SECS Senior Design
Available Projects – Fall 2024

Header Pin Retention Simulator

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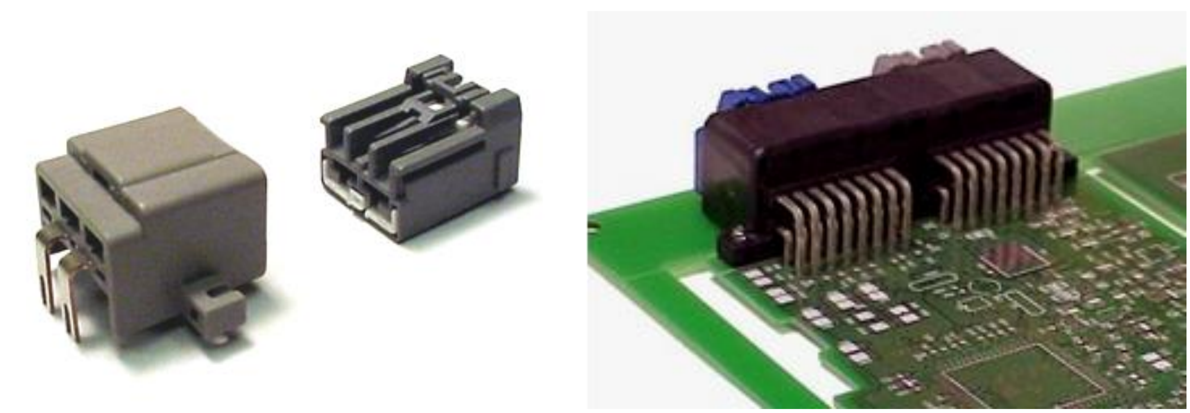
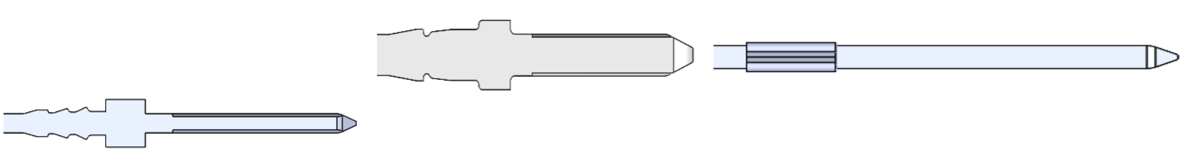
PROJECT SUMMARY

Headers are one of the main types of low voltage connectors utilized in wire harness design. A header is a component that is connected directly to a circuit board, transmitting power through terminals stitched into the plastic. While a standard connector cavity design uses lock arms to secure the terminals in place, a header terminal's main source of retention is a result of interference between plastic and metal. A few common geometries for these retention features are tree shape, bandolier, and barbed. These designs have performed well enough for us in the past; however, it can be hard to understand how they will function when implemented in a new material.

Currently, Yazaki does not have a calculated approach for determining retention force without trial and error on physical parts. The goal of this project would be to simulate header pin retention force using FEA, trialing various materials and retention feature geometries.



Header and mating connector (left); Header soldered to PCB (right)



Three main retention features: Tree shape (left), barbed (middle), and bandolier (right)

SCOPE

Yazaki will provide a variety of headers and terminal types to test. We will also provide CAD models for FEA. We would like to propose two test groups: one where the connector material is the same and retention feature geometry changes and one where the retention feature geometry is the same and the material changes. The scope is flexible and can be homed in on one or two terminals/headers or could be expanded to include a larger variety.

DELIVERABLES

Can header pin retention force be predicted through a calculator or FEA? Can the model be used to verify current test values we have seen? The final deliverable would be a tool that can help us answer these questions without the need to test physical parts. This would save Yazaki money on tool repairs and testing, as the design can be adjusted before the part goes to production. It would help reduce quality concerns and it would give us more confidence in our designs.

Key Deliverables:

1. Header pin retention simulation tool (limitation: ANSYS or Solidworks so it's usable for Yazaki)
2. Weekly check in meetings to review what went well, what went poorly, and any roadblocks (students should set up and lead these meetings, encourage them to ask for help)
3. Test report for any testing done
4. Mid-term design review to outline project progress (for each semester)
5. Presentation of process and findings (present at end of each semester, this should be a continuation of mid-term presentation, final presentation in front of Yazaki stakeholders)

Timeline (Possibly two Semesters, more likely two separate groups in one semester)

Semester 1

- 0.5 Months: Project intro, training sessions, Yazaki tour, create project timeline, DFM
- 2 Months: Test various combinations of terminals and plastic, collect data
- 1 Month: Organize and analyze data in a test report or presentation

Semester 2

- 2 Months: Create tool that can predict header pin retention
- 0.5 Months: Test a new header pin and plastic combination to validate simulation tool
- 1 Month: Create final presentation with results

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

Vision Based Selective Spray System for Weed Control

Sponsors: Paul Fleck (pfleck@dataspeedinc.com), Micho Radovnikovich (mradovnikovich@dataspeedinc.com), Dataspeed

Market Need: The pragmatic deployment of Artificial Intelligence within vision-based systems has enabled the ability to apply herbicides selectively. Current spray systems used within agriculture use non-discriminate methods to apply herbicides, resulting in additional costs and overuse of the herbicides. A selective spray system, where the herbicide is applied only to the nuisance plant is a superior solution.

The Project: Build a selective spray system comprising camera(s), computers, AI/traditional vision-based processing, directional spray nozzles, variable flow control and user control system that applies herbicide only on the nuisance plant

The Test Setup: A green outdoor carpet 5' wide by 20' long will have two artificial plant types randomly located within the 100 sq. feet. One artificial plant will be the nuisance plant, a dandelion bush. The second non-nuisance plant will be an artificial yellow geranium bush. Three of each plant will be randomly placed within the test area and only the dandelion bush should be sprayed. A visible, non-toxic water-based dye will be used to validate the effectiveness of the sprayer.

Deliverables:

- Trade study on current state-of-the-art selective spray systems, this information can be found on the internet
  - https://www.agweb.com/news/business/technology/big-ideas-ag-technology-where-selective-spraying-going
  - Trade study to include information on the different systems being developed today, tabulated attributes for each solution including cost, technology, capability, performance gaps, etc (students to also think up their own attributes
- Paper design of proposed prototype system
  - Technology approach overview
  - Block diagrams of system
  - Bill of materials
  - Other
- Design review slide deck
  - Before building the proposed system, the design will be critiqued by Dataspeed engineers who will offer up recommendations
- Fabricated prototype system
  - Physical prototype of spray system
- Test report
  - Quantifiable test report on the system.

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

Satellite Antenna Rotator

Sponsors: Jia Li (li4@oakland.edu), Simo Meskouri (meskouri@oakland.edu) Oakland University

Objective: Design and build a UHF/VHU satellite antenna rotator to track a selected OSCAR (Orbital Satellite Carrying Amateur Radio) satellite in real time as it moves through the sky for the purpose of radio communications. The rotator will then keep the provided antennas pointed at the satellite until the user terminate the process or the satellite is out of range. The cost of this rotator shall not exceed $400

Tasks and System Requirements:

- Background research to learn about satellite tracking and UHV/VHF antenna mounting
- This system must hold two separate yagi pole-mount antennas (see antenna section for details)
- Full 0-360° Azimuth and 0-180° Elevation sweep
- Accuracy of +/-1 $^{\circ}$ and a backlash not to exceed 1° for both the Azimuth and Elevation
- Must withstand winds of up to 30 mph (will not be tested, but calculations are required)
- Interface with open-source satellite tracking software such as GPredict* over wifi/ethernet or serial port
- Manual control and e-stop circuits are required for testing
- Weight not to exceed 5kg, not including tripod or supporting structure

Deliverables:

- 3D CAD in step and native file formats
- Detailed wind load calculations or simulations
- FEA analysis on high stress components
- Fully functional rotator (mechanical and electrical)
- Electrical schematics and wiring diagrams
- Software flow chart and source code
- User manual and all other supporting documents
- Bill of materials with part numbers

Testing:
Antennas and Radios will be provided for the end of semester testing. A licensed ham operator will attempt to make contact with other radio stations through a selected OSCAR satellite. Students interested in obtaining an amateur radio technician license can contact prof. Jia Li and/or Simo Meskouri.

Antenna dimensions and weights:

	UHF antenna: Frame: 120cmx2.5cmx2.5cm tubing Elements: 38cm, 33cm, 29cm, 23cm, 20,cm, 17cm, 14cm, 11cm (assume equally spaced) Weight:0.5kg		VHF antenna: Frame: 120cmx2.5cmx2.5cm tubing Elements: 102cm, 95cm, 86cm, 85cm, 84cm (assume equally spaced) Weight: 1kg

* GPredict: is a linux satellite tracking application with output data for an antenna rotator. Examples using GPredict: https://www.youtube.com/watch?v=GlFTBP1gEqs and https://www.youtube.com/watch?v=85hPepZsXRM.

Please look at what others have done to learn and improve but not to copy!
https://www.la3t.no/automatic-satellite-tracker/

Control System Design for an Electrified Mobile Construction Machine

Sponsors: Yongsoon Yoon, PhD (yongsoonyoon@oakland.edu) and Weichen Chen (weichenchen@oakland.edu), Oakland University

Introduction
Over the past decade, there has been an increasing demand for sustainable technologies in mobile construction machines, such as excavators, folklifts and wheel loaders, to reduce green-house gas emissions and improve system level energy efficiency. In response to this need, a novel electrified excavator and its control mechanism have been proposed by the adviser and his research group. While significant progress has been made through numerical studies, the team is focused on developing a lab-scale test rig to experimentally demonstrate advanced controls and fault diagnostics in the near future.

Objective
The proposed electrified excavator is composed of various subsystems, including electric parts (e.g., a DC motor and power supply), hydraulic parts (e.g., gear pumps and motor, hydraulic cylinders, accumulator, reservoir tank and various flow control valves), mechanical parts (e.g., bucket; arm; boom; gearbox; bearings). Additionally, an embedded control system (Arduino Due with a PWM driver) is integrated to manage the closed-loop operation. The project objective is to build a real-time operational test rig capable of closedloop control.

Planned Activities
In this project, the mechanical parts, to be specific, the bucket, arm, and boom will be designed based on a comprehensive analysis of a typical work cycle and mechanical constraints. These parts will be machined and integrated with the hydraulic actuators, such as the gear motor and hydraulic cylinders. In addition, the embedded control system will be built using an Arduino Due and PWM driver. Simple PID controllers will be designed and implemented into the Arduino Due using MATLAB/Simulink to ensure closed-loop operation. Most of the required parts, supplies, and tools are available in the adviser's lab at the RIC. Necessary sensors and transducers measuring pressure, linear displacement, angular speed will be acquired soon.

Planned Deliverables
The planned deliverables to assess the project are as follows:

1) Final CAD design of the bucket, arm, and boom.
2) Closed-loop control and MATLAB source code.
3) Real-time demonstration of the system using a prescribed work cycle.

Continued Design of a Sensor Testing and Demonstration Device

Sponsor: Brian Dean, PhD, ECE (bkdean@oakland.edu)

The project involves the continuation of a Summer 2024 senior design project focused on developing a Sensor Testing Platform.

The goal of the project is to develop a platform that provides pressure, temperature, and air flow outputs that can be instrumented and tested by students in a graduate level ECE course.

The summer design group developed separate pressure, temperature, and flow platforms, but the project wasn't fully completed. Students working on this project will be tasked with evaluating the existing designs and finish developing the: mechanical housings/platform, centralized power system, and primary computer interface/control.