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Optimizing Flow and Quality Control of Scampi

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1. Processing of Scampi

Læsø Fiskeindustri is a Danish company that processes about 45% of the scampi (Nephrops norvegicus) landed in Denmark. Currently, scampi handling and quality control are done manually at LF's facilities, which is unattractive as a work environment.
Scampi is a perishable product that requires quick processing. Processing scampi can be a difficult task, especially in terms of handling and quality control. Scampi, as seen in Figure 1, is a type of lobster mainly found in the North Sea. This study aims to develop a solution for automatizing the quality control of scampi by using hyperspectral imaging technology and automatic handling.

Figure 1: Scampi

2. Hyperspectral Vision Technology

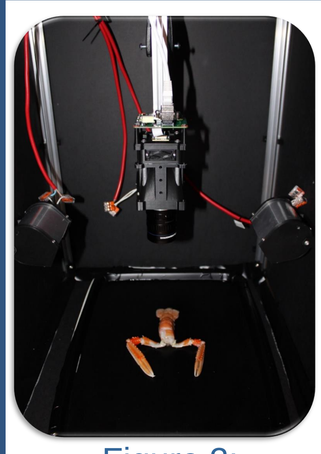

Figure 2: Image acquisition

A hyperspectral vision technology approach was utilized, as Læsø Fiskeindustri wanted to research if this new technology was useful for examining defects in scampi. Together with a third-party hyperspectral vision company, 160 images of scampi were captured using a hyperspectral camera as shown in Figure 2.
Initial research proved that it was possible to measure a change in light intensity over the captured wavelengths when a scampi had been exposed to room temperature for nine hours, as shown on the yellow graph in Figure 3.

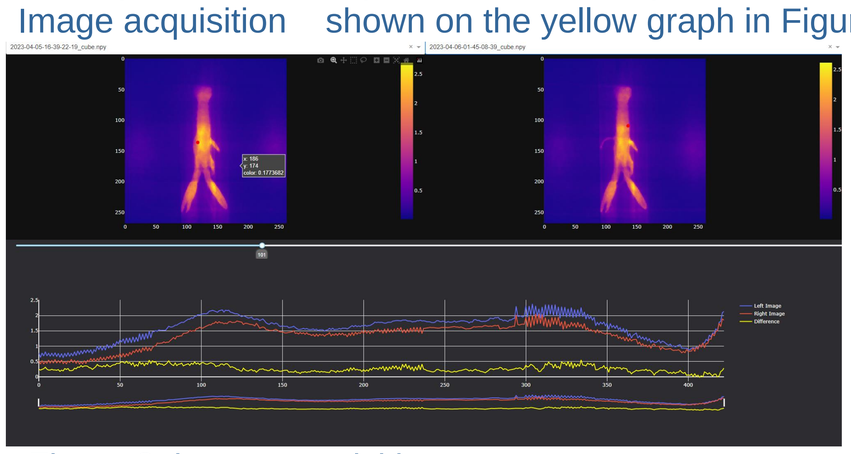

Figure 3: image acquisition

K-Nearest Neighbors (KNN) and Linear Discriminant Analysis (LDA) were tested as machine learning models for detecting spoilage in the scampi. The two models were trained using a section of the captured dataset and tested on the rest. The two proved similar results with 95% accuracy. The KNN model however had an execution time of 80s per image compared to 0.4s per image for the LDA model.

Figure 4: Spoiled Scampi

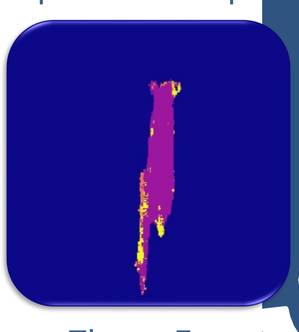

Figure 5: Good Scampi

LDA were implemented as the machine learning model for detecting certain defects, such as spoilage and missing claws in the scampi and further trained. Testing on the small dataset proved an accuracy of detecting spoilage of 94% when inspecting the top of the scampi, and 100% when inspecting the bottom. In Figure 4, a spoiled scampi is classified and in Figure 5, a good scampi is classified. The scampi claws are classified in a yellow color.

3. Mechanical Solution

The mechanical solution aims at solving the problem of separating and singulating the scampi in order to individually grade them visually. Various principles of scampi separation have been tested and prominent principles have been chosen for further concept and solution development. Several concepts have been examined to achieve a broad solution space where the concept with the best fit, according to function and implementation, has been developed (figure 6).

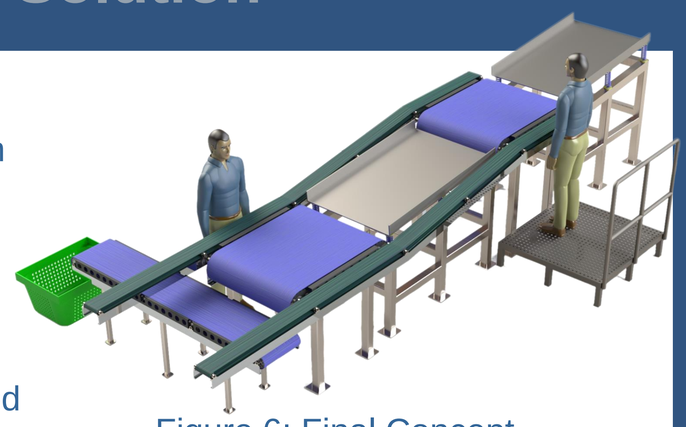

Figure 6: Final Concept

Four implementation steps were proposed to transition gradually towards full automation. The first step includes implementing vibration tables and an automatic vision inspection, with workers performing manual quality sorting. Subsequent steps involve reconfiguring the facility for automated quality inspection using delta robots and vision boxes. See Table 1.

	Current	Step 1	Step 4
Max Capacity (Scampi/min)	300-360	360-420	340
Daily Capacity (800g packages)	6058	6684	6537
Number of workers	3	4	-
Number of vision boxes	-	1	4
Number of Delta robots	-	-	4

Table 1: Parameters throughout implementation steps

4. Conclusion

Læsø Fiskeindustri's scampi processing facility at Skagen has been analyzed, and system combining automatic, mechanical processing and hyperspectral imaging technology has been constructed.

The computer vision part has shown great progress in utilizing machine learning and hyperspectral imaging for detecting spoilage in scampi.

A mechanical system has been designed to separate, singulate, and orient the scampi for the vision inspection.
A solution using vibration tables and accelerating conveyors has been chosen. A stepwise implementation has been established to ensure that the capacity is maintained throughout the implementation.

The solutions have shown to be able to work in conjunction in order to provide automatic quality control of scampi, being capable of taking over the unattractive manual working tasks.

Acknowledgement

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