SUMMARY

- Our section of the wave power team will focus on wireless power transfer (WPT) through seawater.
- This is to aid in supplying AUVs with power in their operating environment.
- We will test efficiency of WPT through seawater over a range of distances, frequencies, and power factors.
Use of AUVs is limited by onboard power storage; it’s costly to dispatch crews to replace battery packs or refuel.

Extension of AUV capability must be effected with new powering schemes.

Distributed network of wave generators to power AUVs is complicated.

Direct electrical connections are frequently used and they pose two main problems:

- Need to recall AUV to buoy or tether it limits the AUV’s useful range.
- Even high end marine connectors have short lifetimes.
Typical AUV battery storage composed of 1.5 kW packs (Bluefin Robotics)

Recharging an AUV of any capacity would require a significant rate of transfer.
PRELIMINARIES

- Preliminary research suggests saltwater attenuates EM waves rapidly.
- Attenuation more severe at high frequencies.
- This poses a serious problem for long distance WPT in the ocean environment.
- For this reason we are testing a resonantly coupled WPT system.
RESONANT POWER TRANSFER

- Since inductive coupling is a very short range method of WPT, and radiative or directional beam (lasers or microwaves) would be quickly absorbed by the ocean, resonant WPT is of natural interest.
- Tests in air have been demonstrated at up to 10 times coil diameter.
Our main goal is the construction of a system that allows for efficient transfer of wireless power over distances.

Resonant WPT is still a developing technology, and so its efficiency operating underwater is not well described.

We will test a resonantly coupled system in a simulated undersea environment.

The test will hopefully allow us to design a microcontroller balanced system with functions that will change frequency and amplitude of wireless signal to compensate for changes in the coupling.
ALTERNATIVE SOLUTION

- Since water absorbs much of the EM waves in it it may do the same for magnetic fields.
- If the water absorbs enough of the signal energy to make long distance transmission unfeasible (2db/meter or more) our end system will not include the microcontroller.
- Since the proximity required to transfer reasonable amounts of energy will be small, WPT would be more easily done with simple inductive coupling.
- The AUV would dock to the generator, while this is less than ideal, it would still avoid high maintenance marine connectors.
PRELIMINARIES

- Shown is an air-gap coupled transformer.
- This is an approximation of our system for shorter distances (less than diameter of coil).
- This model is approx. 40% efficient.

For \( V_{in} = 20V \) @ 100 kHz, \( K = 1 \), \( R = 1 \Omega \), \( C = 10.5 \text{ nF} \), \( L = 24 \mu \text{H} \)
TESTING

- A rig structure will allow coils to be set at set incremental distances.
- At each distance increment a logarithmic frequency sweep and linear power factor sweep will be performed.
- Efficiency trends will dictate optimal frequency and PF for final system.
- If promising combination is found, trip to ocean will be planned to test at longer distance.
- The test rig will be made from 1”*1” hollow square pvc to prevent erosion.
TEST RIG

- Test rig will consist of a 30”*20”*16.5” plastic frame to be immersed in 30 gallon tote. Works out to around 25’ of 1”*1” pvc needed.
- Tank to be filled with water of same salinity as seawater.
- Coils will be waterproofed and attached to ½” plexiglass plates (or other non reactive material).
- Coils and correction circuitry will be driven by a bench signal generator.
- Frame will allow distance adjustments in linear increments of 1 cm demarcated by slits cut into the frame.
Schedule

- Finish rig setup by end of semester.
- Begin testing over intersession period.
- Have finished testing by early February.
- Use test data to finalize system design and order parts.
- Build and test system for demonstration.
QUESTIONS?