SECS Senior Design
Available Projects – Fall 2021

Razor Scooter: Comprehensive Alerting Technology for Scooters (CATS)

Project sponsor: GEKOT Inc. in partnership with Razor USA, Dan Champoux
dchampoux14@gmail.com

“Micro-mobility” means using small vehicles like bicycles, Segways, and electric scooters (e-scooters) to move short distances. Micro-mobility is environmentally friendly, reduces car traffic, and reduces our use of oil. For example, rentable e-scooters are often found in many large city centers and on college campuses for use as “transportation on demand”; customers use a smartphone app to rent available e-scooters for quick trips as needed.

Unfortunately, many accidents and injuries are occurring with the arrival of rented e-scooters. The very real safety concerns cause many people to fear e-scooters and some cities to ban their use. We feel that by addressing the problem of accidents related to electric scooter use we can reduce the major concern that discourages people from using e-scooters.

In this project, students will integrate tech features designed to improve the e-scooter experience. The specific improvements will address vehicle safety, parking, and abuse.

Requirements

- Utilize low-cost, COTS sensor components such as: linear LiDAR, Ultrasonic, accelerometer, and color sensors
- Integrate solution into a Razor electric scooter (share model)
- Coordinate IOT/GPS app features with Razor
- Develop solutions for component housing and mounting
- Several of the desired features are in the “concept only” phase. These will require innovative thinking and extensive experimentation.
- Materials for one prototype systems should cost under $150

Resources

- Several Razor USA scooters are provided
- Arduino IDE based software provided
- All sensors and electronic components provided
- Your liaison, Dan Champoux, developed the initial prototypes and is a system expert
- Razor USA will provide consultation and support from senior company staff

Deliverables

- By the end of the semester, deliver two e-scooters fitted with a fully functional CATS system suitable for customer demonstration; develop and execute a validation plan for the CATS system

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Razor Scooter: Development of Next-Generation Controller for Shared Electric Scooters

Project sponsor: GEKOT Inc. in partnership with Razor USA, Dan Champoux
dchampoux14@gmail.com

Currently, Razor purchases a “black box” COTS controller for their rental electric scooters. The controller is not customizable which limits the ability to add new features. In this project, students will design, develop, and implement an electronic control module to manage all scooter functions. Student(s) might reverse engineer the provided controller for a design starter. Students might consider using a COTS open-source controller for a design starter.

Control all primary vehicle functions as follows:

- Power on/off, throttle input
- Hand brake input
- Motor control (350W, 3-phase, in-hub electric motor)
    - Launch control
    - Vehicle speed determination, vehicle speed limiter
    - Thermal management
- Battery power management (36V, lithium-ion), battery charging
- Headlight on/off
- Brake indication lamp

Control all IoT/GPS requests

- Power enable/disable
- In-service mode
- Speed limiting
- Audio sound bytes
- Speed output signal
- CATS functions

Integrate solution into a Razor electric scooter (share model)
Coordinate IOT/GPS app features with Razor
Component housing and mounting

Special resources

- Several Razor scooters are provided as well as a bench setup (controller, motor...)
- Your liaison, Dan Champoux, is a system expert
- Razor USA will provide consultation and support from senior company staff
- Razor USA will provide requirements and drawings for the current controller in Chinese

Deliverables - By the end of the semester, deliver one bench setup of a functional scooter control system

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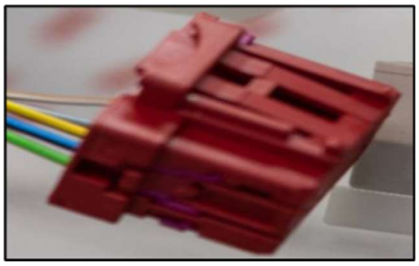
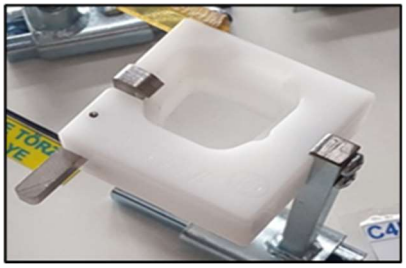
Development of a CAD-Based Connector Fixture - Lear Corporation

Project contact: Neil Martunizzi (NMartinuzzi@lear.com)

The “nervous system” of a modern automobile is the system of power and data wiring harnesses that link the various components of the vehicle. A wiring harness is a wrapped bundle of wires that contains two or more wiring connectors that interface with the various components of the vehicle. The design, layout and assembly of wire harnesses is complex, and suppliers are continuously looking for ways to streamline the process and improve the reliability of the wiring system.



Wire harness connector



Connector Fixture

Currently, wire harnesses are assembled on an 3D *assembly board* that provides receptacles to locate the component connectors in space, allows the assembler to insert wires into the connectors and route them along defined paths, and provides enough room to wrap the wire bundles to finish the wire harness. Designing and manufacturing a complement of 20 assembly boards, with roughly 120 connector fixtures per board, takes about 7 weeks. Much of this time is used designing and machining the connector fixtures.

Lear is seeking to reduce this time by leveraging existing CAD data for 20,000 standard automotive connectors to automatically generate and 3D print connector fixtures. These fixtures must allow for 3D positioning on the assembly board (via the stanchions seen on the right side of the figure above), for the connector to easily slide in/out and secure it during assembly and wrapping (for example, with the metal clip on the left side of the image above), and to give visual reference to the assembler where to begin and stop wrapping the wires. This will be a CAD-based project, using the parametric features of Catia.

In the Summer 2021, a team of students worked with Lear engineers in Michigan, Europe and the Philippines to develop a Catia-based tool that input a connector STEP file, identified the relevant planes of the connector, extruded the body of a connector slot and located the bosses and fixing holes for the locking tab and board mounts. In Fall 2021 this tool will be extended to

complete rest of the steps to produce a 3D-printable connector slot, given a connector STEP file.

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Ford Motor Company - Air Nozzle Study

Project contacts: James Engle jengle8@ford.com, Chip Conrad conrad@ford.com

The current procedure for separating stamping blanks utilizes Silvent air nozzles to separate blanks during the destacking process. This project seeks a non-commercial design that can be manufactured using additive manufacturing. The result must meet or exceed the specifications of the current nozzle.

Silvent nozzles (https://www.silvent.com/products/air-nozzles/705-l/) are a purchased component within the stamping plants. Design a replacement air delivery system that can replicate or exceed the performance of the current nozzles. Replacement component must be able to be manufactured via additive manufacturing and function within or under the current air usage of 140 psi. A side-by-side bench comparison should be included to provide validation of the final product.

Benefits of this project would be a reduced cost of this product, potential reduction of air usage, ability to manufacture in house through additive manufacturing, and potential patent of this technology.

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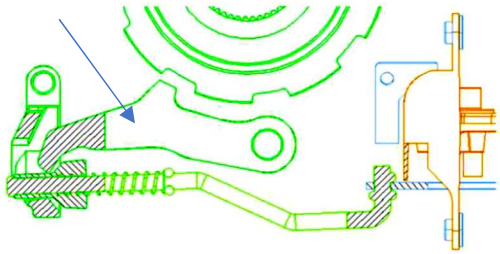
Borg-Warner - Development of Parking Pawl Sensing Method

Project contact: Chris Chirco cchirco@borgwarner.com

As the automotive industry trends towards electrification, new scrutiny is being place on both new as well as legacy technologies. Functional safety standards regulated through such entities as ISO (International Organization for Standardization) and classified through ASIL (Automotive Safety Integrity Level) are driving new design challenges daily. One resultant design challenge involves your vehicles parking system. Often overlooked and underappreciated, the transmission park system is one which must do its job all the time, every time.

The challenge proposed is to determine a viable, accurate and robust means of detecting parking pawl (see figure below) position. While it was once acceptable to infer pawl position via another component in the energy transfer path (often decouple by a spring), OE's are mandating absolute position confirmation of the engaging member itself (the parking pawl).

Continuous output is not required, i.e., positional feedback of full engagement v. disengagement is acceptable



The proposed sensing method must operate in a typical powertrain environment. This includes:

- Temperature ranges of -40 to 150 deg C
- Compatible with ATF/Gear Lubricants
- Robust against driveline vibrations/impulses

The expected outputs of this project include but are not limited to:

- Establishment and execution of a project timing plan
- Establishment and execution of sensor/system test plan (ADVP&R - Analysis/Development Validation Plan and Report)
- Establishment and adherence to a project budget
- Commercial cost assessment of proposed sensing technology
- Renderings of proposed sensor integration using a 3D CAD software
- Justification of proposed sensing technology selection along with creation of DFMEA (Design
- Failure Mode and Effect Analysis) document(s)
- Development and documentation of required electrical interfaces (schematics)
- Gathering and processing of physical test data
- Make a substantiated design recommendation from which BorgWarner can further develop its
- preferred park system sensing method

If requested BorgWarner will loan its park system spin stand to Oakland University for student use.

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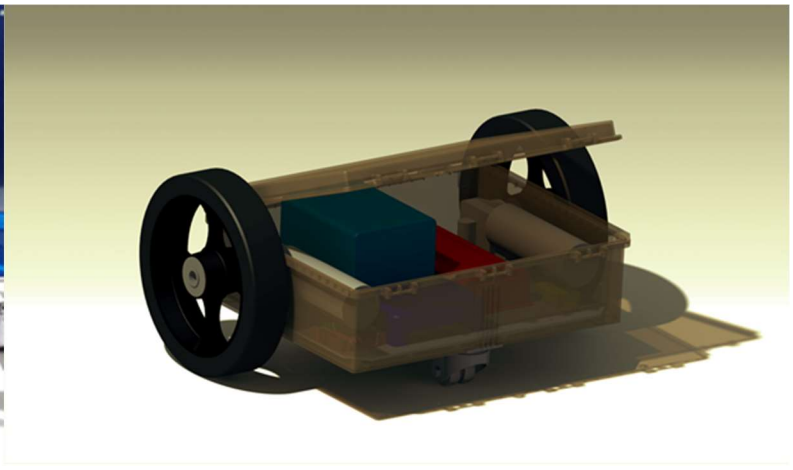
Afreecar E-Kit – Solar Cart and E-Kit Prototype

Project sponsors: Christopher Borroni-Bird (chris@afreecar.org), Richard Saad (rich@afreecar.org) https://afreecar.org/pages/inspiration

Afreecar seeks to achieve its mission to provide sustainable power and mobility for all the world's people by providing a universal E-Kit that can retrofit to an existing non-motorized vehicle (e.g. wheelchair, tricycle, wheelbarrow, hospital bed, linen cart, etc.), providing power

assist and enabling the vehicle to become a mobile power source. Afreecar has sponsored several recent projects with OU SECS that led to both improvements in a solar electric cart (left image below) and to a design for the universal E-Kit (right image below).



The FAll 2021 project can build off both these accomplishments in the following ways:

- During the Winter and Summer 2021 semesters, senior design groups developed and prototyped a universal E-Kit. Unfortunately, the prototype still has issues with the communication between the motor controller and the motion control that could not be resolved before the end of the semester. These issues must be assessed and resolved in order to bring the E-Kit prototype to complete functionality.

- A solar-powered E-Cart has been prototyped for use in urban farm environments for range, performance, load carrying capability, user interface, etc., and to assess its utility for its intended rural Sub-Saharan Africa operation. In the Winter and Summer 2021 semesters several mechanical and electrical issues were identified and resolved. Unfortunately, it continues to have recurring issues with its programmable motor controllers which prevents full functionality. The motor controllers need to be assessed, and replaced if necessary, in order to bring the solar-powered E-Cart to full functionality.

- The solar-powered E-Cart, once brought to full functionality, will be put through a set of rigorous tests to determine load capacity, hill-climbing ability, braking (especially when going downhill), user-friendliness, etc. These tests are vital to assessing the viability of the E-Kit concept under practical scenarios.

- If time permits, explore ways that the working E-Kit can replace the propulsion system of the working E-Cart without loss of functionality or performance.

- In Summer 2021 a student group retrofitted a commercial electric wheelbarrow (PAW Power Assist Wheelbarrow) into a solar E-Cart with the addition of the existing solar

panels of the E-Cart and the E-Kit replacing the commercial electric propulsion system. The result is intended to be lighter/smaller and have significant capacity while steering, braking and propelling properly. This development still needs to be tested and verified.

- If sufficient numbers of students are interested – another Afreecar project would be to develop a scale model (quarter to third scale) of the E-Kit, various carts and attachment systems that could be 3D printed and allow verification of kinematics for proper steering and load balancing in multiple applications.

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OU Immersive VR Experience

Project contact: Khalid Mirza, PhD (mirza@oakland.edu)

Several years ago, a group of faculty and students from across campus (Art/Art History, SECS, others), supported by industry partners have committed to design and build a two-seat mechanical motion-controlled platform that will interface with visual triggers supplied by an interactive movie, creating a VR immersive experience. Nabtesco Motion Control is funding the project along with support from Rave Computers, Epic Games, Autoliv and Roush Entertainment.

This platform is to be a portable, flexible test bed for VR experiences. During the Fall 2018 and Winter 2019 semesters, teams of ECE and ME seniors designed the actuator base using input from Nabtesco and Roush engineers. As a proof of concept, they produced two small-scale models and implemented rudimentary control system based on the Robotic Operation System (ROS). With the recent establishment of the Augmented Reality Center, construction of the full-scale platform can begin.

Construction of an Actuator Base for the OU Immersive VR Experience

In the Fall 2021 semester, teams of ME and ECE students, consulting with industry partners, will thoroughly review the present design, make changes where necessary, and construct and test the resulting motion-controlled system.

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