Robotics for Species Collection and Environmental Monitoring

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GULF & SOUTH ATLANTIC REGIONAL PANEL ON AQUATIC INVASIVE SPECIES

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Institute for the Study of Invasive Species
A Member of The Texas State University System


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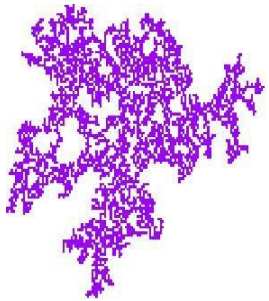
Spinoza

Many errors, of a truth, consist merely in the application of the wrong names of things.

Biological Engineering or Bioengineering



…the application of concepts and methods of biology to solve real-world problems related to the life sciences and/or the application thereof, using engineering's own analytical and synthetic methodologies and also its traditional sensitivity to the cost and practicality of the solution(s) arrived at.

Bio-Robotics

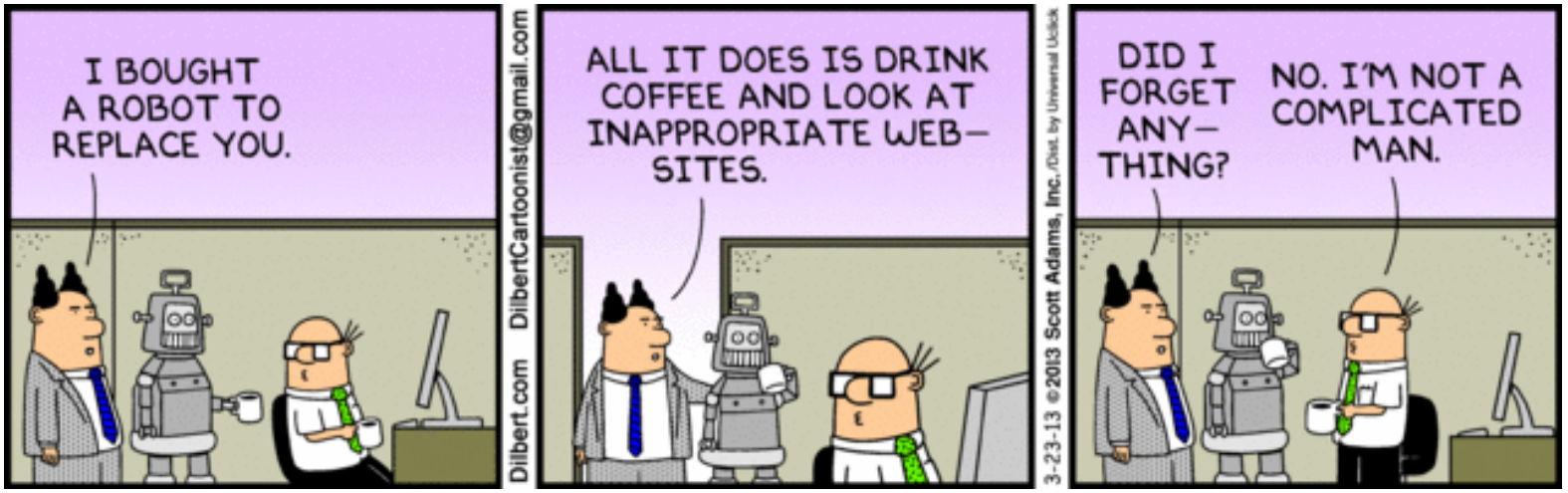
Biorobotics is often used to refer to a real subfield of robotics: studying how to make robots that emulate or simulate living biological organisms mechanically or even chemically.

The term is also used in a reverse definition: making biological organisms as manipulatable and functional as robots, or making biological organisms as components of robots.

.. what is robotics anyway?

- Power source
- Sensing
- Manipulation
- Locomotion
- Environmental interaction and navigation
- Human-robot interaction
- Control
  - Autonomy levels

Robotics is a potential solution…



…to many problems in biology.

VMI engineers develop robot to lure, kill off ticks

- Uses CO_2 to lure/activate ticks
- Denim to provide a landing/attachment surface
- Insecticide to dispatch

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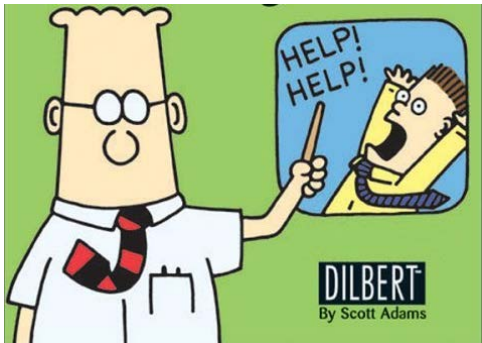
Invasive Species

- Vary widely (mammals, insects, reptiles, fish, plants, microorganisms, etc.)
- Eradication or mitigation efforts have focused on chemical, biological and physical means using either traps or human hunters.
- Chemical and biological methods are problematic and costly. Unintended side effects can be worse than the species of concern.
- Traps and human methods are costly and not useable for a large group of species.



Pomacea canaliculata

Channeled Apple Snail

Class: Mollusca
Order: Gastropoda
Family: Ampullariidae

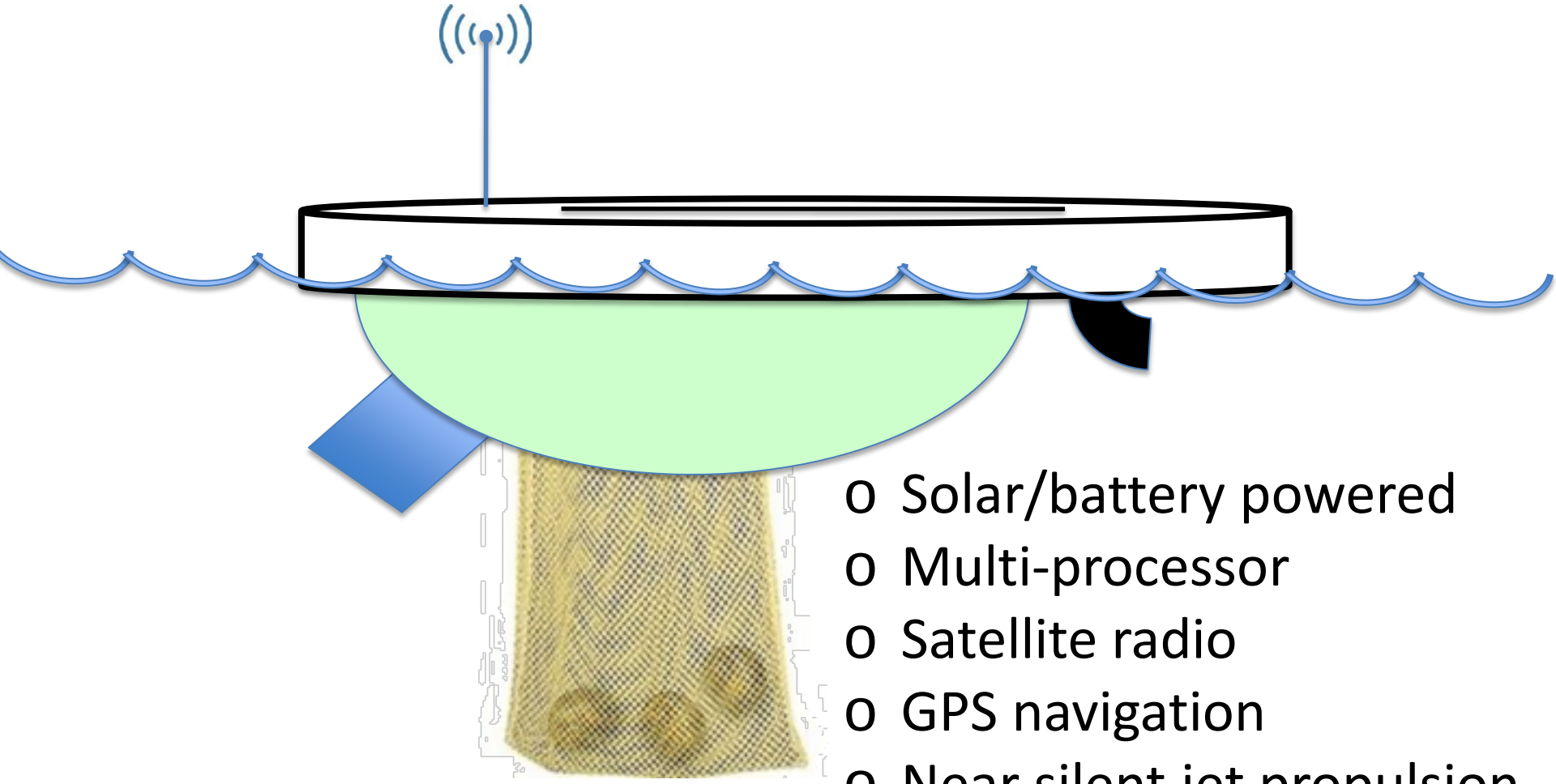
Adult Description: *Pomacea canaliculata* is a large-sized snail. The globular-shaped shells can have a wide variation of color with banded patterns of black, brown, green or yellow. Their bodies can be 6cm wide to 8 cm tall with the shell extending up to 15cm.

Egg Description: Bright reddish-pink eggs are laid on rice plants in groupings of 200-600. The eggs are bright red due to their high levels of carotenoid components.

Ecological Threat: The aggressive and successful invasion of the golden apple snail in irrigated rice systems in many parts of Asia have led to significant economic damages. Direct-seeded rice suffers significantly more damage than trans-planted rice, because golden snails consume greater amounts of the younger, more succulent plants. Snail damage in uncontrolled fields can be as high as 100% for rice seedlings in the germinating stage, as opposed to 20% on average in the transplanting stage. Overall most rice varieties tend to be directly seeded as opposed to transplanted, making them more susceptible to *Pomacea canaliculata*. Farmers in the infested areas are faced with the options of paying additional costs to control the spread of snails, replanting damaged areas of paddy, or ignoring the problem all together at the risk of potentially large yield losses. Since *Pomacea canaliculata* has been documented in Texas since at least 1990 it poses a serious ecological and economical threat to the 22 counties that produce rice in Texas. Also, *Pomacea canaliculata* transmits the Rat lungworm *Angiostrongylus cantonensis* which can infect humans if they eat raw or undercooked *Pomacea canaliculata*. The parasite *Angiostrongylus cantonensis* causes eosinophilic meningitis, which undetected will slowly destroy the human brain and is very fatal.

Biology: The average life span of the snail is 4 years and they reproduce sexually with the male initiating copulation.

Solar-Powered Floating Pond Fountain/Aerator



- Solar/battery powered
- Multi-processor
- Satellite radio
- GPS navigation
- Near silent jet propulsion
- M.O. “Mo” Way

(Rice Extension Agronomist)


The War of the Worlds

Environmental Monitoring

- Expensive and time consuming.
- Lacks precision.
- Satellite and weather station data too coarse.
- Time delays may be significant.

A floating robot can easily collect data on water salinity, dissolved oxygen, temperature, conductivity, depth profiles, turbidity and other parameters.

Atchafalaya River, LA

Drop-off/Pick-up

Boundary

Bryan Deagle

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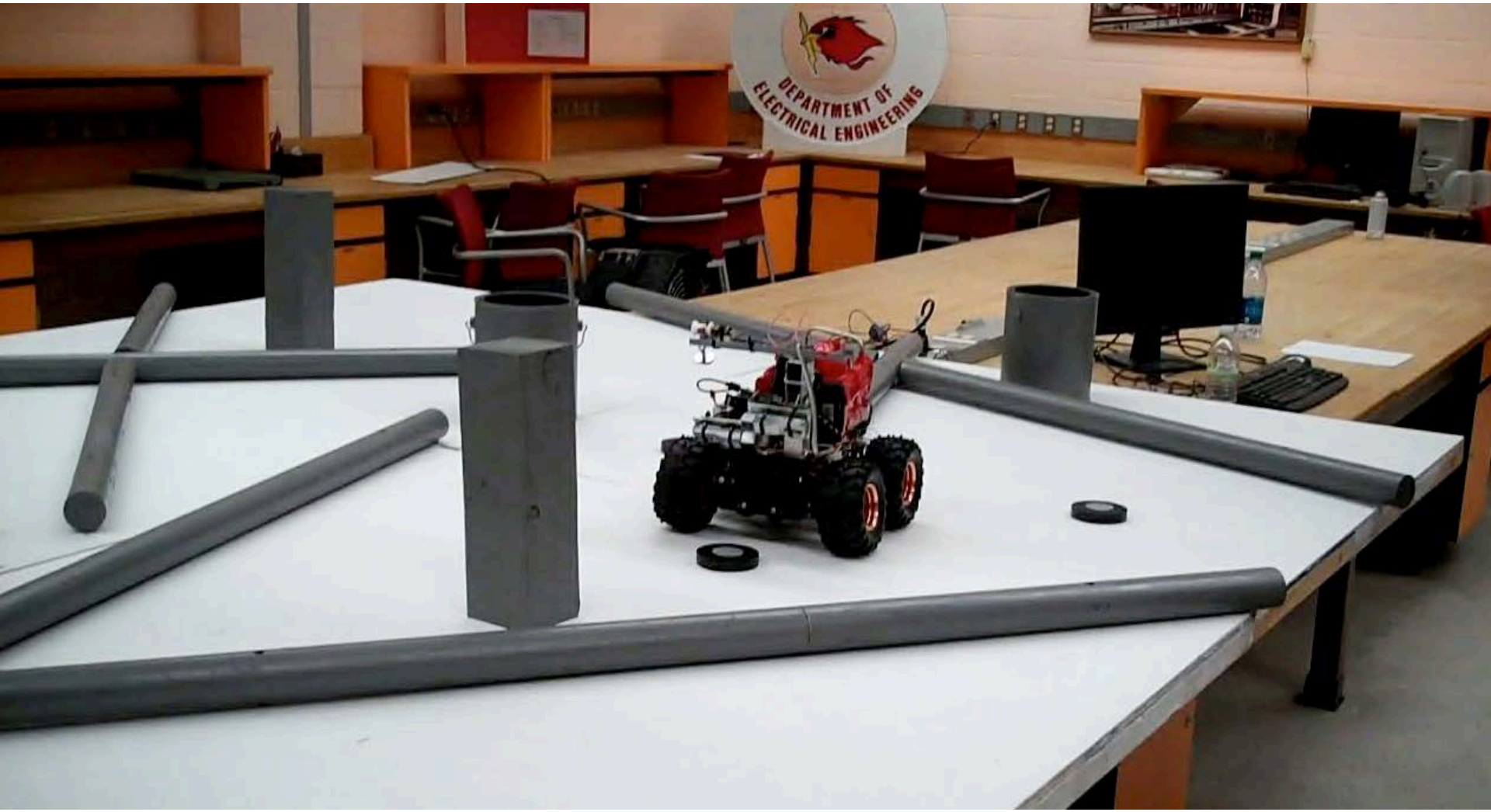

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Woods Hole Oceanographic Institution

Center for Marine Robotics

Untethered ROVs for intervention and surveys

Long-range, unattended AUV surveys

AUV and ROV operations under ice

Underwater acoustic/optical communications and data connectivity

Navigation, localization, and state estimation in complex environments

In situ identification of marine environmental chemical pollution

Co-robotics, scalable autonomy, and adaptive sampling

Advanced materials for deep submergence operations

Networked systems of multiple heterogeneous vehicles and distributed sensors

High-resolution marine gravity measurements with AUVs

Hybrid AUV inspection, monitoring, and intervention of seafloor and sub-seafloor pipelines

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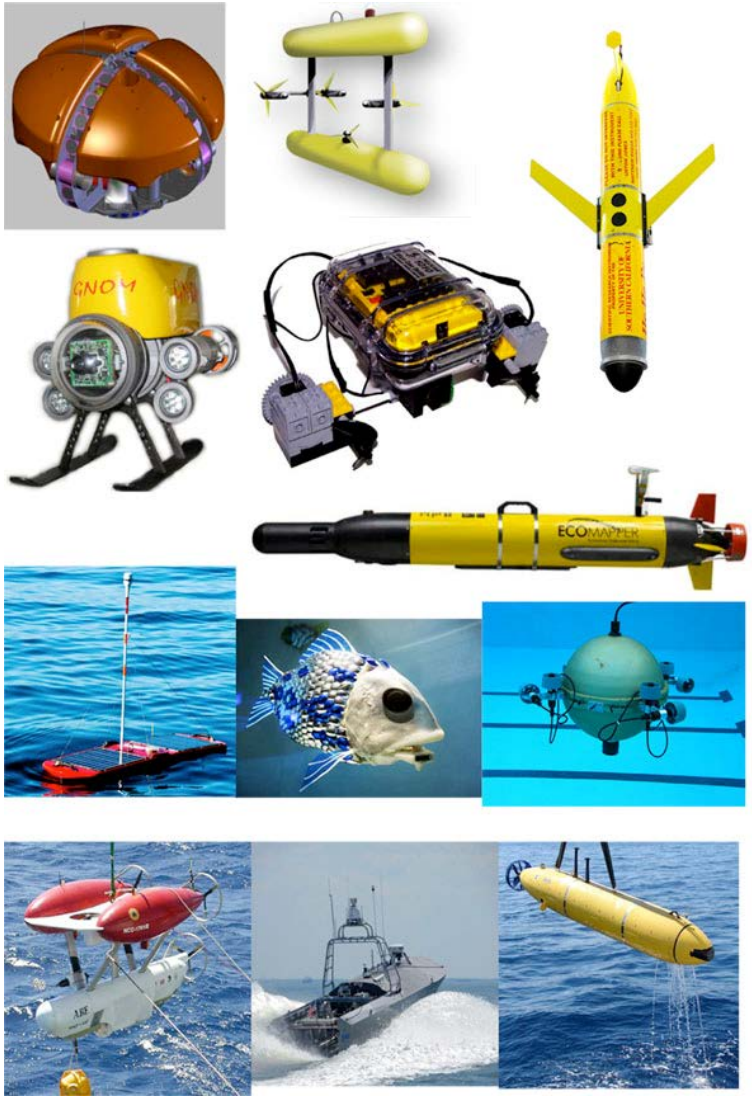
IEEE Robotics & Automation Society

Marine Robotics

Priority research areas:

- Actuation and Sensing Systems
- Communication
- Manipulation
- Interaction
- Guidance, Navigation and Control
- Mission Control Systems
- Localization
- Multi-Vehicle Coordination
- Networked Vehicles
- Outreach and Engagement
- Grand Challenges
- Planning
- Persistent Monitoring



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“tastes like Snapper”

…let’s build a robot.

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Robot Design Process

- Lionfish
  - slow-moving and conspicuous
  - large, d
  - prefer
  - though
  - apex p

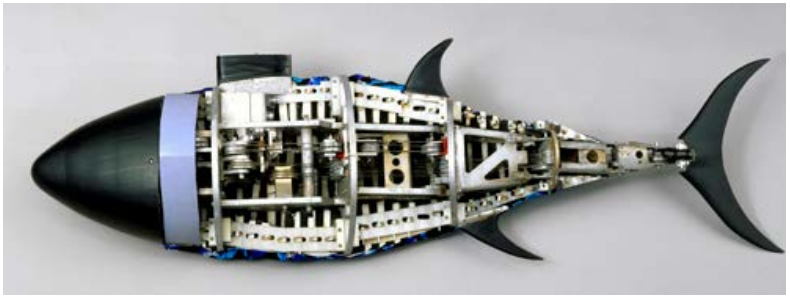
Easy to follow: low energy budget and

Not a problem for vision system, could have

Dispatch/collect rather than survey.

Robot Design Process

- Marine Robot
  - Solar Powered
    - Hunts at night, quiescent on surface during the day, recharging batteries.
    - Communicates at surface and geolocates.
  - Jet or caudal fin propelled
    - Slow, but quiet.
    - Low chance of entanglement.
  - Need not be biomimetic.
  - Shoots dart at Lionfish, records event.



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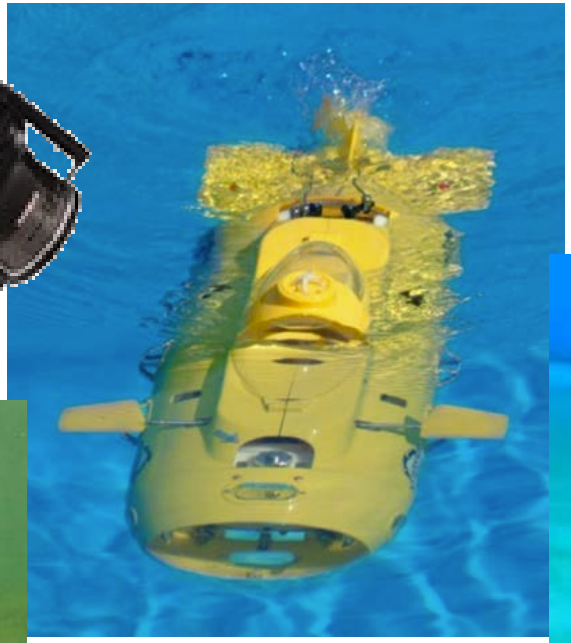
Comparable Devices



- Scooters
- Submarines

Summary

- Robotics has promise for invasive species remediation.
- Robotics has promise for environmental monitoring.
- Technological advances have made these assertions plausible.
- Greatest challenge is engineer-biologist interface.

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Thank you