SEMI-AUTOMATIC RECOGNITION OF PROTOZOA AND METAZOA BY IMAGE ANALYSIS, NEURAL NETWORKS AND DECISION TREES

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Protozoa and metazoa are considered typical indicators of the treatment quality in activated sludge systems. Their role in the purifying processes is partly due to the fact that protozoa and metazoa feed upon dispersed bacteria and other organisms contributing for the ecosystem balance in wastewater treatment plants (WWTP). Furthermore it is known that the main protozoa and metazoa feed upon dispersed bacteria and other organisms contributing for the ecosystem balance in wastewater treatment and metazoa found in the aerated tanks of a wastewater treatment plant can provide valuable information to the current conditions of that WWTP. For instance, by the analysis of the classes and total number of the predominant protozoa and metazoa it may be able to predict the effectiveness of the aeration, the extent of the nitrification process, the sludge age and the final effluent conditions (Madoni, 1994, Canler *et al*., 1999).

Image processing and analysis has become, nowadays, a quite important tool with a vast number of application fields. Its strength resides on its ability to remove the subjectiveness of human analysis, the possibility to extract quantitative data that would be impossible or quite difficult to obtain otherwise and avoid tedious and time-consuming tasks to human researchers (Russ, 1995). However, few have been the studies about automatic image analysis procedures to recognize and classify the protozoa and metazoa in a wastewater treatment plant. In fact, only a few pioneer studies on the use of image analysis techniques for this purpose have been published so far as the cases of Amaral *et al.* (2001) and Golz *et al*. (2001).

In this work the authors extend on a previous developed a procedure for the semi-automatic recognition of several groups of protozoa and metazoa commonly present in wastewater treatment plants by applying image analysis techniques. The protozoa and metazoa were characterized by different morphological parameters of Euclidean and fractal geometry, with or without their external structures (peduncles, cirri, tentacles). Furthermore their signature was also computed and fed alongside a few other parameters (around 40) of the above-mentioned geometries for a multivariable statistical technique to identify and classify each protozoan or metazoan image. The chosen multivariable statistical techniques for identification and classification purposes were the neural networks and the decision trees.

The procedure obtained showed to be robust for distinguishing between amoebas, sessile ciliates, crawling ciliates, large flagellates and free swimming ciliates in terms of the protozoa classes and also for the metazoa. Furthermore, with the exception of some sessile species, the overall species recognition obtained a high percentage value. In terms of the wastewater conditions assessment, the aeration, nitrification, sludge age and effluent quality the results obtained were found to be suitable for the prediction of these conditions.

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