Synchronized Servo Management System

ELECOMP Capstone Design Project 2026-2027

Sponsoring Company:

General Dynamics – Electric Boat
75 Eastern Point Road
Groton, CT 06340
http://www.gdeb.com

Company Overview:

Electric Boat has a distinguished history, tracing its roots to February 7th, 1899, when the company was established to complete a vessel that would revolutionize naval warfare. Named Holland for its inventor, the visionary Irishman John Phillip Holland, this 54-foot vessel in 1900 became the first commissioned U.S. Navy submarine.

Since then, the Holland's successors have been employed to radically reshape naval warfare and maritime strategy, while contributing to the successful outcome of World War II and play an indispensable role in the country's Cold War victory.

Today, Electric Boat is the design yard and prime contractor for the Virginia-class submarine program. The Virginia class is the first major warship completely designed in a virtual environment, a capability pioneered by the people of Electric Boat. Employing many of the best practices used in the Virginia program, Electric Boat is currently engaged in the development of the Ohio Replacement, the third generation ballistic-missile submarine, which will provide strategic deterrence for the nation well into the remainder of this century. The Ohio Replacement Program represents the future of our company, as we develop new tools and processes to design submarines for the U.S. Navy. Key to our future success will be the new employees who come aboard and learn how to design, build and support nuclear submarines and their undersea systems.

Throughout its distinguished history, Electric Boat has been defined by its people, their skills and the legendary commitment they bring to their jobs. A tangible sense of pride runs through the entire workforce - shipyard trades, designers, engineers and the rest of the disciplines required to produce what is arguably the most complex product built by man.

Technical Director(s):

Fotios Angelopoulos
Communications Systems Engineer

Mike Brawner
Staff Engineer, C5I Systems and Above Water Sensors

Project Motivation:

A system for umbilical cable deployment and retrieval requires a synchronized system for management of up to six (6) motors to ensure constant tension and variable speed control.

Students will investigate and assess technology options, develop a simulation model and fabricate a prototype for management and tension control of an umbilical cable during deployment and retrieval.

- Areas of exploration will include motor specification/selection, speed and tension control methods, circuit development, DC power control and management algorithm development for a system level solution.

Anticipated Best Outcome:

Goal is to identify novel and emerging servo-mechanism monitoring and management technologies, develop simulation model(s) and fabricate a scaled prototype of a system for potential leverage by EB Engineering for continued model development and prototyping in support of ongoing evolving electronics systems.

- Includes increasing students' engineering knowledge of DC Power Distribution and Management, synchronized timing circuits and corresponding feedback system options. Efforts will include approaches to system development and modeling (key EB Engineering Skills); fostering interest in EB for post-graduation employment, and continuing to foster the EB/URI relationship

Project deliverables will include a mid-year and final technical report.

Project Details:

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Students will be provided with notional system requirements, CONOPs and guidance and will be expected to develop, model and build a prototype.

Hardware/Electrical Tasks:

Develop Control Unit Design:

- Speed Control and Synchronization
- Torque Matching and tension monitoring
- Rotation Direction

- System Design and Component Selections
- Prototype Plan Development
- Prototype Fabrication and Demonstration

Firmware/Software/Computer Tasks:

- System Simulation(s) Development
- System Control and Monitoring Algorithms
- Prototype Plan Development
- Prototype Fabrication and Demonstration

Composition of Team:

2 Electrical Engineers, 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Direct Current Principles and Circuits
- Motor Theory
- MatLab and Simulink (or equivalent capabilities (Python, C++, etc))
- Access and Familiarity with the URI Power Laboratory
- Access and Familiarity with the Intelligent Control and Robotics group

Computer Engineering Skills Required:

- MatLab and Simulink
- TCP/IP and MIB Equipment Control and Monitoring

Team Expectations:

1. Student(s) shall present a Project Plan within the first 30 days of Project start, for approval by the Sponsor's Project POCs, that includes the following:
    a. Interpreted goals
    b. Additional Information required from the Sponsor
    c. Project Schedule
    d. Project Milestones to Track Progress
2. Student(s) shall develop a presentation that will be used to document the following:
    a. Research and findings of the applicable AC and DC Power technologies and devices including commercially available systems
    b. The system concept model including applicable components' TRL for new technologies and potential risks for maturity of that technology
    c. Approach to use of MATLAB and Simulink for concept modeling
    d. Show the engineering and analysis work used in developing the system concept model including recommended further investigations and analysis
    e. Proposed prototype and test approach

In Phase II (Spring Semester) of the Project

1. Development of detailed models, simulation and prototype using the URI Power Laboratory
2. Student(s) shall continue to develop their presentation with the following:
    a. Additional engineering analysis results
    b. As possible, document the concept build progress and test results
3. Final Deliverable to the Sponsor shall include the following:
    - Student(s) shall present the final presentation, for approval by the Sponsor in electronic format in its native software (i.e., Microsoft Power Point)
    - Analysis models of the concept including projected heat generated
    - Any ancillary hardware/components that the system may require to provide the desired capabilities
    - Recommendation for next steps and further work

The project team shall have weekly correspondence (i.e., email, phone calls) with the Sponsor's Project POCs at a time that is mutually agreed upon. In addition to the weekly correspondence, a monthly virtual, or if possible in person, meeting will be held to discuss project status.

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

The benefit to EB is to obtain outside (non-traditional) engineering innovation, explore and better understand the design challenges associated with synchronized motor speed and tension control.

- Capstone projects enable us to not only collaborate with new parties but also obtain firsthand knowledge from seeing how the students may approach and solve the problem(s) in unique ways.
- Real world problems offer unique opportunities for student growth and potential EB employment assessment.
- Workforce Development

Understanding the options and limitations of this capability and platform integration dependencies will enable Electric Boat to help guide its development and concept of operation.

Broader Implications of the Best Outcome on the Company's Industry:

In today's shipbuilding environment, shipbuilders must deliver more innovative products and services, reduce costs, improve quality, and shorten time to market, while achieving their targeted return on investment (ROI). To reach these goals, shipbuilders must continually improve how they integrate new systems to become more efficient and productive. Innovation must occur in all dimensions—product, process, and collaboration. The broader implication is for the Navy to save dollars on new system integration while improving system performance.

AI use Policy – Synchronized Servo Management System

Allowed

- Students may use AI tools for
  - ☒ brainstorming support
  - ☐ concept development
  - ☒ literature and publicly available documentation review
  - ☐ software development
  - ☒ debugging
  - ☐ data analysis
  - ☒ test development
  - ☒ non-proprietary paragraph editing
  - ☒ non-proprietary single-slide formatting
  - ☐ preparation of project deliverables
  - ☐ note taking or transcription of meetings
  - ☐ Others: _____

Not Allowed

- Using AI in violation of university policies, applicable laws, or course-specific rules identified by capstone instruction team and project-specific rules identified by the technical directors.
- Entering proprietary, confidential, personally identifiable, security-sensitive, or otherwise restricted information into an AI system without authorization.
- Submitting AI-assisted work without understanding, reviewing, verifying, and appropriately disclosing its use.
- Submitting entire documents or presentations to an AI system for editing or formatting
- Any unchecked items from the allowed list above

Requirements

- If any use is allowed, AI tools may only be used to enhance, but not replace, students' technical reasoning, engineering judgment, and understanding. Students must be able to explain, justify, and defend all submitted designs, code, analyses, test results, documentation, and conclusions.
- During the first two weeks of the project, the student team shall work with the Technical Directors to:
    - Identify any proprietary or confidential information that may be involved in the project.
    - Determine what information may or may not be shared with AI systems;
    - Identify the AI tools, models, accounts, and configurations approved for project use; and
    - Document any project-specific restrictions or approval requirements.
- Students shall transparently document the uses of AI using the URI CYPHER AI Usage Marking guidelines (https://web.uri.edu/cypher/ai-marking/). A workshop is planned for September to familiarize students with these guidelines.
- Students retain full professional responsibility for all design decisions, analyses, implementations, testing, documentation, presentations, and final deliverables, regardless of whether AI tools contributed to the work.