**Acoustic tracking of micro air vehicles (inc. Honors)**

The goal of this project is to passively acoustically track micro air vehicles, or hovering animals such as hummingbirds or insects. The main focus will be to construct an array of inexpensive microphones and the necessary interfacing and software. A well-design test program will be needed to demonstrate system performance. Ancillary goals may be to demonstrate strategies for a quieter MAV, or to consider differences in system design for different environment (e.g. indoor versus outdoor uses). A four-element array prototype / feasibility study was previously conducted and is available to build upon. Multi-disciplinary teams highly encouraged.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Airborne / underwater animal maneuvering and control during competitive interactions (inc. Honors)**

The goal of this project is to create an indoor, auto-tracking arena and use it to track insects (in air) or marine invertebrates (in water) doing paired interactions such as predator-prey interactions, courtship displays, fights to establish dominance, etc. The scientific goal of this project would be to quantify and compare maneuvering abilities and mechanisms; the engineering goal is to apply machine vision and automation to recover states of a system performing maneuvers; a naval goal would be to identify strategies or techniques especially amenable to future air or underwater vehicle platforms. Multi-disciplinary teams highly encouraged.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Flock / swarm control strategies & extreme maneuvers inspired by Chimney Swifts (*Chaetura pelagica*) (inc. Honors)**

Using multiple camera videography and automatic tracking, we now have long recordings of maneuvers conducted by large flocks Chimney Swifts entering a roost at dusk. Follow-on projects could be conducted to (1) use computer vision methods to examine visual cues available to birds within the flock; (2) examine information flow and networks within the flock – are there leaders, subflocks within the flock, regions with more or less cooperation; (3) use quadcopters or gliders to attempt landing maneuvers into vertical tube structures, solo or in a flock; (4) analyze the actions of 25 vs 25 UAV swarm combat maneuvers from the DARPA Service Academy Swarm Challenge and/or develop bio-inspired control strategies. Multi-disciplinary teams highly encouraged.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Control and maneuvering strategies during skydiving, tumbling, or directed aerial descent (inc. Honors)**

This project will examine control and maneuvering strategies during flight regimes that are wildly different from straight and level forward flight or hovering. In biology/biomechanics, such flight regimes are observed in many intermediate forms as clades evolve flight; they are also seen during ontogeny, i.e. as baby birds learn to fly. Skydiving free-fall behaviors are known to occur in animals as small as *Cephalotes* ants all the way to animals as large as humans. In naval use, perhaps there are applications for actuators, augmentative technology backpacks or suits, or super-smart cargo pallets that can assist with automatic control during free-fall. Kites and gliders potentially considered. Further identification of future naval capabilities of interest or mission needs would be part of the early planning work. Midshipmen interested in skydiving, gymnastics, ballet, and parkour are especially welcome. Multi-disciplinary teams highly encouraged.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Control of posture, stance, or balance during paired martial arts interactions (inc. Honors)**

This project would examine posture and balance during paired martial arts interactions. Previously, this has been studied only briefly in the context of t’ai chi push-hands exercise and without deep quantitative examination of control. This project would require the use of a force plate for ground reaction forces, human motion-capture for kinematics, and potentially foot-pressure mapping etc., as well as human research protocols which would have to be established as part of the early planning. Midshipmen interested in all forms of martial arts, dance, gymnastics, etc. are especially welcome.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Comparative Biomechanics / Stability and Control in Organisms**

The goal of this project is to examine stability and control in an organism and apply what is learned to a novel device. In the past, USNA midshipmen have worked with humpback whale fins; a customer from that project is keen to have more work done, such as designs for fixed and oscillating wings, propellers, and planes; oscillating propulsive systems, flexibility in control surfaces and propellers, animal jetting, and trailing edge projections in wake modification and noise reduction. Other general possibilities include stability and control during standing, walking, or running; design of a treadmill for studies of arboreal locomotion in animals and robots, intact stability and inclining experiments in aquatic plants; design of wearable equipment for data collection in biomechanical studies; simple robots to demonstrate principles of aerial stability and control from falling animals; flying and self-burying seeds; animals crashing through free surfaces; machine vision, identification/tracking/counting of animals in video, and observatory design for long term animal movement studies. Now is your chance to indulge your curiosity about some strange organism. Fast-moving or carnivorous plants and multi-disciplinary teams highly encouraged.

Contact: Prof. Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu) or contact Evangelista with any strange interesting organisms

**Biomedical Devices / Biomechanics (capstone or 1 credit research)**

This project would be joint with Prof. Jaramillo-Cienfuegos. Students would perform market research with clinicians to identify customer needs for medical devices, brainstorm strategies and concepts and downselect, create mockups and models, perform detail design and construct an alpha prototype. One potential goal is to enter the resulting device in various medical device business plan competitions (e.g. Mass General Hospital; Duke University Hospital). Examples of topics done at other universities: pulse duplicator for actuating cadaver hearts for testing stent and percutaneous valve deployment; needle biopsy robots; orthopedic surgery glue dispensers; dose-measuring assistive devices, etc. Multi-disciplinary teams highly encouraged.

Contacts: Prof Jaramillo-Cienfuegos [cienfuego@usna.edu](mailto:cienfuego@usna.edu), Prof Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Smart Monopod for 3D Reconstruction from Multi-camera Videography (capstone or 1 credit research topic)**

The goal of this project is to construct a smart monopod with sensors and multiple, calibrated cameras that will allow recovery of camera pose and 3D reconstruction of the position of tracked objects. The monopod is intended for use in studies of flying animals and UAVs and must be field portable and rugged.

Contact: Prof Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Support of Sailbot of the Future (1 credit research topic)**

This project will support the Sailbot project by examining high risk / high payoff technologies, potentially including: (1) designs enabled by automatic control, possibly including hydrofoiling, planing, kiteboarding, windsurfing; (2) alternative hull forms and rigs such as multihulls, hydrofoils, proas, multiple wing sails; (3) highly modular system designs and fault tolerant, alternative control strategies; (4) concepts to reduce cost for the Trans-Atlantic Sailbot, such as reduced displacement, alternative hull construction methods, alternate actuation strategies, and the tradeoffs between reduced cost, greater numbers, and the likelihood of successfully reaching Ireland. As a 1 credit research topic, it is hoped that underclass midshipmen potentially interested in Sailbot will develop technologies to be incorporated during their first-class capstone. NAOE and Multi-disciplinary teams highly encouraged.

Contact: Prof Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Support of DARPA Service Academy Swarm Challenge (1 credit research topic)**

This project will support the DARPA Service Academy Swarm Challenge by examining launcher systems; situational awareness, command and control issues, means of identifying the intent of an enemy swarm, and efficient communication between commanders and autonomous assets; or UAV support of fixed wing and quadcopters.

Contacts: Prof Dawkins [dawkins@usna.edu](mailto:dawkins@usna.edu), Prof Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Future Lab Exercises, possibly Autonomous Robotic Croquet or Curling (capstone or 1 credit research topic)**

The goal of this project is to develop next-generation lab exercises for the WSE department curriculum. This could explore the use of spherical robots (e.g. Sphero, BB-8) as autonomous croquet balls or other boules-like sports, potentially combined with mobile robot elements (moving hoops and peg), machine vision, and planning. Alternatively, **build me a bowling ball that never misses** (the Bowler in the film Mystery Men). Team will be responsible for developing common hardware and rules, and potentially organizing a competition. Other possible lab exercises could be development of a torpedo-like exercise, targeted at ES200/ES202, incorporating sensors and actuators as well as providing historical context of the challenges in WWII submarine torpedo designs; “hack an IED” exercise; Bancroft smart mousetrap challenge; or assembly/development of robotic demonstrations for teaching, such as adding autonomy to a Caipirinha flying wing drone, Craziefly quadcopter demonstration, or autonomous sailing land yacht on the Isherwood terrace.

Contact: Prof Evangelista [evangeli@usna.edu](mailto:evangeli@usna.edu)

**Autonomous and Remote Deployable Equipment for Biological/Ecological Monitoring**

The goal of this project is to develop autonomous and remote deployable equipment for use in studies of biology/ecology. Potential devices include: oceanographic measurements, in situ forces on organisms in flow, machine-vision-enabled observatories, unmanned aerial or underwater vehicles and methods for coverage, counts and surveys, deployable wind-generator powered / autonomous kite flying systems for persistent observation. Part of the planning will require identifying potential customers and their needs and selection of concepts for further study. An over-arching goal would be devices that can be deployed (to ecological study sites anywhere from the tropics to the poles, oceans to deserts) with the hope the especially successful projects will accomplish an actual deployment in support of science. Multi-disciplinary teams highly encouraged.

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