Multiclass SVM for embryo time-lapse image classification

A. Leida Mölder, G. M. Hartshorne, N. Costen and S. Czanner

***Abstract*— The timing of mitotic divisions is important for embryo health, the understanding of individual cell development, tracking and lineage computation. Division timing can be detected by classifying frames in image sequences according to number of cells. Two methods for feature extraction are proposed, providing classification accuracy of 89.4% to the 4 cell and 74.9% to the 8 cell stage.**

I. INTRODUCTION

The timing of mitotic events is an important measure in embryo studies, being correlated with embryo health [1]. Usually a correctly performed segmentation provides the most detailed information on cell position, shape and outline, but the segmentation process can itself be prone to errors, especially when used under clinical. We propose a supervised learning method operating on image texture. This technique has previously been illustrated [2] where a single feature was used as a cue to embryo development.

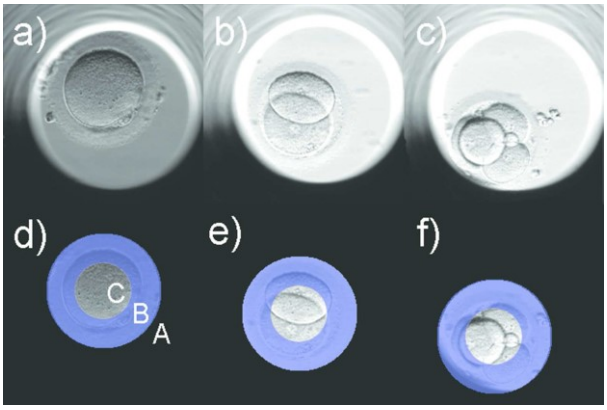

Figure 1. Test images with a) 1, b) 2 and c) 4 cells per embryo. d-f) Image feature extraction of the example images. Region A: Excluded area, region B: Outer layer, region C: Inner embryo.

II. MATERIALS AND METHODS

A set of 620 grey scale time-lapse images of 18 in vitro human embryos was acquired using the Embryoscope system, with 7 focal depth planes 15-25µm apart, recorded at 20 minute intervals for up to 6 days. Twelve standard grey level image traits were used for classification, with features for two separate regions of interest combined into a 24 vector, see Figure 1. The Directional Acyclic Graph SVM [3] and the Successive Slicing SVM variants were used. SS-SVM performs a set of cascading one-versus-all classifications, successively dividing the data into smaller units, until samples are consistent. Naıve Bayes and Random Forest classifiers were used for comparison.

III. RESULTS

The accuracy for the SS-SVM was slightly higher than that of the DAG-SVM; both were significantly higher than the NB and RF (see Figure 2). Using both ROIs, as here, improved the results for the SS-SVM by up to 45%. For a small class set (1-4 cells) processing time for the DAG-SVM was comparable to the SS-SVM, but for an increased number of classes, the SS-SVM outperformed the DAG-SVM by 63% (1-6 cells) and 73% (1-8 cells)

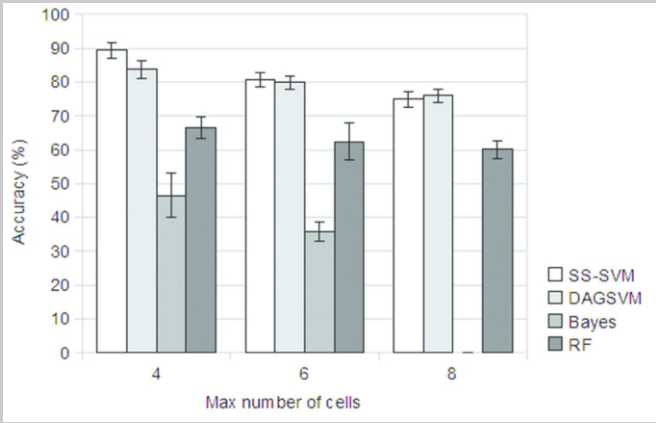

Figure 2. Example of a figure captionAccuracy as a function of maximum number of cells in the classification. Mean values and confidence intervals are calculated from 10 classifications. The Bayes classifier failed to classify in the 1-8 cell case.

IV. DISCUSSION & CONCLUSION

We have demonstrated the usefulness of spatial image filtering in embryo image classification, showing an improvement in classification accuracy of up to 45%. We further describe the successive slicing SVM, allowing successful classification of embryo images up to the 4 cell stage with an accuracy of 89.4% and up to the 8 cell stage with an accuracy of 74.9%. To our knowledge, this is the highest cell number in embryos reported in the literature.

REFERENCES

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