Lehrstuhl Steuerung,
Regelung und Systemdynamik

Master Thesis

Literature review, Construction, Programming

Conception, development, and testing of a camera-based system for analyzing fish behavior and biomass estimation in RAS aquaculture

Keywords: RAS aquaculture, Pikeperch, Sensing, Image processing

Conditions:

Duration:	6 months
Language:	English/ German
Requirement:	Good MATLAB knowledge
Target group:	Master students

Contents:

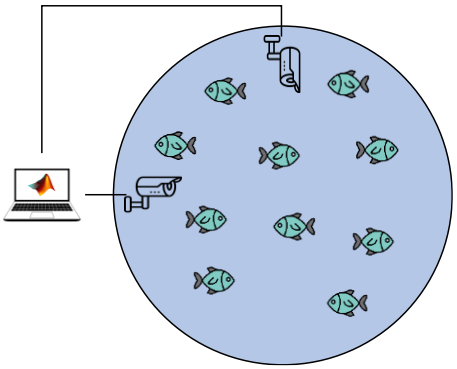

Figure 1: Fish behavior monitoring

The growing population is leading to an increased demand for food, particularly protein-containing animals. Furthermore, the limitations of fresh water, poor soil quality, a lack of nutrients in the soil, and a reduction in agricultural land contribute to a negative impact on agricultural production. It is therefore necessary to develop alternative sustainable methods for producing food. Aquaculture systems are currently employed as an alternative means of animal and, in particular, fish production. Recycling water in aquaculture results in a modified system known as a Recirculating Aquaculture Systems (RAS), which are also used for fish farming. These systems prevent the spread of diseases caused by the pollution of ground and surface waters due to water discharge. The objective of RAS systems is to maximize fish yield (accelerating their growth) and guarantee all fish welfare requirements. In RAS systems, this is achieved by optimizing the water quality parameters for fish in the aquaculture farm while simultaneously reducing water consumption. One of the fish species cultivated in these systems is the pikeperch (*Sander lucioperca*), which possesses numerous advantageous characteristics. These include widespread demand in the food market and its potential for cultivation in RAS systems. Further investigation is necessary to achieve a more complete understanding of RAS systems using pikeperch. This can be achieved by meticulously monitoring the behavior of pikeperch within the RAS system under different water quality parameters conditions using a camera system in real time for the purpose of 3D trajectory detection of the fish. Fish length is also a crucial variable that provides information about the state of the fish depending on the water quality parameters. The videos recorded by the fish camera system could be evaluated using, for e.g., the Matlab image processing tool. This work should include a literature review on the behavior of pikeperch in RAS systems and its reaction to different water parameters (under stress and no stress). Fish welfare requirements of pikeperch should also be determined from the literature. Following the literature review, the depth of a 2D image estimated from a stereo camera should be compared with that estimated from a monocular camera using a neural network-based tool (Depth Anything V2). This comparison would make it

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possible to evaluate the reliability of monocular depth estimation using Depth Anything V2. The next step is to develop a camera system with an algorithm that tracks fish motion in 3D and estimates its length under different light conditions. The measured 3D trajectory and estimated fish length should be compared with the actual trajectory and length, respectively. This should be done under different light conditions.

The objectives of this Master's thesis are:

- A literature review on pikeperch behavior, motion, reaction to different water quality parameters (under stress and no stress), and fish welfare requirements
- Evaluation the reliability of monocular depth estimation using the neural network based tool (Depth Anything V2)
- Conception and development of the camera system
- Developing an algorithm for detecting the 3D trajectory and estimating the fish length under different light conditions
- Verifying and validating the determined results using real data
- Detailed documentation/presentation of the research results

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