SPOT DETECTION IN 2D-GEL ELECTROPHORESIS IMAGES

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Introduction

Two-dimensional gel electrophoresis (2D-GE) is a powerful and well-established method for separating complex protein mixtures according to their isoelectric points and their molecular weights [1]. The digital product of 2D-GE is grayscale images that may contain up to ~10.000 spots [2]. Detecting these spots is a challenging task of 2D-GE image analysis. The available software packages and techniques fail to detect some spots and detect a large number of spurious (false-positive) spots. The proposed approach is effective in spot detection and outperforms the compared state-of-the-art software packages.

Method

In order to detect spot center candidates, the proposed spot detection approach incorporates information based on the contourlet transform decomposition [3] and the regional intensity of 2D-GE images. Spot center candidates are then examined in order to eliminate multiple spot centers corresponding to the same spot.

Results

Several experiments utilizing real as well as synthetic 2D-gel image datasets containing a total of ~3000 spots were conducted in order to evaluate the performance of the proposed approach against two software packages (Delta2D [4] and Melanie 7 [5]). The results were statistically evaluated using sensitivity (S), precision (P), and the weighted harmonic mean of them, i.e. the F-measure (F). The proposed approach achieved an S value of 78%, outperforming Delta2D (74%), and Melanie 7 (69%). Regarding P, the proposed approach achieved 92%, compared to 77% for Delta2D and 95% for Melanie 7. For F, which is the most reliable measure, the proposed approach achieved a value of 84%, performing better than both Delta2D (75%) and Melanie 7 (80%). Detection results for a region of a real 2D-GE image for the proposed approach as well as for Delta2D and Melanie 7 are shown on Figure 1. It is evident that Delta2D and Melanie 7 missed some spots (yellow arrows) and also detected spurious spots (white arrows). On the other hand, the proposed approach detected all protein spots without detecting any spurious.

Conclusions

In this paper, an original approach for spot-detection in 2D-GE images is presented. The experimental results on real 2D-GE images demonstrate that it outperforms state-of-the-art software packages and is effective in detecting protein spots in 2D-GE images.
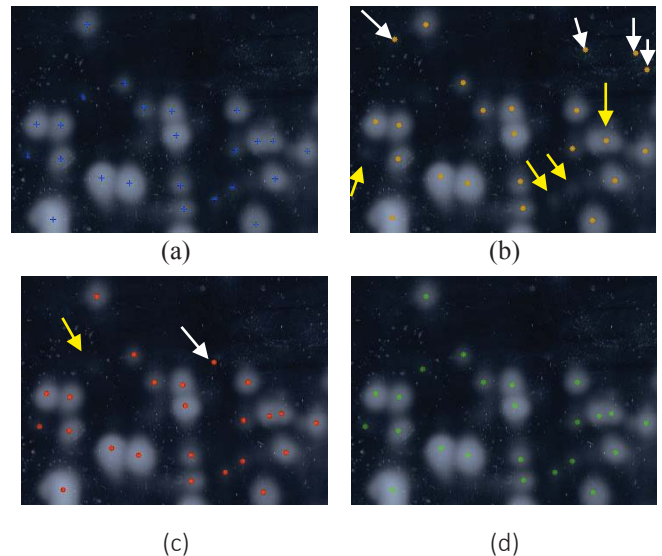

Figure 1. (a) Region of a real 2D-GE image with its detection ground truth (blue crosses). Detection results stemmed from (b) Delta2D, (c) Melanie 7, and (d) the proposed approach. Yellow and white arrows indicate missed and spurious spots respectively.

References

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