CELLS GROWTH RATE MEASUREMENT USING TIME LAPSE IMAGE PROCESSING

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Abstract

Gathering useful information from biological experiments that can last for several days, e.g. cells culture growing in the special medium, requires much efforts from the researcher. Image processing techniques applied to the time lapse photos of cells taken during such experiments can significantly reduce the time spend on obtaining and processing of the biological data.

According to the current approach RGB histogram bandpass filtering and thresholding algorithms can be used to process the photos taken during the "Chlorella Kessleri" cells culture growing experiment. Applying this technique on one photo allows to accurately separate the cells from background and to measure the square area occupied by each cell group. Processing the sequence of time lapse images can also reveal the cells culture growth rate.

1 Background

Growing algae cells cultures, e.g. "Chlorella Kessleri", in different nutrient mediums is a type of experiments used in biology. Its purpose is to find the best and/or the worst conditions for growing the cells. At the beginning of the experiment the cells culture is putted on the Petri dish with nutrient medium using the special stamp tool that can have several pillars. After that the cells grow on their own for several days according to Fig.1a.

One of the problems associated with such experiments is that they require a person (scientist) to constantly watch for the cells growing and logging the data (the sizes of the cells groups, dynamics of growing, etc.). To solve this problem one can use the time lapse image processing. According to this approach the Petri dish with growing cells can be photographed using digital camera once during the specified amount of time, e.g. 5 minutes. After the experiment is over the time lapse photos can be processed by the image processing algorithms and useful experiment results can be obtained in a few minutes.

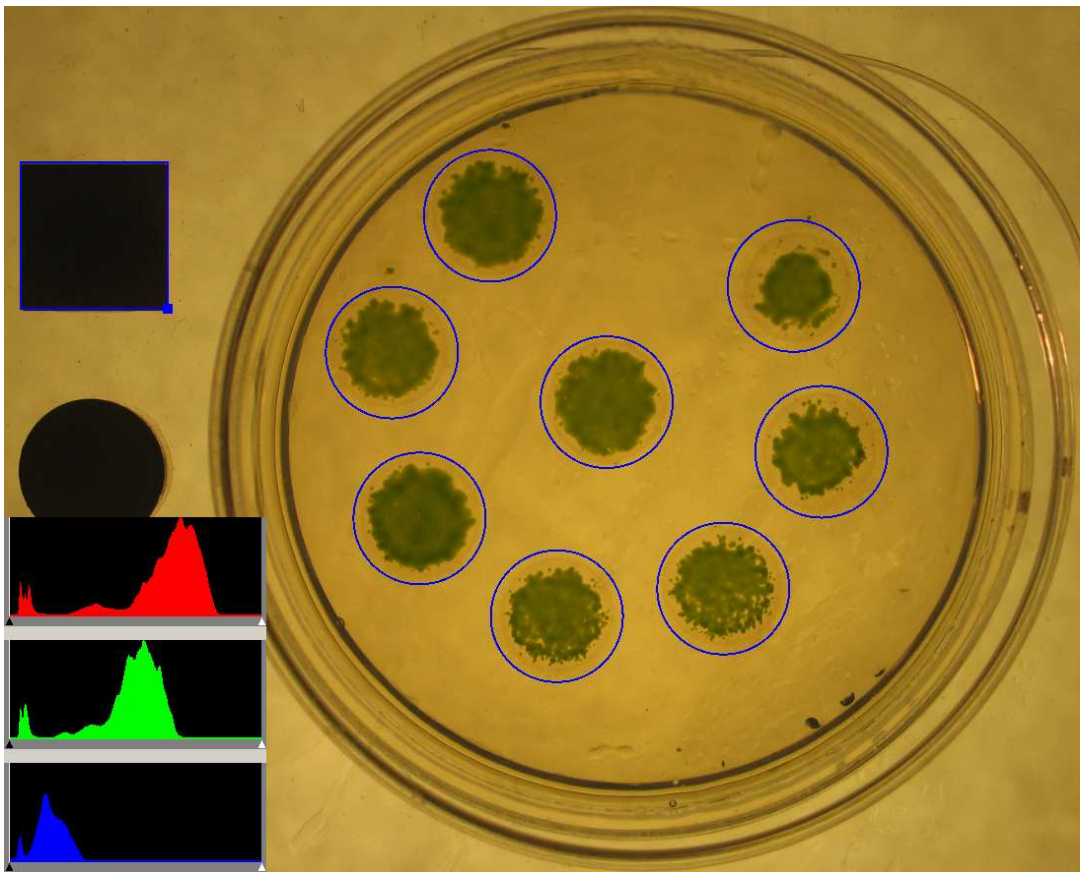
2 Methods

After analyzing the original digital photos of the Petri dish with cells RGB histogram bandpass filtering and thresholding [1] were chosen as a sequence of image processing algorithms for segmentation of the cells from background.

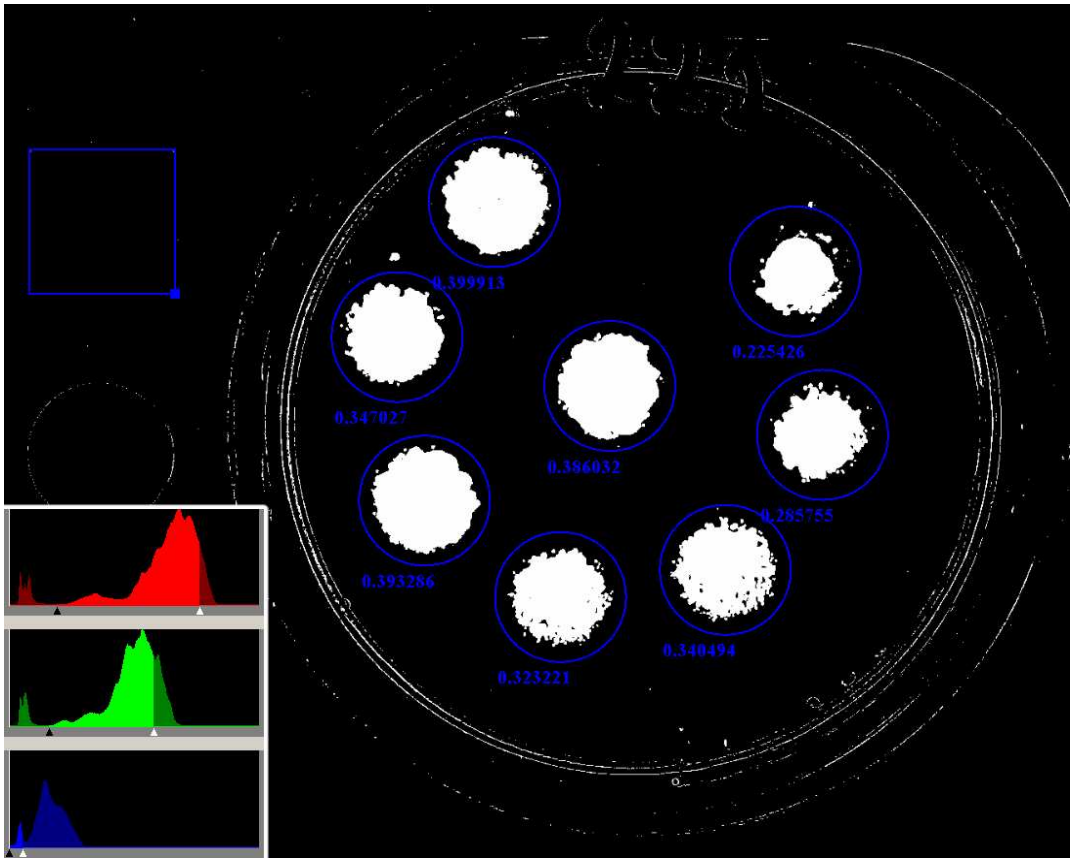
According to RGB histogram bandpass filtering the pixels that don't fall inside the specified RGB histogram bands are considered to be a background. The tuning of such RGB bands can be done manually using interactive software tools and only one time for the whole batch of time lapse photos. The next step algorithm called thresholding converts the founded background pixels to black and other pixels (cells pixels) to white according to Fig.1b.

To distinguish the cells groups from each other and from other object (white pixels) found on the image after applying image processing sequence the special software regions setting tool can be used. This tool can be tuned so that only the cells and no other objects pixels fall inside the regions. Such tuning can also be done only once for the whole batch of the time lapse photos. In the current research the round regions tool was chosen according to Fig.1b (boundary of the tool is outlined in blue color).

To calculate the area covered by each cells groups on the image in the units of area, e.g. cm^2, the special "scale" setting object can be places near the Petri dish so that it is fully captured by the camera and is show on the photos. This "scale" object should have a known size, e.g. width and height of 1cm, and can be used to covert the square area in pixel units to the square area in cm^2 units.



(a)



(b)

Figure 1: Photo of the “Chlorella Kessleri” cells culture growing in the nutrient medium before (a) and after (b) applying image processing algorithms

3 Results

The image processing approach described above allows to precisely calculate the square areas covered by each of the cells groups on the photo taken from the "Chlorella Kessleri" cells growing experiment. Applying it to the batch of time lapse photos also allows to estimate the dynamics of the cells growing. This approach can be used for processing the data from the biological experiments with other cells cultures and also extended to some other types of cells growing experiments.

References

[1] Bernd Jähne, *Digital Image Processing*, Springer, Berlin Heidelberg, 5th edition, 2002.

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