Autonomous Vessels for Towing Tasks in Offshore Fish Farming

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Challenges and Opportunities for Robotics and Automation Applied to Aquaculture
Woods Hole, MA
Jan. 11, 2016
## Vessel Use at Offshore Fish Farms

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Role of the typical fish-farm service vessel
Cage towing often involves the charter of tugboat
The Valella Project

A 65’ motorsailer connected to a 22’ diameter Aquapod™ cage.

While obviously a pilot effort, it demonstrated that unanchored, drifting cages can be commercially viable.

C. Goudey 
Challenges and Opportunities for Robotics and Automation Applied to Aquaculture, Woods Hole 
Jan. 11, 2016
Is this a more viable approach?

A 17’ vessel connected to a 70’ diameter, 5,000 m³ Aquapod™

17’ Diesel-electric TowDrone  Robofeeder and buoyancy control

Requires re-supply visits (feed & fuel) every one to two weeks depending on stocking density
TowDrone Specifications

LOA = 17’
Beam = 7’
Draft = 9’
Prop draft = 13’
Light disp = ~6,000 lbs.
TowDrone Preliminary Design

- Radar
- Nav. lights
- Water-tight hatch
- Diesel genset
- Fuel
- Water ballast
- Tow winch
- Tow point
Control Electronics
Block Diagram

Remote Operations Control
Human in The Loop
Backup Communications Link
Iridium / RF

Sense

Vessel
- Battery Level
- Charge Rate
- Fuel Level
- Temperatures
- Bilge Level

Environment
- Temperatures
- Wind Speed
- Sea State
- Humidity
- Barometric

Main Vehicle Computer
Watchdog micro-PC
CPU – Ardu-Pilot

Control

Actuation
- Thrusters
- Pumps
- Nav. Lights
- Hailer
- Cooling Fans
- Payload Control
  Winch / Tow Line

Safety / Alarms
E-Stop, Fire Suppression

Navigation / Avoidance

Communication

VHF
WLAN
Cellular

Power System

Management
Generator
Shore Power
Solar

Maribotics, LLC
Gray, ME
http://maribotics.com/
TowDrone uses in conventional offshore fish farming

Cage installations

Anchor installations

Fresh water for treatments
Most marine propellers are diameter limited due to draft constraints and the need for a broad range of operating speeds. A kort nozzle slightly improves a bad situation.

The key to efficient towing is a large-diameter, slow-turning propeller

By turning to the wastewater-treatment sector we find systems intended for mixing that offer the sort of thruster efficiency needed.

Flygt, a Swedish company and a subsidiary of Xylem, Inc. of NY has a range of low-speed mixers with AC power up to 8.0 kW.
By selecting the combination of blade length, RPM, and motor size we can achieve optimal performance.

Maximum thrust comes with a 2,500 mm (98”) dia prop spinning at 42 RPM and drawing 5.44 kW (7.3 hp)
Experience to date: demonstration of a self-propelled aquaculture cage to enable deep-ocean fish farming in cooperation with OFT and Snapperfarm off Culebra, PR.

A pair of 98”-diameter, 5.44 kW Flygt thrusters for “twin-screw” operation
Installed at the equator of a 3,250 m³ Aquapod 30’ underwater

Bollard tests against mooring to verify thrust then self-propelled tests achieving 0.5 to 0.6 kts
Thruster operation during bollard tests

Scuba air used for flow visualization
Conventional tugboats and trawlers offer 20 to 30 pounds of thrust per horsepower. The Flygt thrusters offered 5.6 to 7.5 times that thrust ratio.

Flygt 4430 thruster vs. conventional tug

Using rules of thumb:
- 20 & 30 pounds per HP
The TowDrone offers the following:

1. Fuel efficient towing
2. Autonomous or remotely-piloted operation
3. Eliminates the human urgency for speed
4. Slow cage towing is better for cages and fish
5. Extended endurance
6. Battery powered version is feasible
7. Can serve as a security patrol
8. Zero carbon footprint using biofuels

Work to be done

- Determine off-design propeller performance
- Develop towline dynamics solutions
- Examine propeller options
- Need clockwise rotation model
- Final design, construction, sea trials
Thanks for your attention.

Questions?

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