

# Application of Image Analysis Techniques in Biotechnology, Wastewater Treatment and Food Technology

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Image analysis (IA) is commonly used nowadays in a wide range of applications due to the development of faster computers, advanced frame grabbers, and sophisticated software. IA allows the enhancement of pictures as well as automatic identification and isolation of particles so that they can be properly studied. It also provides an extremely fast means of getting morphologic information, thus saving tremendous effort and time.

Although the availability of commercial sophisticated software some efforts have been made at DEB in software development using MATLAB (The Mathworks, Inc.) programming environment. This programming approach permits to tailor the software to our specific needs. In-house software currently in use and development include:

automatic differentiation of flocs and granules through fractal dimension [1];

monitoring methanogenic auto-fluorescence [2]. IA was used to quantify the blue-green light intensity (co-factor  $F_{420}$ ) developed during the start-up of a CSTR with a VFA based synthetic substrate and during the steady state operation of an anaerobic filter fed with a synthetic dairy waste;

determination of the reduction in mobility of ciliates exposed to toxics [3]. Ciliated protozoa play an essential role in the purification of wastewaters by removing, through predation, the major part of the dispersed bacteria, in the aeration tank;

automatic quantification of filamentous bacteria (to characterize bulking phenomena in activated sludge processes);

automatic counting of viable/non-viable yeasts [4] by epifluorescence microscopy with acridine orange as dying agent;

simultaneous monitoring of lactic acid bacteria and yeast during *Vinho Verde* fermentation using phase contrast microscopy coupled to image analysis [5].

Other developments cover automatic determination of the number of yeast flocs and their size distribution [6], dynamics of bacterial adhesion [7], estimation of the tortuosity of porous media [8], and automatic detection and counting of ink spots in recycled paper [9].

A list of image analysis resources (hardware, software) may be browsed throughout the Laboratory of Image Analysis web page at [http://www.deb.uminho.pt/lab\\_imagem](http://www.deb.uminho.pt/lab_imagem).

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