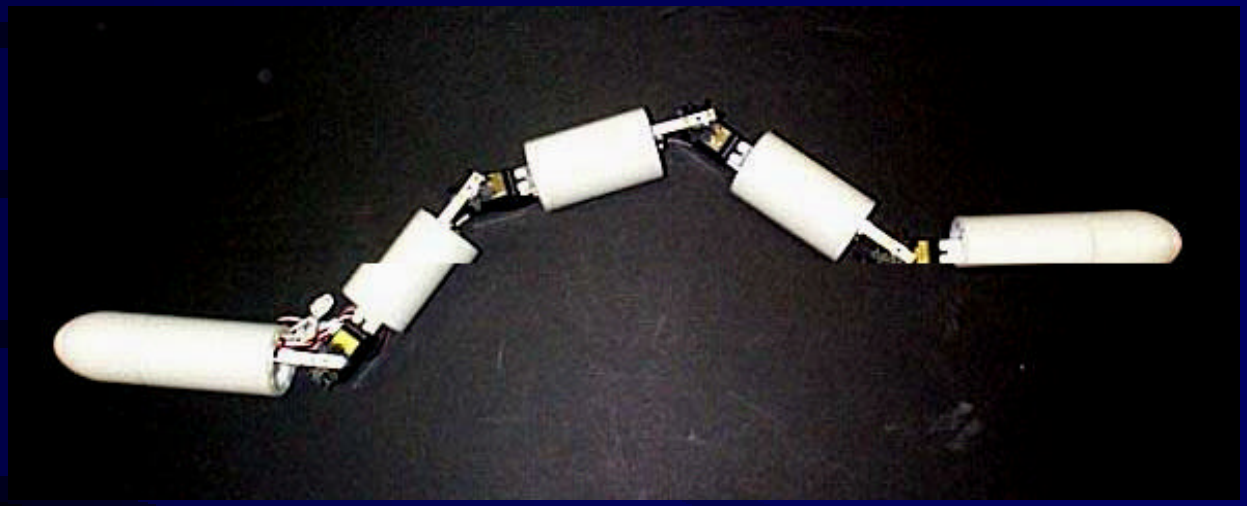
Designing an Underwater Eel-Like Robot and Developing Anguilliform Locomotion Control



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Supervisors:

Jim Ostrowski and Ken McIsaac

Why an Eel-Like Robot?

The Challenge of Applying Robotic Technology to New Environments

- Underwater Exploration and Surveillance
- Medical Instruments (Endoscopes)
- Manipulators in Confined Spaces
- Mobile Robots in Hazardous Areas

Undersea Exploration

Goal: Untethered Mobile Robots

Increase Efficiency, Agility and Maneuverability

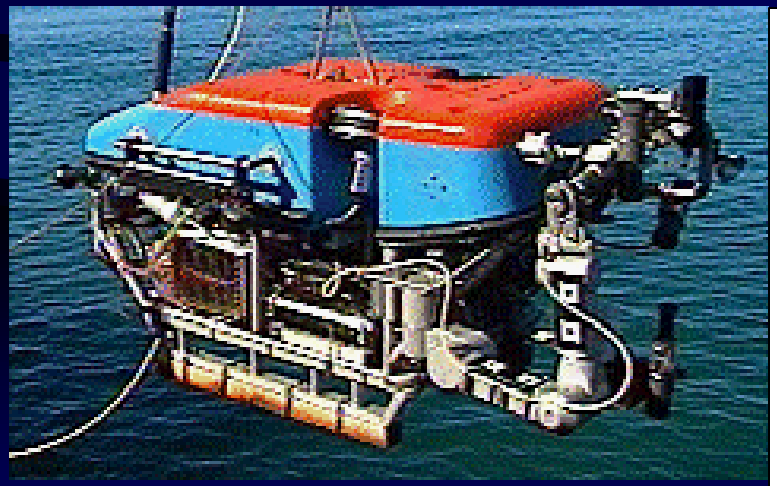


Figure 1. (left) Woods Hole's JASON Underwater Robot

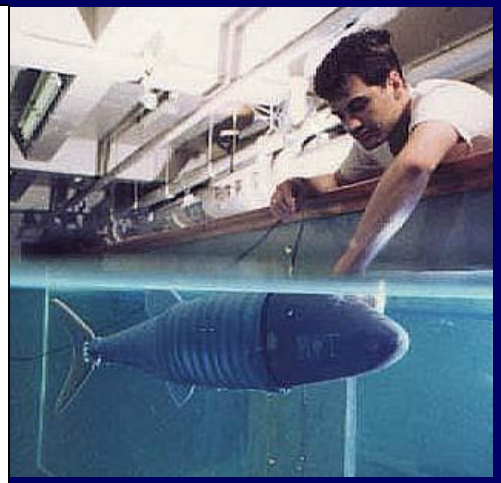


Figure 2. (right) MIT's RoboPike Robot

Manipulators in Confined Spaces

- Medical Instruments

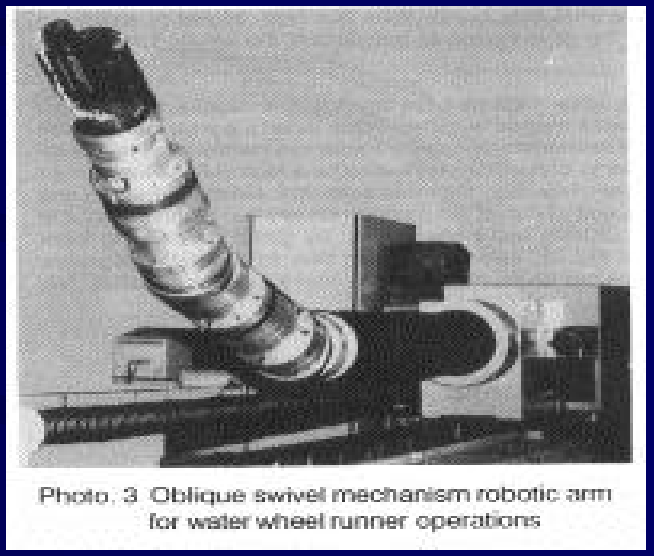
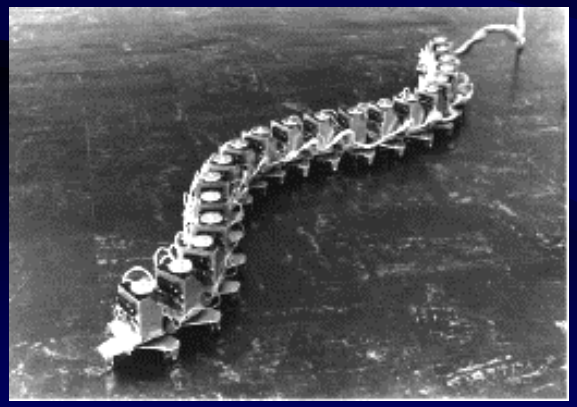


Photo. 3 Oblique swivel mechanism robotic arm for water wheel runner operations

- Industrial “Gripping” Manipulators

Mobile Robots for Inaccessible Environments

- Legless and Wheel-less
- Locomotion by Undulating Waves of the Body That Exploit Forces of Resistance in the Environment



The Eel-Like Robot:

- Underwater, Un-tethered Mobile Robot
- Biomimetic-modeled after the eel and snake

- Hyper-Redundant-composed of a series of repeated links

My Project:

I analyzed the prototype created by Kenneth McIsaac and Jim Ostrowski

and redesigned its key mechanical, electrical and communication components.

The Mechanical Changes

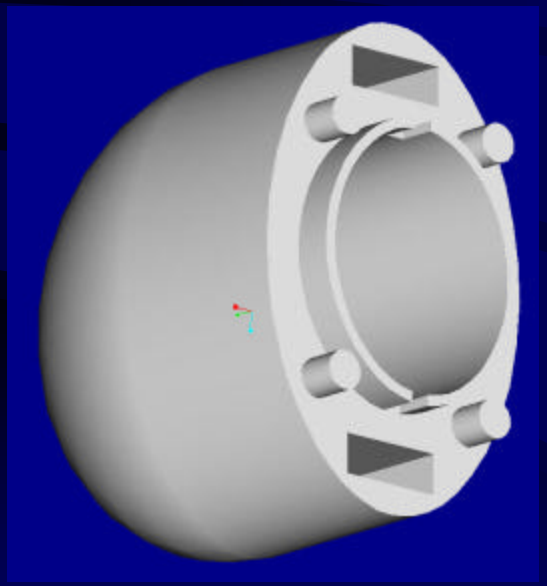
- Increased the Number of Links from 4 to 5
- Created Shells to Mimic Body Shape of Eel
- Created Belly Scales to Mimic Snake
- Developed Waterproofing Method

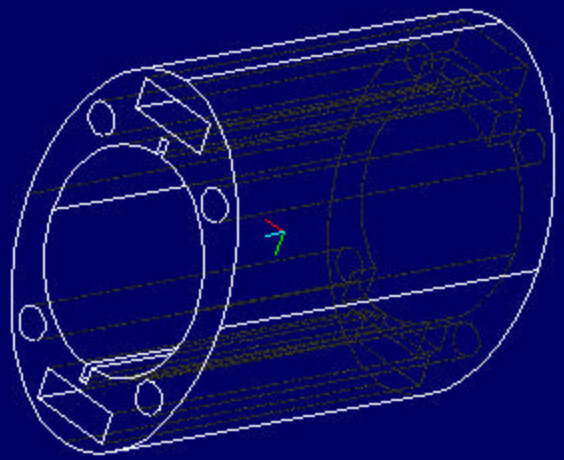
The Five Link Robot

- Increased Symmetry
- Allows Novel Gaits, Not Yet Observed Biologically

Shells to Mimic Body Shape of Eel

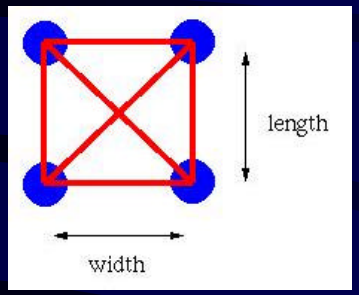
- Better Simulate Environmental Forces Acting on the Eel in Water



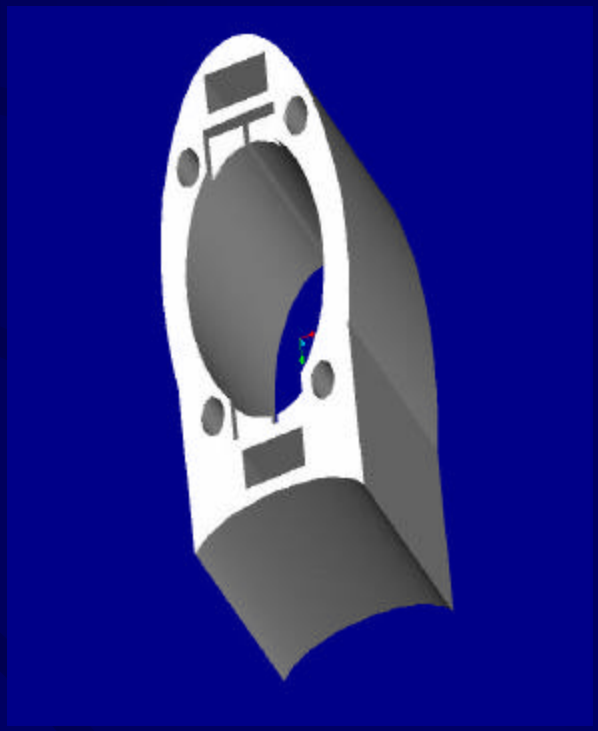


Belly Scales to Mimic Snake

- For land locomotion, important that lateral resistance is greater than ventral friction



Square Cross-Section of Snake versus Elliptical Cross-Section of Eel



Waterproofing the Hardware

- Model Generation #1

  -rubber tube covering

- Model Generation #2

  -blue plastic coating

  and putty

- Model Generation #3

  -epoxy resins and dielectric grease to waterproof

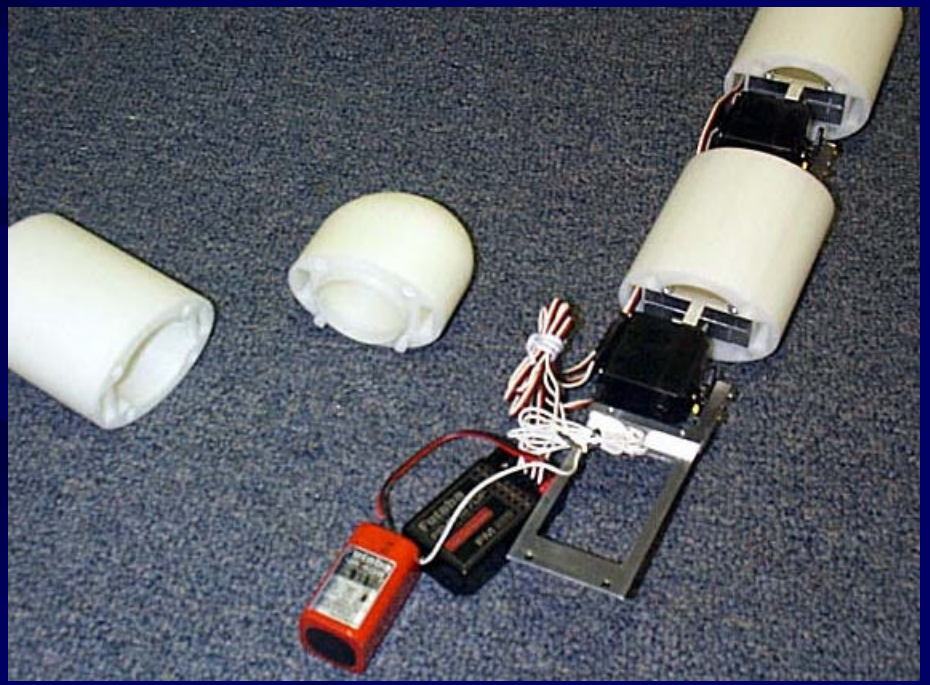
#1: rubber water-proofed well, but very inflexible

#2: imagine this coated in blue plastic very leaky, kept short-circuiting

#3: waterproofed

Electrical Changes

- Due to increased number of motors (joint actuators), change from Basic Stamp II mediator, to PIC controller
- Use Futaba S9303 Servomotors (Water-Resistant)
- Use Waterproof AC Adaptor



Communication Changes

- Developing Closed Loop Control of Robot from Open Loop Control

Further Work

- Model has improved modularity (parts are accessible and replaceable) and functionality (better mimics biological models)
- Need to develop better buoyancy
- Need to develop closed loop control using video feedback of position and orientation