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Wastewater protozoa survey by image processing and analysis methodologies

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Protozoa and metazoan are considered good indicators of the treatment quality in activated sludge systems being sensitive to physical, chemical and operational processes. Therefore, it is possible to correlate the predominance of certain species or groups and operational parameters of the plant. This work presents a semi-automatic image analysis procedure for the recognition of the metazoan and protozoa species most frequently found in WWTP by determining morphological data and multivariable analysis with discriminant analysis and neural network techniques. The non-stalked organisms' identification obtained individual recognition percentages above 80% with insignificant misclassification errors (usually below 1%) therefore yielding good overall recognition performances (above 80%). Furthermore, a closer look revealed a slight misclassification problem between the Monogononta and Digononta assessment. Although the overall results were not satisfactory for the stalked organisms, the identification ability of the biological indicators *Opercularia* and *V. microstoma* has attained some degree of confidence in accurately establishing their presence on WWTP. Furthermore, good identification percentages were obtained for the most significant Carnivorous and large stalk Colonial whilst the less significant *Vorticella* and small stalk Colonial only attained reasonable identification percentages. The main protozoa and metazoa groups (flagellates, ciliates, sarcodines, and metazoa) and protozoan ciliates (carnivorous, crawling, swimming, sessile and non-ciliated) recognition attained good overall recognition performances (above 95%, except for crawling ciliates), with global protozoa and metazoa groups assessment around 95%. The overall recognition performance for the plant operating conditions assessment were quite fair for the effluent quality, aeration and nitrification evaluation (above 80%) and good on the sludge age determination (91.7%). Close related to the overall results, the assessment of critical conditions such as low effluent quality, low aeration, and fresh sludge attained also good overall recognition performance levels around 90%. From these results it may be inferred that the current methodology can be used to predict at some extent, critical WWTP conditions in a feasible time period (within few hours) and without the need of specialized personnel in protozoology. The acquisition of the protozoa and metazoa images can be performed in a one to two hours period for a total of one to two hundred images, whilst the images treatment, data determination and analysis in two to three hours.