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Bacteria identification using digital image processing

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Abstract

The identification of bacteria is an important and unavoidable task in medical disciplines and nutritional hygiene. But in the field of microbiology, No direct method is available for determination of bacterial species. The common manual technique is the microscopic sample analysis combined with more than 20 biochemical tests to identify the bacterium. These tests are more time consuming processes and required the training person for conducting these tests. To overcome the above problems the digital image processing can be used. The primary objective of the proposed work is to use the digital image processing techniques to identify the bacteria from the microscopic images. In this work the image of bacterial species were captured using a digital camera attached with the transmission electron microscope. After capturing the image, the preprocessing, segmentation and morphological procedures of digital image processing techniques are used to identify the bacterial species.

Keywords: Bacterial species; Biochemical tests, Electron microscope; Digital image processing; Microscopic images

1. Introduction

The bacteria are mostly pathogenic and cause more human and animal diseases.These microorganisms which are not visible to naked human eyes. To view the bacteria the microscopes are needed. In this work the transmission electron microscope is used for visualization of the microorganisms. There are millions of bacteria of different types in the world. They are mainly classified according to their thickness of wall and shape.According to the shape the bacteria species are classified as cocci (spherical shaped),bacilli (rod shaped) and spiral &others. In this work the cocci shaped bacterial species are identified. The following cocci bacterial species are taken for the work.

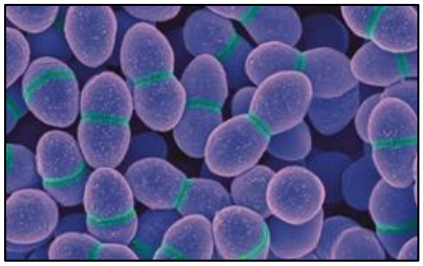

Figure 1 *Enterococcus faecalis*

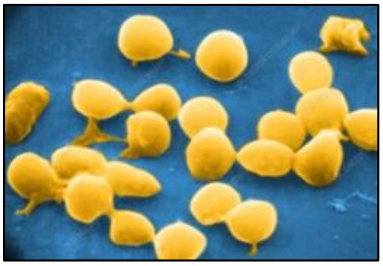

Figure 2*Micrococcus agilis*

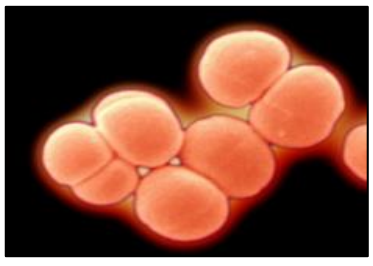

Figure 3*Micrococcus roseus*

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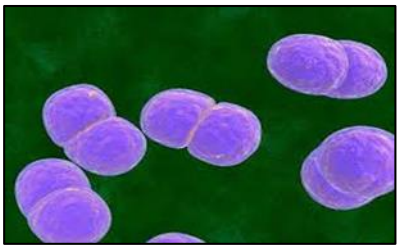

Figure 4 *Moraxella catarrhalis*

Figure 5 *Staphylococcus aureus*

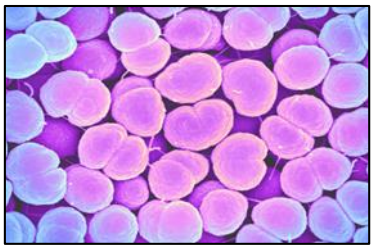

Figure 6 *Neisseria gonorrhoeae*

The main and first task in this procedure is the preparation of culture plate. For making the cultural plate the spread plate technique is used. The dilute mixed population of microorganisms is separated using this technique. The individual colonies are isolated and spread to the nutrient Agar medium plates. Then the plates are incubated at the temperature 37^0C for 24-48 hours. In general after this procedure biochemical tests were done to identify the bacterial species which are time consuming process and subjected to low specificity. To overcome this existing manual biochemical tests the digital image processing technique is used in this work.

2. Methodology

This method uses very basic steps of digital image processing for identification of bacterial specices. In this method the following steps are involved.

- The image of microorganism in the culture plate is captured using the Digital camera attached with microscope.
- After capturing the image noise removal technique is applied to the image and the image is restored.
- To select the particular segment from the restored image Region of interest (ROI) technique is applied. This ROI technique segments the particular portion of the image by omitting the remaining portions.
- After segmentation, the image is converted into binary using thresholding.
- Then a morphological operation is done for feature extraction. Here the diameter of image is obtained.
- The diameter obtained using digital image processing is compared with the database.
- The name of bacteria is displayed as a result.

2.1. **Bacteria and their size**

The diameter of bacteria ranges from 0.5-2μm approximately. By using the digital image processing technique the manual work is reduced and the cost of chemicals for biochemical tests is reduced. The time involved is also reduced.

Table 1 Dimensions of Bacteria

S.No	Name of the bacteria	Diameter of bacteria in μm
1	*Enterococcus faecalis*	0.792
2	*Micrococcus agilis*	0.923
3	*Micrococcus roseus*	0.529
4	*Moraxella catarrhalis*	1.609
5	*Staphylococcus aureus*	0.961
6	*Neisseria gonorrhoeae*	0.965

3. Results and Discussion

The bacterial identification based on digital image processing is a very simple and accurate method. The diameter fetched from the morphological operation is compared with the database which contains bacterial name and size. This comparison allows the tolerance of $\pm$5% change from the base value.This work tests the total of 60 images obtained from the microscope. For each bacterial species 10 images are obtained. The culture plates are developed in laboratory condition for the six bacteria mentioned. For each bacterium five plates are prepared and two images are taken in each plate. Thus 60 images are obtained. The diameter of bacteria is extracted using (Digital image processing)DIP technique

and compared with database. The name of bacteria is displayed as result. The output is correctly displayed for 58 images. The accuracy of the present work is 96.66% and computational time of 56.66 seconds.

4. Conclusion

The time and cost involved for identification of bacteria using the DIP method is getting much reduced compared with the previous biochemical tests. In future this work can be extended for other types of bacteria. The time of computation and accuracy may be improved by combining this technique with neural networks.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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