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An Antibiogram Classification System Based on an Hybrid Hough Transform and Gradient Approach

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1. Introduction

The antibiogram is a test of major importance in clinical microbiology since it evaluates "in vitro" the sensibility of a microorganism towards different antibiotics. Susceptibility tests are most often recommended when an infectious process is ascribed to a microorganism though to belong to a species capable of exhibiting resistance to commonly used antimicrobial agents [1]. In these cases, appropriate treatment of the patient is straight related to the result of this test. Although nowadays several different methods are available in clinical microbiology laboratories to access antimicrobial susceptibility, the disc diffusion technique is still routinely used because it is a simple and reasonably cheap method [1,2]. The principle of this method consists in the use of a paper disc impregnated with a known amount of the antibiotic which diffuses when placed in the agar surface of a Petri dish, creating a radial decreasing gradient of the drug around the disc. If the microorganism is sensitive to the antibiotic it will not grow and an inhibition zone around the disc is visible. In general, the measurement of the diameter of the inhibition zone is manually performed allowing the classification of the bacteria as sensitive, intermediate, or resistant to the antibiotic under evaluation.

In this work an automatic system to measure the inhibition zones and to classify the bacteria susceptibility is proposed. Images of the Petri's dishes with the bacteria culture were acquired with an optical scanner. The obtained images were filtered with a 5x5 Gaussian mask low-pass filter and the antibiotics discs were detected using the Hough transform for circles [3]. The inhibition regions edges were identified using a gradient methodology. According to the average distance of the inhibition edge to the antibiotic disc, the bacteria was classified into one of the three categories above mentioned. Results proved the efficiency and robustness of the implemented strategy to perform the desired tasks.

2. Antibiogram

Three different bacteria were used, namely two Gram-negative (Escherichia coli and Pseudomonas aeruginosa) and one Gram-positive bacteria (Staphylococcus aureus). The bacteria susceptibility was tested against three antibiotics, namely Penicillin, Kanamycin and Imipenem. The preparation of the bacteria inoculums and the performance of the antibiograms followed the procedures described in [1]. Figure 1 presents an antibiogram image for an Escherichia coli culture with two antibiotics. In the image it can be observed that the bacteria is resistant to Penicillin but not to Kanamycin, since around the last antibiotic disc there is no growth of bacteria (inhibition zone). Images were obtained by using an optical scanner with a resolution of 600dpi.

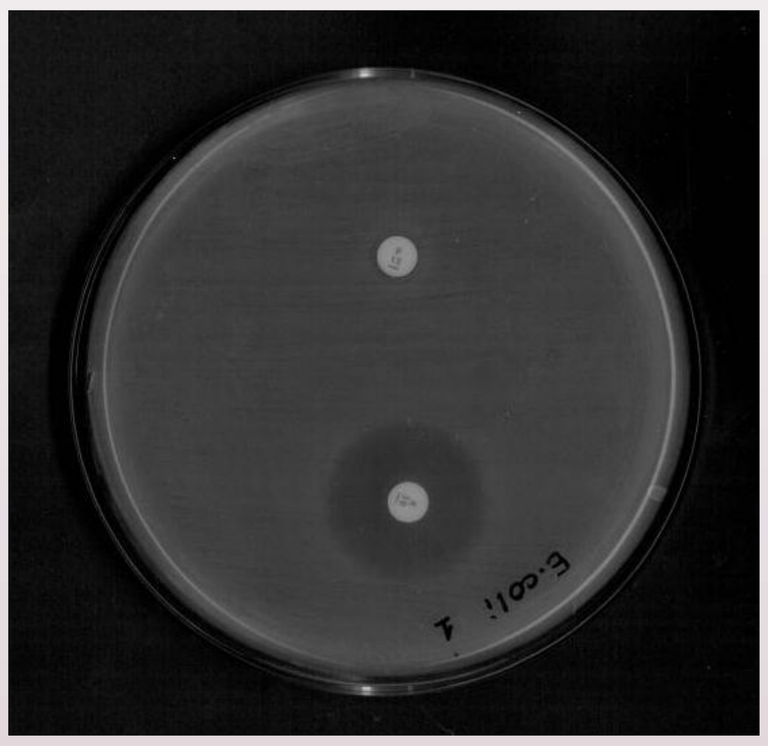

Figure 1 – Antibiogram for an Escherichia coli culture with two antibiotics (Penicillin: upper disc, Kanamycin: bottom disc).

3. The Algorithm

The work was developed in Microsoft Visual Studio 2008 using C++ language and recurring to the OpenCV (Open Source Computer Vision) libraries.

The acquired images were first transformed to grey levels and filtered with a Gaussian 5x5 mask filter to remove the high frequency noise. To perform the antibiotic discs isolation, the Hough transform for circles was applied with parameterization for minimum and maximum diameter of 20 and 42 pixels, respectively. Once the discs were identified, from its centers, 180 radial lines were traced in different directions covering 360° to detect the inhibition zone edge.

For each original pixel positioned under these radial lines the gradient was calculated and the value compared to a limit. Every time a point presents a value above that limit this means that a discontinuity exists and, probably, that point belongs to the edge of the inhibition area. Once all the edge points were detected an average of its positions is calculated to know the average diameter of the inhibition zone and all those points in that diameter are marked as contour points of the inhibition zone. Based on the calculated diameter of the detected inhibition zones, classification labels were displayed according to the three defined categories: sensitive, intermediate or resistive.

Figure 2 – Original Image.

Filtering and Grey Levels Transformation

Figure 3 – Filtered Image.

Local Adapatative Binarization

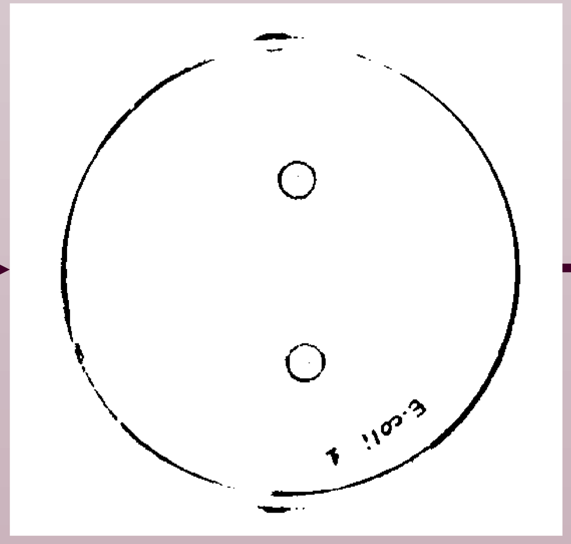

Figure 4 – Binary Image.

Hough Transform for Discs Detection

Figure 5 – Discs Segmentation.

Gradient Approach for Inhibition Zone Detection and Classification

Figure 6 – Inhibition Zone Classification.

4. Conclusions

The presented strategy was applied to 12 antibiogram images, each one containing two discs. The algorithm was able to detect and classify all the antibiotics discs and inhibition zones correctly. However, the inhibition zone detection algorithm needs some refinement for generalization improvement.

References:

[1] Clinical and Laboratory Standards Institute (CLSI), "Performance Standards for Antimicrobial Disc Susceptibility Tests", Vol. 29, Nº. 1, CLSI, Wayne, PA, 2009.
[2] Felmingham, D., and D.F.J. Brown, Journal of Antimicrobial Chemotherapy, 48, pp. 81-85, 2001.
[3] Duda, R.O. and P.E. Hart, Use of Hough Transformation to Detect Lines and Curves in Pictures, Communications of the Acm, Vol. 15, Nº 1, pp. 11-15, 1972.