trans algae INFOSHEET

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Artificial Intelligence Aided Algae Cultivation

Artificial Intelligence is useful when growing micro algae. Algae cultivation can benefit from machine learning through automation and pattern recognition, in our specific case automation of population count and pattern recognition between population growth and growing parameters respectively.

ARTIFICIAL INTELLIGENCE - TWO TOOLS

Research attention towards artificial intelligence has dramatically grown as an effect of the always increasing computational power and speed of nowadays computers.

Given the large span of disciplines it can be applied to, there is no standard definition of artificial intelligence, nevertheless it is frequently associated with the science of making computer and machines performing tasks without having programmed them explicitly.

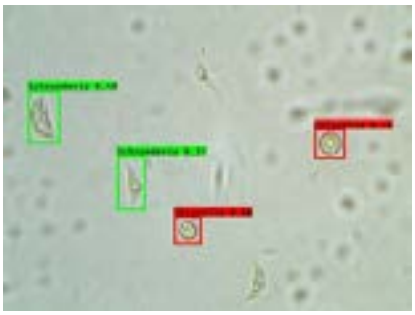
This subject, often known as Machine Learning (ML) consists of several techniques and this work shows our approach of using them for micro-algae cultivation.
We are indeed developing two independent tools which can also be used in synergy together:

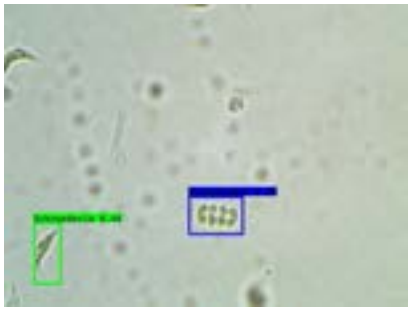
1. A classifier able to recognize micro-algae from their morphology. Computer vision will allow to automatically follow micro-algae populations by detecting individual cells even in mutli-cultivations from pictures taken with a microscope.

2. A control system to automatically intervene on growing parameters. Artificial neural networks are used to perform a regression analysis on laboratory data. The aim of this analysis is to retrieve those patterns of algae growth which usually takes longer time to be identified. Then the cultures growth can be optimized by controlling parameters such as the water temperature, nutrients content, light exposition etc.

COMPUTER VISION MONITORING

A fully convolutional network (FCN) inspired by YOLO V3[1] structure has been implemented to recognize the algae species through keras[2] backend with tensorflow[3]. The network is now under its training process which at the moment aims to the detection of 3 different algae species.
Some preliminary results are shown in the following pictures:





The network was able to recognize both the strains of micro-algae of the picture, discard the blurry spots but could not detect all the algae.

The numbers displayed next to the captions represent the degree of confidence of the classifier: after a 30% confidence threshold level the program draws a square around the portion of image it identifies and label it accordingly.

SMART CULTIVATION CONTROL

The second tool under development uses Artificial Neural Networks (ANN) to predict the growing behaviors of a micro-algae cultivation and to control the growing parameter for maximizing the harvest yield over any resource: energy, nutrients, profit etc.

The system is trained to predict both the short and long term effects of several parameters on the growing culture.

The training requires a large amount of data collected by testing several growing conditions, configurations and algae species, monitoring the algae population (even through computer vision) and performing a regression analysis on the cause-effect correlation between controllable factors* and algae growth.

A similar system will be used by Peckas Naturodlingar AB[4] in Härnösand to control the quality of the water in fish farming section of their aquaponic system.

CONCLUSIONS

The aim of this project is to deliver a product which applications range from scientific research to industrial migro-algae cultivation optimization.

The first releases are expected to be ready in the end of 2019, until then data will keep be collected by Nattviken Invest AB in the laboratory of Mittuniveritetet in Härnösand (see picture below).

Nattviken Invest AB in the laboratory of Mittuniveritetet in Härnösand

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REFERENCES

[1] https://pjreddie.com/media/files/papers/YOLOv3.pdf
[2] https://keras.io/
[3] https://www.tensorflow.org/
[4] https://www.peckas.se/

*(medium temperature, pH, light exposition, wavelength, cultivation time, cultivation setup, oxygen, carbon-dioxide, P-N-K content, growing species etc)