal fertility [1,2]. Also, it has been shown that the unusual morphology of sperms is considered a danger in men's fertility [3,4]. Consequently, assessing
the male semen to determine sperm population and morphology has ended up being the most preferred policy of researchers in checking infertility [5,6]. In recent years, tiny imaging has been extensively used for researching semen. The process of separating sperms from various other particles in semen acquired images is called sperm detection. Throughout several years, hands-on sperm detection by an experienced individual has been the primary method to do such a separation. Nonetheless, the aesthetic studying approach is considerably effort-demanding and also time-consuming. Moreover, the intrinsic absence of neutrality in examining human sperm morphology in this technique causes a high degree of variation between different laboratories and service technicians [1]. Based on the abovementioned constraints, automated sperm detection and analysis methods have been established quickly throughout the last two significant obstacles in automated approaches. Regardless of the substantial quantity of work done in this field, the automated discovery of sperm has remained open to trouble. Some techniques try to spot sperms using details collected from the sperm head. However, this method is not with the ability to remove the sperm tail entirely [2]. Because edge details can not be removed from microscopic images that are intrinsically reduced contrast, active contour-based sperm detection algorithms have been developed. However, these techniques need numerous versions that make them inappropriate for real-time applications. In some prior arts, threshold-based division formulas have been applied. These techniques are conscious worths of the limits used for a division that leads to significant missing of sperms or false discoveries [7]. In some other investigates, finding human sperms is performed using the region growing algorithms. However, these methods commonly bring about merging the neighboring sperms [8]. As for a lot more sophisticated methods, numerous kinds of matching can be termed. In these techniques, constant or versatile masks are used to separate sperms from other seminal fluid parts. These strategies deal with some constraints, such as a high level of sensitivity to form, size, and turning of sperms [8,9]. In some investigations, the wavelet change has been utilized to identify sperms from other parts of semen. Regardless of this method’s capacity in drawing out sperm morphology, its performance is degraded substantially in sperm specimens with a high density of sperms [10-15]. Some approaches make use of watershed segmentation for separating sperms from other specimens of sperm. Although these approaches may estimate the existence of sperm, they may not identify an exact boundary between it and history. As a result, the above approaches might not draw out sperm morphology too.

3. AN OVERVIEW OF THE PROPOSED SYSTEM

This paper introduces an image processing technique for an automated morphology estimation of motile sperm. The proposed approach initially distinguishes sperm from non-sperm shape (e.g. epithelial cells and separated sperm heads or tails) present in sperm. The main objective of this process is to spot and identify each sperm in the image. The graphic diagram of normal sperm and its World Health Organization’s guideline (WHO’s guideline) is presented in Figure 1 and Table 1.

![Figure 1: A schematic diagram of normal human sperm](image)

<table>
<thead>
<tr>
<th>Table 1: Normal Sperm WHO's guideline (5th Edition) [9]</th>
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<tbody>
<tr>
<td>Volume</td>
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<tr>
<td>Total Sperms (millions)</td>
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<tr>
<td>Count (millions per ml)</td>
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<td>Motility</td>
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<td>Morphology</td>
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A. Image Acquisition Step

The semen specimen images are captured by a smartphone-based data acquisition approach from the ocular part of a microscope as a ported step from the CAD system. The data acquisition is utilized the mobile phone to get more noisy data. Then, the result of the proposed technique will be compared later with the specialists. In this paper, 200 different unclear and noisy images of 20 subjects who came to the were randomly collected and examined. This study was agreed with the ethics committee of the society. The acquired images are taken from the Integrated Fertility Center in Egypt. These images are virtually unfit for the regular use of a CAD system, and it would have been destroyed, or it will be forwarded to the specialists if there is a problem in taking another sample of the patient. Samples of the examined images are shown in Figure 2.

![Image](image_url)

**Figure 2: Samples of the examined images**

B. The Description of the Proposed Technique

Medical images always required segmentation involved in partitioning an image right into non-overlapped, consistent areas that are homogeneous and extracting only the areas of interest, plus discarding other unwanted textures. The suggested crossbreed approach consists of the segmentation, classification, and counting steps. Succeeding to instantly ROI segmentation and also discarding actions for sperm and also non-sperm parts respectively. The sperm parts should be identified as normal or abnormal sperm. Pre-processing is one of the essential stages in any information retrieval applications based on image-processing in order to reduce noise and/or undesired objects. The main steps of the proposed are shown in Figure 3. The result of the proposed algorithm is a count of the variety of sperms. Discarding the non-sperm objects is another challenge in our system.

![Diagram](diagram_url)

**Figure 3: The block diagram of the proposed technique**

Hence, the main steps can be summarized as:

1) Image Preprocessing
2) Edge Detection
3) Shadow Detection
4) Gradient Detection
5) Crossing-Over Detection
6) Sperm Detection + Sperm Counter + Length frequency and phenotypic noise
i. Image Preprocessing
The initial essential step in the introduced system is preprocessing. This process is applied to change pixel values in the acquired images to expose the sperm head features. Because of deficiency of image clearness as it might be influenced by numerous factors of falsifications like a non-uniform background, deflection or poor lighting conditions, the shadows' existence, out of focus, overlapping sperms, or other levels of noises besides the degree of similarities to the background which might degrade the performance of the proposed technique. Thus, the preprocessing process is a crucial step that should be employed to enhance sperm image quality to get correct sperms detection. Firstly, to take less preprocessing time, the RGB captured image from a smartphone is converted into its grayscale form. The most usual technique for development on the preprocessing is histogram equalization, which depends on the presumption that the quality of an image is uniform and unique mapping of the full details of a single provide a similar correction to all regions of the image. Nevertheless, this hypothesis is not typically valid, specifically when grayscale pixels' distributions transform from one area to another. Figure 4 shows the transformations between histograms of the same sample of human sperm data after using CLAHE and Histogram Equalization methods individually. The difficulties of very concentric distribution or a very low-contrast image could not be solved with a complete histogram equalization technique. Hence, to enhance the contrast and fix the result of non-uniform illumination, the contrast-limited flexible histogram equalization (CLAHE) is adopted, which might exceed the typical methods.

![Image showing the results of applying different preprocessing techniques of the proposed technique.](image_url)

**Figure 4:** Results of applying different preprocessing techniques of the proposed technique; (a) the grayscale sperm image and its corresponding histogram, (b) the result of applying histogram equalization (HE), (c) the result of applying contrast stretching (CS), and (d) the result of applying CLAHE.

ii. Edge Detection
It is a mathematical technique to discover those factors in images where illumination, intensity, and connection adjustments. Nowadays, this technique is beneficial in lots of fields. As it is generally a subject of Digital Photo Handling in its applications are widely reviews. Side discovery brings about the precise output of methods like segmentation as well as object classifying. Noise is an external consider any image it can be an ecological result, tool failure or any type of human mistake. Canny edge detecting method can outstand the issue of noisy images. There are some steps with which we eliminate the noise and spot the edges i.e., Gaussian filters. It incorporated weak edges with strong to locate edges of sperms in an image. Unlike Sobel as well as Laplacian operators, it utilizes its Gradient feature. Based on MATLAB Image Processing Toolbox suggested treatments, we spotted sperms making use of the Canny Side Detector, followed by dilation, hole-filling, as well as boundary cleaning; Figure 5. The segmented sperm areas were then subjected to a skeletonization regimen, which thinned the lengthened frameworks to a 1-pixel wide contour. These steps were made use of for the quantification of sperm length.

![Canny Edge Detection Example](image_url)
iii. Shadow detection

The microscopic images' topographic appearance reveals a prominent dark shadow, as exposed in the 2D images. The darkness was recognized by histogram equalization to improve contrast. A 3×3 mean filtering mask was then complied with by a 2D wiener filter to maximize strength threshold; Figure 5. Built-in object detection was used to extract the border and locate the small axis (l) sizes for discarding small objects existing in the binary image.

iv. Gradient detection

To quickly detect the standpoint shadow's, a pixel-wise gradient in $X$ ($\delta x_{i,j}$) and $Y$ ($\delta y_{i,j}$) is calculated from the change between a pixel and its neighbor's value. The neighboring pixel value is the mean value of $n$ neighbors, and the gradients are described as following [16]:

$$\delta x_{i,j} = |I(i,j) - \langle I((i+1)+(j+n+1))\rangle|$$
$$\delta y_{i,j} = |I(i,j) - \langle I((i+1)+(i+n+1))\rangle|$$

Equation (1)

where $i$ and $j$ are the pixel's coordinates, and $n$ is the mask size, by trial and error and several experiments, the optimal value of $n$ was set to $n = 3$.

![Figure 5: Results of the consequences of human sperm detection process.](image)

v. Crossing-Over Detection

A pixel-wise branch detecting approach was employed to avoid overestimating human sperm lengths. The skeletonized images are the inputs in this step; the neighboring pixels and their locations were distinguished utilizing a deconvolution filter with every 8 neighborhood neighbors (i.e., Moore's Neighbourhood).
vi. Sperm detection
The obtained data from each image were plotted and analyzed as a frequency distribution to get the sperm dimension. The protuberant characteristic of the data is the long tail, as shown in Figure (6)

![Sperm length distribution](image)

Figure 6: Sample of human sperm detection results.

4. CONCLUSIONS AND FUTURE WORK
In this paper, a new approach was presented for sperm detection in noisy microscopic images of human sperm. The recommended approach is capable of identifying sperms from various other sperm specimens utilizing a combination of decline of transitions across borders and watershed-based division. In order to review the performance of the proposed approach, several samples of the acquired database with low and high densities of sperms were collected and examined. The performance of the suggested algorithm has an excellent efficiency of the proposed algorithm was shown. Outcomes revealed that the proposed formula drawn-out sperm no matter the existing noise. The drawback of the recommended method for discovery and discrimination of sperm's tail is that items positioned on the sperm's tail affect the efficiency of the proposed method. So, in future investigations, we plan to use different geometric functions to increase accuracy values.

REFERENCES


