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Recognition of Malaria Parasite using Image Processing

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Abstract: Malaria is a very serious infectious disease caused by a peripheral blood parasite of the genus Plasmodium. Conventional microscopy, which is currently "the gold standard" for malaria diagnosis has occasionally proved inefficient since it is time consuming and results are difficult to reproduce. As it poses a serious global health problem, automation of the evaluation process of high importance. In this work, an accurate, rapid and affordable model of malaria diagnosis using stained thin blood smear images will be developed. Images of infected and non-infected erythrocytes will be acquired, pre-processed, relevant features will get extracted from them and eventually diagnosis will be made based on the features extracted from the images. A set of features based on intensity will get proposed, and the performance of these features on the red blood cell samples from the collected database will be evaluated using a Support Vector Machine (SVM) classifier.

Keywords: Malaria, erythrocyte, Parasite, Digital Image Processing.

I. INTRODUCTION

Today, one of the most significant elements in diagnosing diseases is the appearance of the living tissue. Since the visual diagnosing in diseases is a difficult and time consuming way, the automatic diagnosing makes a significant help in saving the time and reducing the possible errors. Malaria is a serious infectious disease caused by a peripheral blood parasite of the genus Plasmodium [1]. Every minute, all over the world, a child under the age of five dies because of malaria. It is estimated that every day 1,500 children die. About 216 million people got malaria in 2010 [2]. Malaria is the most important parasitic disease in Iran which has a long outbreak history. Malaria is transmitted by the infected female Anopheles mosquitoes which carry Plasmodium sporozoites in their salivary glands. The genus Plasmodium has four species that can cause human infection: falciparum, vivax, ovale, and malariae. The complete life cycle has separate development stages in the human and mosquito body. When an infected mosquito feeds on a person's blood, the sporozoites enter the blood stream and move to the liver where they multiply asexually for a period. Then they produce merozoites to enter the peripheral blood stream again to invade Red Blood Cells (RBCs) . Parasite grows in RBC till it becomes a full grown up, in order to pour the extra merozoites into blood, then, it pierces the cell—about 6-24 parasites come out from each RBC [3,4].The malaria disease happens due to one of the four-type Plasmodium parasite: falciparum, vivax, ovale, and malariae. Staining blood slides with giemsa, while working with microscope, is used to detect malaria parasite. Giemsa stain is used to differentiate nucleus and cytoplasm of parasites, morphology of platelets, red blood cells and white blood cells. Giemsa staining solution stains up nucleic acids and, therefore, parasites, white blood cells, and platelets, which contain DNA, are highlighted in a dark purple color. Red blood cells are usually colored in slight pink colors [5].

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II. Literature Review

Visual detection is time consuming and causes great differences among microscopists. Hence in new remedies of this disease, automatic detection of malaria by using giemsa stained blood is of significance importance.

Ruberto et al. [6] used the hue and saturation components from the HSV color space to detect the parasite regions. They assumed a paraboloid model for the non-uniform illumination of the scanned images, which is not always the case.

Ross et al. [7] have proposed a histogram based thresholding method to detect RBCs and parasites but their technique is heavily dependent on image quality and fails when the histogram does not have distinct valleys.

Automated image analysis-based software "MalariaCount" for parasitemia determination, i.e. for quantitative evaluation of the level of parasites in the blood, has been described in Weiling Sun et al. [8]. The presented system is based on the detection of edges representing cell and parasite boundaries. Their proposed technique includes preprocessing, edge detection, edge linking, clump splitting, and parasite detection steps. The preprocessing of the image, which involves the enhancement of the image contrast via adaptive histogram equalization, is followed by an edge detection, where a pixel is determined to belong to the boundary edge of the red blood cells if a defined edge correlation coefficient exceeds an empirically determined threshold. The resultant edge contours are linked together through their terminal points to form closed boundaries. The system requires well-stained and well-separated cells in order to provide accurate result. Moreover, artifacts, 'holes' inside red blood cells and noise can lead to a false interpretation of a red blood cell. Their software is not intended for studies involving patient samples [8].

The paper by Diaz et al. [9] evaluates a color segmentation technique, based on standard supervised classification algorithms, for separation of pixels into three different classes: parasite, red blood cell and background. The article presents a simple method for red blood cell and parasite detection with no classification of parasites. Their approach is based on a classification process that finds boundaries that optimally separate a given color space. No details on the filtering process performed to separate the relevant objects of interest are given. The system assumes constant color tone in the input images, since only luminance differences are corrected. To classify the stained pixels as parasite or non-parasite, they used a distance weighted K-nearest neighbors classifier. They also used four discriminative features – color histogram, Hu moments, relative shape measurements vector, and color auto correlogram. The relative shape measurements vector is formed of simple measurements representing the object shape. According to the results of the study, the most successful feature to classify the stained objects as parasite/non-parasite was the combination of correlogram, Hu moments and relative shape measurements [10].

This approach once digitized will diminish the time taken for screening the sickness. This will upgrade the consistency in conclusion. This examination investigates the use and utilization of modernized picture planning for perceiving wilderness fever parasites using minute shading images. A beneficial procedure is proposed for parasite area in perspective of power and surface features. Parasite revelation is the basic limit of this semi-automated finding. A proficient technique is proposed for parasite location in view of force and surface highlights. Parasite identification is the key capacity of this semi-automated finding.

III. System Architecture

The system model is implemented using six main processes, namely; image acquisition, image preprocessing, image segmentation, feature extraction, comparison and classification as shown in Fig- 1.

A. Image Acquisition

A proper survey for image database will be done for further process of detecting the parasite.

B. Image pre-processing

The goal of this step is to make the acquired images more suitable for subsequent processes, mainly image segmentation and feature extraction. Basically, there are three main objectives for image pre-processing. One is to resize the image for the purposes of either magnifying the image through digital zooming, or reducing the image size in order to speed up processing. The second objective of image pre-processing is to reduce or eliminate noise from the acquired image. The third objective is to enhance the image contrast for visual evaluation.

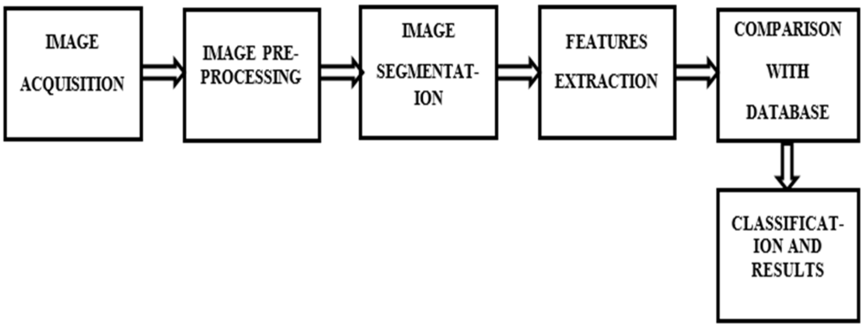

Fig -1: Block diagram of the malaria diagnosis system.

C. Image segmentation

Image segmentation is the fundamental step to analyze images and extract data. Image segmentation is a mid-level processing technique used to analyze images and can be defined as a processing technique used to classify or cluster an image into several disjoint parts by grouping the pixels to form a region of homogeneity based on the pixel characteristics like gray level, color, texture, intensity and other features. The purpose of the segmentation process is to get more information about the regions of interest in an image, which helps in annotation of the object scene. The main goal of segmentation is to clearly differentiate between the object and the background in an image.

D. Feature extraction

In order to distinguish between infected and non-infected red blood cells, we need to extract features from the image array and compute new variables that concentrate information to separate classes. The set of features should discriminate between infected and non-infected RBCs as well as possible. An additional requirement is robustness, so that the results can be reproduced for new independently collected material. Raw images cannot be used directly as features due to high variations in morphology, which are coupled with arbitrary rotations and scales and because the raw images contain large amount of data, but relatively little information. The aim of feature extraction is to transform the input data into a reduced set of features that extract the relevant information from the input data.

E. Detection of plasmodium parasites

Based on the feature extracted, detection of Plasmodium parasites will be carried using Support Vector Machine (SVM).

IV. METHODOLOGY

The methodology is described briefly as follows.

4.1. Pre-Processing

The aim of pre-processing is an improvement of the image data that suppresses unwanted distortions or enhances some images features important for further processing.

Categories of image pre-processing methods according to the size of the pixel neighborhood that is used for the calculation of a new pixel brightness, pixel brightness transformations, geometric transformations, pre-processing methods that use a local

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neighborhood of the processed pixel, and image restoration that requires knowledge about the entire image. Image pre-processing methods use the considerable redundancy in images.

The objective of this progression is to make the procured images more appropriate for ensuing procedures, for the most part image division and highlight extraction. Fundamentally, there are three principle destinations for image pre-handling. One is to resize the image for the reasons for either amplifying the image through advanced zooming, or diminishing the image estimate keeping in mind the end goal to accelerate preparing. The second goal of image pre-preparing is to decrease or dispense with clamor from the gained image. The third goal is to improve the image differentiate for visual assessment.

When an image is acquired by a camera or other imaging system, often the vision system for which it is intended is unable to use it directly. The image may be corrupted by random variations in intensity, variations in illumination, or poor contrast that must be dealt with in the early stages of vision processing. Filtering in image processing is a process that cleans up appearances and allows for selective highlighting of specific information.

4.2 Segmentation

Image segmentation is the process that partitions a digital image into disjoint (non-overlapping) regions, each of which typically corresponds to one object. Once isolated, these objects can be measured and classified, as discussed in the following subsections. This sub-section groups and reviews the methods proposed on the literature for the segmentation of malaria stained components on thin and thick blood smears.

4.2.1. Thresholding

Thresholding is an essential region based image segmentation technique that is particularly useful for scenes containing solid objects resting on a contrasting background. All pixels at or above/below the threshold are assigned to the foreground and all pixels below/above the threshold are assigned to the background [11].

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

4.3 Feature Extraction

The primary objectives of feature extraction are reducing the computational complexity of the subsequent process and facilitating a reliable and accurate recognition for unknown novel data, being the last objective particularly important for computer vision and pattern recognition systems. Moreover, the in-depth understanding of the domain-specific knowledge gained by human experts on the problem being addressed can be of extreme importance for the design of reliable feature extraction[12].

4.3.1. Local Binary Pattern (LBP)

The local binary pattern (LBP) operator is defined as a gray-scale invariant texture measure, derived from a general definition of texture in a local neighborhood. Due to its discriminative power and computational simplicity, the LBP texture operator has become a popular approach in various applications, including visual inspection, image retrieval, remote sensing, biomedical image analysis, motion analysis, environment modeling, and outdoor scene analysis. Recent developments showed that the local binary pattern texture method also provides outstanding results in representing and analyzing malaria parasites in blood cells.

Local binary patterns (LBP) are a type of visual descriptor used for classification in computer vision. LBP is the particular case of the Texture Spectrum model. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets.

The LBP operator, proposed by Ojala et al. [13], is a basic, effective and generally utilized surface descriptor in restorative image analysis. This operator is the most prominent administrator in medicinal applications robustness to monotonic gray-scale changes caused by brightening changes.

4.4 Classification

In machine learning, support vector machines (SVMs, likewise support vector systems) are supervised learning models with related learning calculations that break down information utilized for classification and regression analysis. A SVM model is a representation of the cases as focuses in space, mapped with the goal that the cases of the different classifications are isolated by a reasonable hole that is as wide as could be expected under the circumstances. New cases are then mapped into that same space and anticipated to have a place with a classification on which side of the gap they fall.

The SVM is a powerful solution to the classification problems. It can be used for the recognition and classification of cells. The main advantage of the SVM network used as a classifier is its very good generalization ability and extremely powerful learning procedure, leading to the global minimum of the defined error function.

In machine learning, support vector machines are supervised learning models that used for classification and regression analyses. The basic SVM takes a set of input data and estimates, for each given input, which of two possible classes forms the output; thus it is a non-probabilistic binary linear classifier. SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible.

V. Conclusion

Lot of research has been done to make malaria diagnosis process automatic. There are various methods available for detection of malaria parasite such as histogram based thresholding method, Holography technique, Morphological operations and so on. The proposed System is used to improve the accuracy of the malaria parasite detection system. Also, the proposed system can be used to detect malaria parasite in early stages to avoid any health complexity.

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