Technical Note
Application on mussels (*Mytilus edulis*)

Innovative detection and quantification of fouling organisms in mussels

The fishery of mussels is an important seafood industry worldwide which reached 2.2 million tons in 2018. In Denmark, the wild production of blue mussels (*Mytilus edulis*) represents 95% of the total production, and only 5% comes from aquaculture. The main strength of the Danish mussel industry is the capacity to have all round year production from natural banks. Moreover, the Danish mussel industry is export-oriented with the main destinations to The Netherlands, Germany, France, and Sweden.

The mussel industry has identified quality and sustainability as the main strategies to increase its market. Under this context, the removal of mussels with attached fouling organisms (defects) is of key importance as the first step to obtaining a high-quality product. Currently, mussels with fouling are removed manually by operators at different stages of production. For instance, operators remove mussels with defects in the processing line as well as before packaging to obtain a product with desirable visual characteristics. Due to the manual removal process, this task is time-consuming, dependent on operators' skills, and prone to errors due to operator fatigue. Thus, image analysis arises as an objective tool for the detection of mussels with fouling organisms attached to their shell.

This technical note aims to present how Quality by Images, using image analysis, can detect and quantify the presence of fouling organisms attached to mussel shells. In this study, fouling is defined as the presence of undesirable organisms attached to the mussel's shell such as barnacles, tubeworms, and snails. We, at Quality by Images, have developed an image analysis algorithm to detect and quantify the presence of fouling organisms in mussels. To this end, a total of 16 samples between 250-300 grams of mussels were weighed and their image was captured using an office scanner (selected device for this Proof of Concept), covered with a black lid to avoid external light. All images included a color reference consisting of 18 color patches made of dyes. Images were saved in

an uncompressed format (TIFF). The **p**ercentage of **f**ouling **o**rganisms (PFO) is expressed in % of a reference area. The conclusions drawn from this work are:

- Our image analysis algorithm allowed the detection and quantification of the presence of fouling organisms. In the current project, the color of fouling organisms was perceived as "whitish-pink" and the color reference was used to facilitate the selection of corresponding pixels. It is important to mention that shaded areas were observed in the images due to the mussel's ovoid shape and the limited focal distance of the optical scanner. These areas were excluded from the image analysis since they were too dark to accurately describe the color of fouling organisms. Those shade areas did not limit the applicability of the image analysis method deployed in this Proof of Concept.

- Our algorithm can be used as a quality control tool to confirm that packaged mussels do not have any fouling organisms. It could also assist in control activities of outgoing and incoming goods as well as documentation control based on images.

- Our algorithm can assist in sorting mussels with fouling based on criteria defined by operators as well as perform grading of mussel's quality. In the current project, a hedonic scale ranging from light to heavy was used to describe the presence of fouling organisms (Fig.1). PFO scale (%) is used to rate the quantity of defects detected in mussels.

- Based on this result, our algorithm can be implemented and used for the automatic removal of mussels with fouling in processing lines. To this end, a camera or scanner is proposed as the acquisition device.

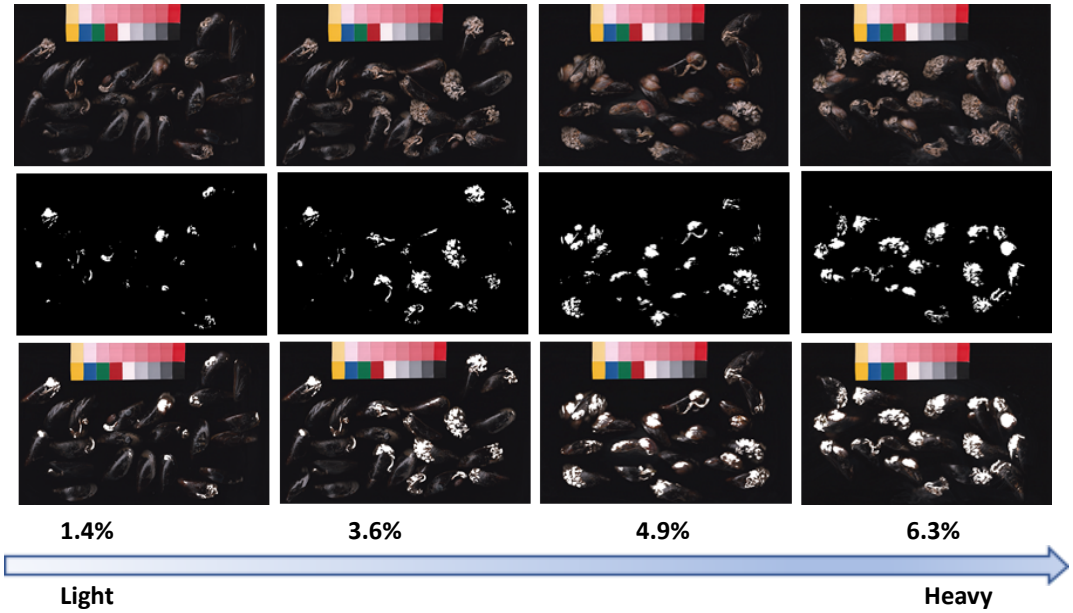

Figure 1. Quantification of fouling organisms in mussels

Quality by Images is keen to cooperate and suggests these next steps for co–creation. We can:

- Provide software for fouling detection and quantification.
- Assist with the implementation of QBI software in processing lines.
- Participate as a partner in the development of the automatic removal of mussels with fouling organisms. Feel free to reach out to kdeza@qualitybyimages.dk.