Investigation of light response and swimming behaviour of salmon lice (*Lepeophtheirus salmonis*) using feature detection and tracking

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ProfyLax

This master thesis is a part of the multidisciplinary project ProfyLax. The overall goal for the project is to increase the knowledge about salmon lice and what attraction it has towards different light settings, with respect to wavebands, pulsation rate and light intensity. With this knowledge the aim is to get closer to finding a solution to the problem of salmon lice in the fish farming industry. The project is initiated by Jørgen Ås Vatn, master student at The Norwegian University of Life Science (NMBU).

Research question

How can the phototactic swimming behavior of salmon lice be quantified with the use ofncustomized algorithms for feature detection, tracking and analysis? Can this algorithm be used to distinguish between different light settings with respect to wavebands, light intensity and pulsation rate when it comes to attraction of salmon lice towards light? Lastly, how will the light sources giving response among the salmon lice propagate in the ocean?

Summary and conclusion

In this project, it is shown that the phototactic swimming behaviour of salmon lice can be mapped with the use of image processing techniques such as noise filtering, thresholding and contour detection. Algorithms that can map behaviour of salmon lice when exposed to different light sources have been implemented, and difference in the behaviour when exposed to different light settings can be seen. The detection algorithm can detect the overall response among a group of lice. The tracking algorithm uses the detection algorithm and is able to track the swimming pattern and swimming velocity of individual lice. A theoretical calculation of light propagation in the ocean is also included to get an impression of how artificial light might affect salmon lice.

Contributions

The main contributions of this thesis include algorithms for detection and tracking of multiple moving salmon lice in experimental videos. Analyses of 216 experimental videos, including 36 different light settings and three replicates for both detection and tracking, are completed.
The results from the studies conducted in this project, will be published in a conference paper *Light response of salmon louse (Lepeophtheirus salmonis) copepodites* by researcher Anna Båtnes (NTNU) for the conference Aquaculture Europe 2019 and in an article by researcher Cecilie Miljeteig (NTNU).

Acknowledgements

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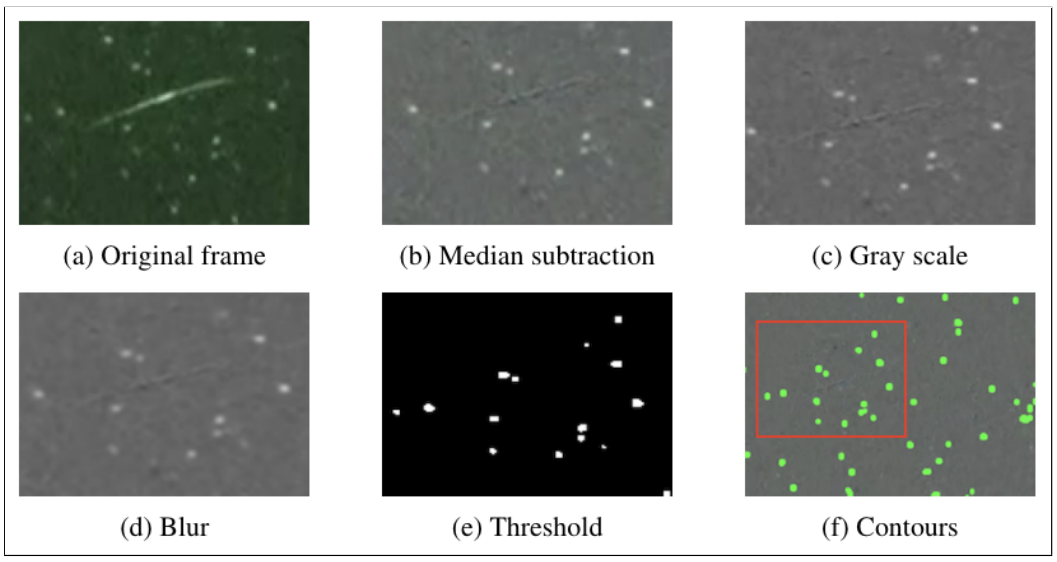
Method

Each experimental video was analyzed using contour detection and extracting the center coordinates of the detected lice. The image processing steps used in order to find contours of the salmon lice are shown in the figure below.



(a) Original frame (b) Median subtraction (c) Gray scale

(d) Blur (e) Threshold (f) Contours

When tracking the lice from frame to frame, the Euclidean distance (Equation 1) was used to match current detections to previous tracks.

$$d = \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2} \qquad (1)$$

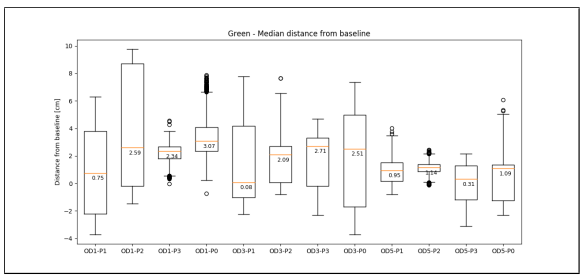
Calculations of light propagation under water was also done, using Equation 2.

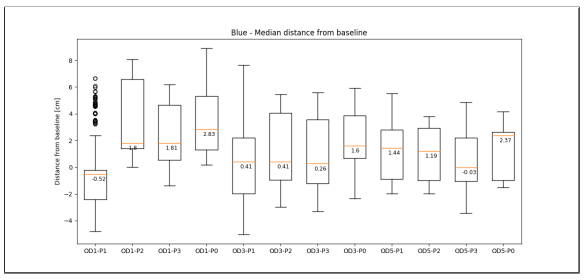
$$L_\lambda(z) = L_{0,\lambda} e^{-c_\lambda z} \qquad (2)$$

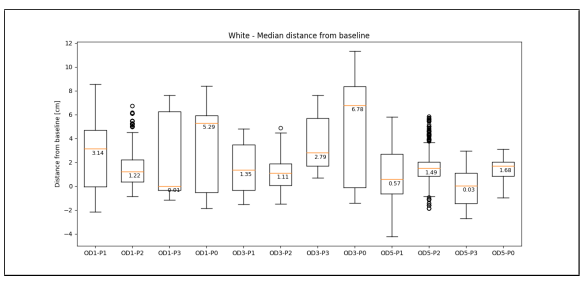
$L_\lambda(z)$ is the light intensity at distance z, $L_{0,\lambda}$ is the original light intensity, and c is the light attenuation coefficient.

Results

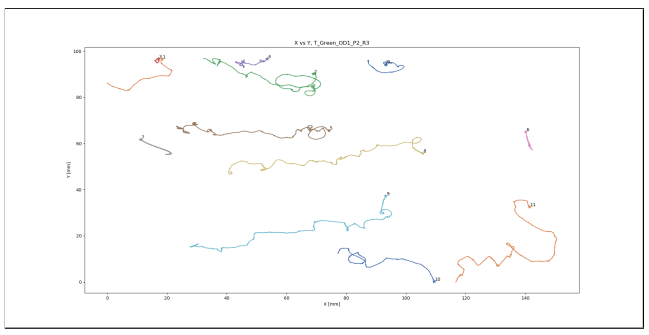
Detection analyses showed that green and white light attracted the salmon lice more than blue light. Longer pulsation rates gave higher response than short pulsation rates. Light without pulsation was also shown to give a positive response.

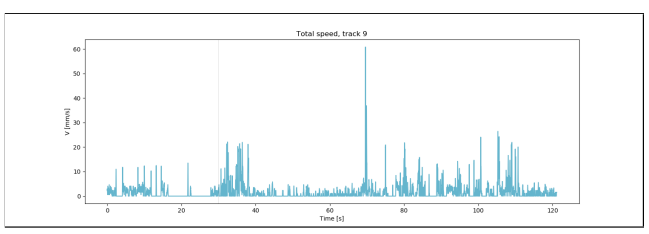


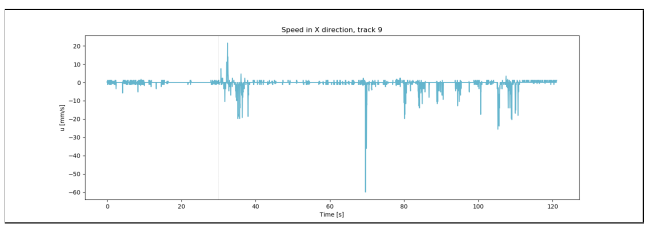




In the plots above, positive values show movement towards the light source, and negative values show movement away from the light source. Tracking was performed for each individual lice in all the experimental videos. The following figures show the path of the detected lice as well as the total velocity and velocity in x-direction.







The figures show that the louse with track id 9 obtained a maximum velocity of 60 mm/s, whereas its average velocity was 1.71 mm/s. For all the lice in the experiments with light setting green-OD1-P2, the maximum obtained speed was 101.84 mm/s.

References

[1] Båtnes A. S. 1*, Vatn J. A. Å. 2, Solstad M. A. 1, Bjørnstad L. F. 1, Børset E. 1, Tyssedal J. S. 1, Sture Ø. 1, Ludvigsen M. 1, Evensen Ø. 2, Altin D. 3, Miljeteig C. 1 *LIGHT RESPONSES OF SALMON LOUSE (LEPEOPHTHEIRUS SALMONIS) COPEPODITES*, Norway 2019