SECS Senior Design
Available Projects – Winter 2024

Robotic Sailing Training Marks

Sponsor: Gregg Kittinger <gregg.kittinger@gm.com>
Community Sailing School Foundation (CSSF)

CSSF is a nonprofit foundation founded in 2013 with the sole focus of introducing and advancing the sport of competitive dingy sailing at the middle school and high school level. Our foundation is represented national by Interscholastic Sailing Association, ISSA, where we cater to local Oakland County public and private schools. CSSF currently serves 15 high schools comprising of ~100 sailors of which 95% had no sailing experience before joining our program. Pontiac Yacht Club on Cass Lake in Waterford MI is our base of operations where we have several volunteer coaches that train sailing and racing skills from beginner to advanced racers.

The coaches use marks anchored to the seabed to conduct drills, which often require adjustment in location during practice. Adjustment of the marks requires constant anchor line adjustment as the seabed changes drastically over a short horizontal distance. Inexperienced sailors often contact the marks and drag them out of position requiring the coaches to reset the drill before continuing. These factors reduce the limited on-the-water training time, impacting the efficiency and effectiveness of training.

The objective of this project will be to improve on the current low tech training tools and bring CSSF into the 21st century increasing coaching efficiency and on-the-water training time. Robotic marks exist today as a tool for modern sailors, but they are large, expensive, and “buggy,” requiring a semi tech savvy person to operate and troubleshoot errors. This project will focus on developing a mark, roughly the size of a child’s Hippity-Hop ball, that, once activated and deployed, will maintain its position on the water with 1 meter or better accuracy.

The focus will be on safety, function, simplicity, and reliability across a wide variety of weather, wind, and sea state conditions.

Our target budget per robotic mark will be ~$500, as we would expect to clone the final design for usage by multiple coaches during drills. Many of CSSF coaches are automotive engineers and can serve as a good basis to expand technically on our problem statement. I am excited for you to consider this project and look forward to addressing any questions you might have.

NOTE: Confidentiality and assignment agreements are required before students can begin work on this project.

Development of Battery Thermal Management System

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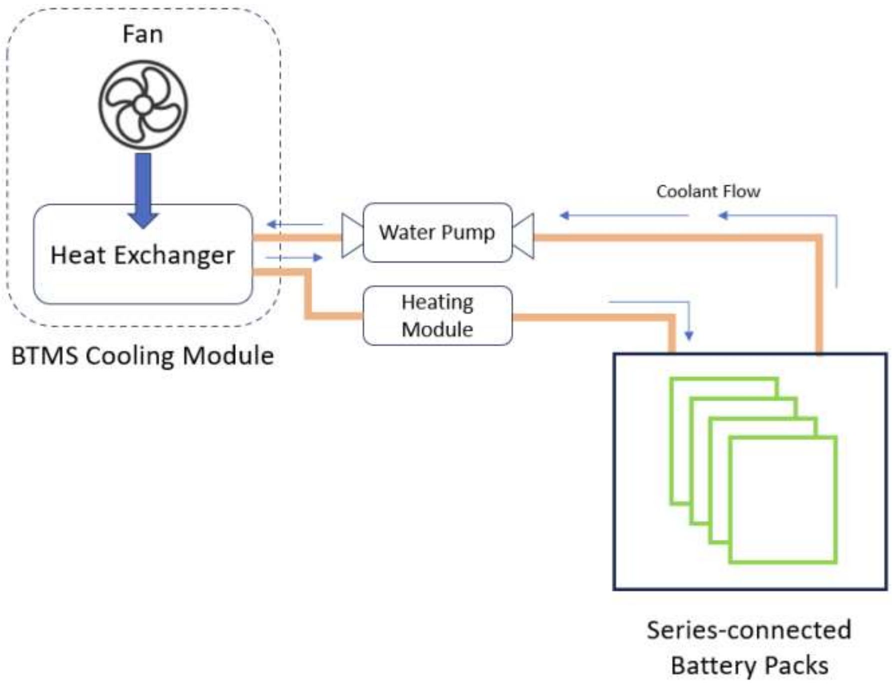
Objective:
Students will be tasked with researching and designing a working battery thermal management system (BTMS), verifying its performance on a physical setup of series-connected, lithium battery cells. Below is an example of a high-level BTMS system.



High-level Tasks and Deliverables:

- Background research on BTMS to inform the design process
- Comprehensive BTMS design – appropriate selection of materials, sensors & supplies (simulation tools such as MATLAB Simscape may be needed for theoretical verification), along with the physical implementation of proposed BTMS design
- Use of a low-cost microcontroller for pulse-width modulation (PWM) control of fan and
- temperature measurement of battery packs
- Collect serial data from the microcontroller and generate results to confirm heating and cooling ability of the implemented BTMS
- Create a repository for any accompanying documentation, code version control, etc.

NOTE – only one design group will be assigned to work on this project.

Development of a Scale Autonomous Vehicle based on Ride-On Car

Jun Chen, Ph.D.
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Objective:
Research, design, and development of a scale autonomous vehicle platform using ride on cars. An example of a ride on car is shown below. The car should be fully autonomous using appropriate sensors, computing devices, software (should run on ROS), and X-by-wire systems (potential upgrade needed).

High-level Tasks and Deliverables:

- Model selection
- Research on battery and steering mechanisms for potential upgrade
- Design a camera-based perception system with object detection algorithms (may upgrade to LiDAR)
- Interface design between laptop computer and X-by-wire system while retaining remote control functionality
- Required features: lane following, collision avoidance, and object tracking with a desired following distance
- Create a document repository on all aspects of the project

NOTE – only one design group will be assigned to work on this project

Development of a Multi-Image Sensor (MIS) Pipeline Inspection Camera

Sponsor: Telespector Corp, Dave Piccirilli (davepic@telespector.com)

Telespector is a Michigan-based manufacturer of waste and storm water pipeline inspection and joint sealing repair systems.

Project Overview

Currently, most pipeline inspection cameras are electromechanical devices which require small electric motors, gears, bearings and waterproof seals to pan and rotate the head of a single-image video camera. The moving parts of the camera head are often damaged due to accidental mishandling which leads to expensive repairs and downtime. If the seals fail, wastewater can enter the camera body causing extensive damage to the electronics.

With the advances in small CMOS video image sensors, video stitching technology and small high-intensity LED lighting, we believe that a multi-image sensor camera that mimics the operation and viewing range of a mechanical pan and tilt camera is a viable option. This camera would have no moving parts, gears, and dynamic seals, eliminating the vast majority of pipeline camera failures and associated downtime.

Project Scope

- Take the physical prototype developed in the Fall 2023 Senior Design course and implement the image processing capabilities outlined below

MIS Camera Requirements

- Operate the stitching or viewing function with a joystick to mimic current pan and tilt camera operation.
- Object measurement capability through the forward-looking image sensor.
- Pipe diameter and roundness (ovality) measurement through the forward-looking image sensor.
- Camera designed for easy maintenance.
- All image sensors must have high definition (1080P minimum) specifications.
- All image sensors must have digital zoom capability.
- Video and signal transmission through 150-ft of cable (HD over coax).
- Minimize the number of conductors in the transmission cable by utilizing current multiplexing technologies.
- Operation voltage 12-36 VDC.
- Electrical protection for over/under voltage, short-circuit, reverse polarity and power-on-coax.

NOTE: Confidentiality and assignment agreements are required before students can begin work on this project. Only one design group will be assigned to work on this project.

Development of a small engine/motor dynamometer

Sponsor: Michael Latcha, Oakland University (latcha@oakland.edu)

In developing electromechanical systems, it would save considerable time and effort to verify the actual performance of a motor that has been purchased (or found as surplus), instead of relying on the specifications that are reported in the data sheet (if a data sheet is available). The use of a small (<100 W?) dynamometer that would quickly, conveniently, and accurately produce the torque vs rpm curve would greatly enhance the efficient and accurate development of such systems.

The design and construction of small engines (powered by steam or compressed air, internal combustion, or Stirling engines, and more), is an ongoing source of industrial research and a popular hobby world-wide. However, there does not exist a commercial device that can be used to quickly, conveniently, reliably, and repeatedly produce the torque vs rpm curve that would allow these researchers and hobbyists to objectively measure the performance of such systems.

This project will address both needs by developing, constructing, and demonstrating a small dynamometer with the following characteristics:

- Quickly measure the power (torque x angular speed) curve of a small motor or engine, ideally with a single sweep from stall through its top speed.
- Able to attach quickly and securely to common small engine and motor shafts.
- Able to be quickly and accurately calibrated.
- Top speed 15,000 rpm, max power ¼ hp (200 W)
- Parts to be either 3D printed or readily obtained with minimal machining.
- Choice of microprocessor is determined by the measurement techniques selected by the design group.
- Optional but desirable – the device is scalable and can accommodate engines and motors up to 1 hp (750 W).
- Budget - $300

There have been many, many attempts to develop such a system in the past. Googling micro (or model or tiny) dynamometers will lead you to some of them. Searching for "prony brake" will show you a common technique of measuring torque. The smallest commercial engine dynamometers are for go-karts, far bigger and more expensive than the target here. I have a basic idea of a system that I haven't seen before but might work (depending on the speed and accuracy of the rpm measurements), so if you are interested in the project and can't find inspiration, I might be able to help.

NOTE: Confidentiality and assignment agreements are required before students can begin work on this project. This project will be part of a series of projects submitted by OU to the State of Michigan to encourage entrepreneurial activity in MI college graduates, so if you wish to go into business for yourself, this may be the project for you.

Challenge Project: Table-to-Floor-to-Table Robot

Sponsors: Senior design instructors

Student design groups will design, build, test and compete with an autonomous robot that will

- Begin within a 24-in square of 1-in wide blue painter’s tape located in the middle of a lab table, then
- the entire device must move to the floor and locate a 6-ft square of 1-in wide blue painter’s tape near the table, then
- the entire device must trace around the 6-ft tape square (line following) without hitting the cones placed near the corners, and
- the entire device must move back onto the lab table and within the tape square.

The budget for each design group will be limited to $300.

All groups choosing this project will compete against each other during the Expo on April 17, 2024. Each group will have a maximum of three attempts at the challenge. The winning group will have the minimum score, which will consist of the time to compete the challenge (in seconds) multiplied by the cost of the device.