Automation in Fisheries and Aquaculture

Giancarlo Marafioti, PhD
Dept. of Engineering Cybernetics
E-mail: giancarlo.marafioti@itk.ntnu.no
NTNU
Norwegian University of Science and Technology

Faculty of Information Technology, Mathematics and Electrical Engineering

Department of Engineering Cybernetics

Research groups

- Process control
- Motion control
- Industrial computing
- Medical cybernetics
- Aquaculture cybernetics

Dept. Eng. Cybernetics:
- 15 professors
- 10 technical/admin. staff
- ~11 Postdocs/researchers
- ~50 Doctoral students
- ~70 Master students/year
Engineering Cybernetics, a broad field

- Autonomous Underwater Vehicle
- Prosthesis
- Ships
- Snake robots
- Oil refineries
- Vertical plate freezers

Control, System, Model, Optimal, Stable, Measurement, Estimate
Aquaculture

- Modeling and simulation of aquaculture systems
- Automation and control of aquaculture processes
- Instrumentation, sensors and underwater telemetry

Cybernetics

Fisheries

Sea ranching

Marine resource management
Some examples

- Marine juvenile production
- Modeling of aquaculture processes
- Remote sensing of fish behavior
- Biomass estimation of farmed Atlantic salmon in sea-cages
NTNU CodTech
Hatchery automation laboratory

- Feeding robot
- Plankton density monitoring and control
- Water flow control
- Lighting control
- Underwater cameras
- PC-based process control & GUI
Feed distribution

\[ \frac{\partial c}{\partial t} + v_h \frac{\partial c}{\partial x} + v_v \frac{\partial c}{\partial y} + \nabla \kappa \nabla c = u - f_1 \]
Feed distribution
Emergence of schooling behavior in sea cages
Fish – talk to me!

*Acoustic fish telemetry* as a fish farming tool

Relevant for:

- Farm operations
- Feeding
- Monitoring of environmental conditions
- Escape detection
- Stressor and disease detection
- Documentation of living conditions and life history
Farmed salmon with depth transmitter
Salmon biomass estimation

- **Problem:**
  - Difficult to know the exact biomass (tot. weight of living fish) in the cage

- **What can we do?**
  - Modeling salmon growth and biomass development
  - Use well-established tools in cybernetics to combine model and measurements for an improved biomass estimate

- **Benefits:**
  - Improving productivity, planning, reducing feed waste
Salmon biomass estimation

- **Biomass model**

  ![Biomass model diagram](image)

- **Number of salmon distribution and biomass estimate**

  ![Graph showing biomass and number of fish distribution over time](image)