EOC 4804L OE Systems Control & Design Lab (Spring 2022)
Project Topics Description

Four Project Topics

1. Micro Hydroelectric Kinetic Powered Desalinator.
2. Remote Concrete Mattress Deployment Frame.
3. Bio-Inspired Autonomous Underwater Vehicle to Detect, Track and Follow a Surface Moving Object.
4. Bio-Inspired Self-Burying Autonomous Underwater Vehicle.

Technical Performance Scores

The performance score of any system will be evaluated using three levels of requirements:

60% Achievement of Level 1 Challenge
80% Achievement of Level 2 Challenge
100% Achievement of Level 3 Challenge

Project Team and Tasking Requirements

- Six students per team.
- In each team, there will be technical and administrative responsibilities
    - Technical: two students will be accountable technically for mechanical engineering design & development, two for electrical engineering design & development, and two for software design and development. Students are strongly encouraged to collaborate across their required disciplines. Each student is required to generate a list of tasks that is he/she is accountable for.
    - Administrative: purchasing/budget, machine shop coordination, electronics shop coordination, environmental hazard and safety (EHS), and progress tracking. (boat scheduling, diving safety)
- Meet with the instructor and staff every week to discuss the progress and issues.
- The budget for each group is typically $2,400: $1,200 from external sponsor(s), plus $1,200 in FAU Office of Undergraduate Research Initiative sponsoring. Every group must submit an FAU OURI proposal in the first semester. Donated parts are also welcome.

Micro Hydroelectric Kinetic Powered Desalinator

A hydroelectric power sources traditionally converts the mechanical energy of moving water into electricity. There has been extensive research and development on extracting energy and fresh water from the ocean but a fusion of the two in a closed system has attracted much less attention. A closed system eliminates losses in power from converting and transporting energy which makes for a much simpler, reliable and less expensive design. The demands for fresh water has risen exponentially and in most locations it has or is expected to exceed its supply.

System Level of Requirements:
Develop a desalinator that can

1. Extract and measure the hydropower (tentatively 20 [W] on average) from a water current driven by tides. Log the data. Safe operation set as priority. Maintenance minimized with regards to antifouling, corrosion. The system would be operated in a traffic-free location near Seatech. The system would be operated with human in the loop and should have an emergency shutdown system.
2. Requirement 1 + Autonomously extract fresh water from saltwater using the turbine as a power source. A tentative extraction rate is 0.1 [liter/min]. The water salinity must be monitored and logged locally. The fresh water must be stored in a tank.
3. Requirement 2 + one week maintenance free operation.

Operating Requirements:

- Two-person deployable from a research vessel or dockside
- Maximum depth rating: 5 [m]
- Diver-less operations

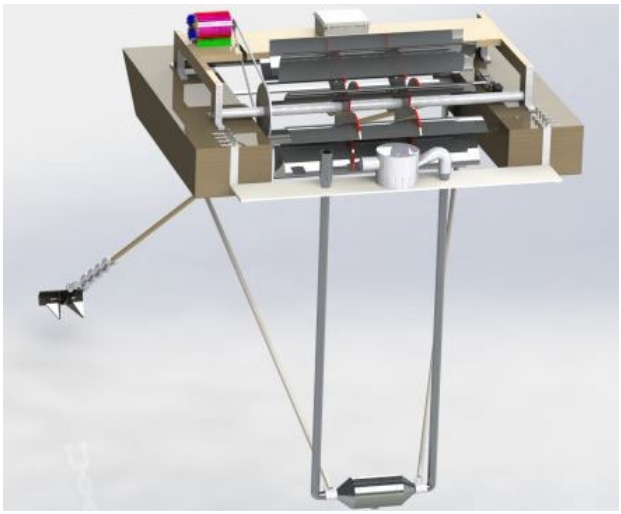

Figure 1. Micro Hydroelectric Kinetic Powered Desalinator.

Remote Concrete Mattress Deployment Frame

Concrete mattresses provide a recognized engineering solution for several of the challenges faced in subsea pipeline construction, umbilical deployment and seabed and soil protection/stabilization. They are cost effective and may be readily deployed using standard handling systems. Typically, concrete mattresses may be used to provide protection from dropped objects, added weight and stabilization, scour prevention, crossover support and separation for pipelines and umbilicals, supports or foundations for other subsea activities, riverbank erosion control. The group shall design and implement a remotely operated concrete mattress deployment frame for use in shallow water from a deck crane.

System Level of Requirements:

1. While a standard unit can lift a standard 20 [ft] x 8 [ft] x 1 [ft] concrete mattresses offshore, the group shall design and build a scaled prototype (1:4 scale suggested) for deployment and cost purposes. The maximum operating depth shall be 60 [ft]. The automated deployment frame shall have positioning and orientation thrusters built-in to mattress frame. These shall be manually controlled by an operator on the barge. The automated deployment frame shall include a failsafe capacity/design in event of signal or hydraulic pressure loss. The automated deployment frame shall carry 1 mattress and release this mattress within an area delimited by optical markers, over a pipe or a cable (Figure 1). The automated deployment frame shall permit remote viewing of the mattress frame orientation relative to the seabed using at least 2 cameras.
2. Requirement 1 + the automated deployment frame shall carry 2 mattresses and release 1 concrete mattress at a time so that they lay side-by-side over the pipe or cable.
3. Requirement 2 + a short-range sector scan sonar shall be mounted for low visibility operations (the sector scan sonar would be supplied by the Center for Acoustics and Vibrations). The acoustic data shall be displayed in real-time and shall be recorded simultaneously with optical data.

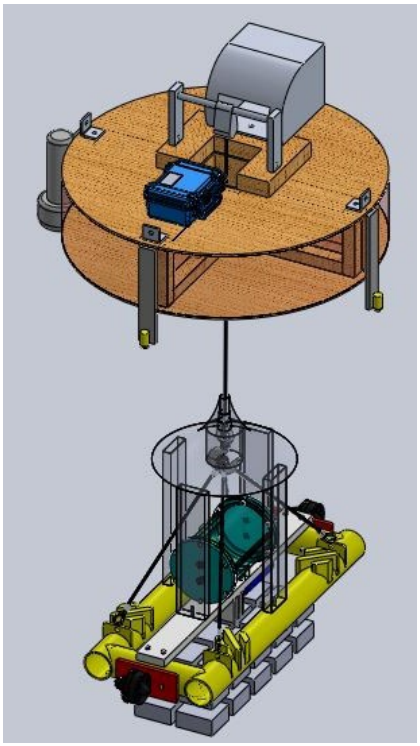

Figure 2. Remote Concrete Mattress Deployment Frame.

Operating Requirements:

- Crane operation from the R/V McAllister.
- No diver or ROV intervention.

Bio-Inspired Autonomous Underwater Vehicle to Detect, Track and Follow a Surface Moving Object

Autonomous underwater vehicles (AUVs) can be used to monitor and track a surface moving object. In this case, it may be beneficial for the vehicle to stay on the sea floor until an object of interest appears. The team shall design, fabricate, and test a bio-inspired underwater vehicle capable of sitting on the seafloor, detect a surface moving object based on optical signature, measure its wake and follow this object.

System Level Requirements:

1. The group shall design an underwater vehicle that can travel over a distance of approximately 10 [m] using programmed waypoints, land on the floor, continuously acquire video and pressure to record the motion of a surface moving object and its wake, then surface following a predefined time, and end mission.

2. Requirement 1 + detect the presence of the surface object, and surface once the object is outside of the field-of-view, or after some pre-defined time if the object is not detected.

3. Requirement 2 + infer the course of the moving object, surface once the object is outside of the field-of-view and move in the same direction as the surface object.

Operating Requirements

- The vehicle should be carried by two persons.
- The vehicle must have the capability to operate for at least 2 [hrs].
- The vehicle must be small enough to operate in the outside pool of the Engineering West Building in the Boca Campus.

Figure 3. Bio-Inspired Autonomous Underwater Vehicle to Detect, Track and Follow a Surface Moving Object.

Bio-Inspired Self-Burying Autonomous Underwater Vehicle

In between missions, autonomous underwater vehicles (AUVs) typically need to dock or be retrieved out of the water. However, such operation can be difficult to complete. If the vehicle missions are short, it may be beneficial for the vehicle to stay on the sea floor until an event or a timer triggers the next mission to start. Unfortunately, ocean currents may cause the vehicle to be picked off the seafloor and caught in the current. To overcome this challenge, the team shall design, fabricate, and test a bio-inspired underwater vehicle with self-burying capability.

System Level Requirements:

1. The group shall design an underwater vehicle that can travel over a distance of approximately 10 [m] using programmed waypoints, land on a sandy bed, and stay on the ground when a vertical pull of 40 [N] is applied to the vehicle. Following a triggered event (which could be a timer), the vehicle shall return to the surface and travel back to its launch point.

2. Requirement 1 + when on the ground, the vehicle shall move to the sides half its volume in sand from underneath its body.

3. Requirement 2 + instead of moving the sand to the side, the vehicle shall cover itself with the displaced sand.

Operating Requirements

- The vehicle should be carried by two persons.
- The vehicle must have the capability to operate for at least 30 [min].
- The vehicle must be small enough to operate in the outside pool of the Engineering West Building in the Boca Campus.

Figure 4. Bio-Inspired Self-Burying Autonomous Underwater Vehicle.