Senior Design Projects, Winter 2020

Afreecar

In many parts of the developing world, such as sub-Saharan Africa, people lack access to electricity and mobility. Purchasing a vehicle is too expensive for most people and building one from scratch is often not practical.

The Afreecar concept is a common solar-powered electric system (or e-Kit) that can be made at large scale to achieve low cost and high quality. This e-Kit can be relatively affordable but will need to easily integrate into a wide variety of commonly found low speed vehicle types (e.g. wheelbarrow, rickshaw, pedicab, golf cart).

In summary, the e-Kit can enable easy retrofit of existing vehicles (whether human-, gasoline- or electric- powered) or be integrated into clean-sheet vehicles which can be made or found locally. The goal of the Senior Design project is to develop an intuitive and logical solution that allows an e-Kit propulsion system to be integrated into a wide variety of vehicles and validates the electrical, mechanical and software configuration of finished vehicle to meet the intended needs of the vehicle assembler.

Senior Design Project Deliverables

1. Prototype e-Kit Configuration Checker (Software 2) and e-Kit Performance Estimator (Software 3) on Android smartphones with limited UI and workflow automation and simulated wireless connection to the server as USB wired connection.
2. Prototype e-Kit Server on PC with MATLAB/Simulink

Tasks for Senior Design team

1. Develop an image recognition part of Software 2 (QR code and mechanical alignment recognition).
2. Develop configuration matching algorithm of Software 2.
3. Develop an I/O part of Software 2.
4. Integrate Software 2.
5. Develop an acceleration measurement part of Software 3.
6. Develop a parameterized generic EV model with MATLAB/Simulink for performance estimation.
7. Develop friction/mass calculation algorithm of Software 3.
8. Develop and I/O part of Software 3.
9. Integrate Software 3.
10. Develop Lego-like demo e-Kit for demonstration

Non-disclosure and assignment agreements are required before students can commence work on this project.

Keep-On

Keep-On is a small wearable safety device that can be worn as a jewelry/pendent/accessory and can be attached to necklace, bracelet, belt loop, or other clothing aspects. When you pull it apart, it activates the battery to communicate via Bluetooth to your phone to send a text message or call to a predefined contact list.

Keep-On currently has an initial prototype that is a triangle shape and plastic exterior. Further work is needed to research, design, and test additional Keep-Ons that may differ in shape, size, color, and materials. Keep-On would like to test possibly making it a smaller enclosure that can fit the battery and chip inside of the device, and test how consumers would pull the device to trigger the alarm via Bluetooth to the phone. Keep-On would like to explore water resistant / waterproof enclosure as well.

Non-disclosure and assignment agreements are required before students can commence work on this project.

No Respect Wakeboards

(morning section only)

No Respect Wakeboards are made with a core of either foam or wood and then layered with fiberglass, innegra, or carbon using an epoxy resin. The challenge is to create the lightest wakeboard possible without sacrificing strength. The search for the perfect combination of material properties and geometry is a constant, ongoing challenge.

This project will research and establish performance metrics for wakeboards and explore through CAD simulation different shapes and layup schedules in order to design an optimally light and durable wakeboard. Depending on time and progress through the semester, prototypes may be produced and tested.

Scallop Blank Positioning – Ford Motor Company

Scallop blanks have a sine wave configuration that do not have square edges making it difficult for vision systems to find a corner to identify blank edge location for robot pickup and place into a draw die station.

Scallop blanks offer significant metal savings over straight cut blanks (~$100K per part), however locating the blanks accurately has and continues to provide difficulty. The result of a mis-located blank is damage to a draw die and cause for significant downtime and repairs to the die and possibly the press. The stamping industry has struggled to implement the sine wave scallop blank and often has to forgo the cost savings to allow the lines to run at high rates and not damage equipment in the process.

Material savings (~$100K) per part that can implement scallop blanks. Each year Ford has a task to achieve $4-5M in material utilization and one of the largest opportunities is to reliably run scallop blanks. Scallop blanks have a sine wave on the edge rather than a straight cut and thus produce a blank with no straight edge for a vision system to locate, at least not to this point. The scope of this project would be to see if a vision system could be developed to accurately identify blank position to allow a robot to pick and place the blank in the draw die without mis-loads and damaging the equipment used to form the part.

Non-disclosure and assignment agreements are required before students can commence work on this project.

Autoliv – Steering Wheel Capacitive Sensor

(morning section only)

Highly automated driving will become mainstream in the automotive industry. One of the big challenges is the control handover between vehicle and human. It is critical for the vehicle to know if the human is holding the steering wheel or not.

Many OEMs rely on a steering rack torque sensor to determine when the driver is holding the steering wheel. However, torque systems are capable to be "tricked" by hanging bottles of water on the steering wheel and thus do not provide enough statistical reliability. Therefore, Autoliv has integrated a capacitive hand sensing system into production steering wheels to compliment the vehicle torque sensing system to achieve the necessary reliability.

For this senior design project, Autoliv will provide current production steering wheels with a capacitive sensor mat installed as well as capacitive sensor mats by themselves for technical investigation. The objective would be for the students to create a proof-of-concept ECU (Electronic Control Unit, can be mocked up using bread boards and a software like Labview) design that can distinguish a human touch of two fingers or more, and take additional data to demonstrate the effect of one hand, two hands, etc.

The students would start by researching and determining findings on the basic capacitive principles of the system, design an ECU with an integrated detection method according to the principles, and take data to demonstrate the performance of their design.

Non-disclosure and assignment agreements are required before students can commence work on this project.

Pneumatic Air Cannon and Ballistic Pendulum

(afternoon section only)

The primary objective is to analyze, design, build and verify the exit speeds of a pneumatic (120 psi maximum) cannon capable of firing ball bearings of various diameters ranging from 1/8 inches to 2 inches in diameter. The ball bearings are made of different homogenous materials and will vary in weight. The cannon can be designed in any manner and be constructed from any non-ferrous material provided it can produce repeatable exit speeds and meets the Primary Objective Design Specifications.

The secondary objective is to analyze, design, build and verify a ballistics pendulum to aid in the testing of the pneumatic air cannon. The pendulum can be made of any non-ferrous material but must be able to withstand large forces while maintaining a high degree of accuracy when measuring both large and small forces. The pendulum must be able to catch the projectile without deformation to the projectile so that it may be reused in the pneumatic cannon. Data from each impact is to be collected and stored through electronic means. The pendulum can be designed in any manner provided it meets the Secondary Objective Design Specifications.

Primary Objective Design Specifications:

1. Cannon will be made from a non-ferrous material and will accommodate round projectiles of varying size and weight, to be specified.
2. Cannon will produce predictable and repeatable exit speeds of the projectile.
3. Cannon will be mounted on a platform that allows for firing at various angles, including straight down.

Secondary Objective Design Specifications:

1. Pendulum will be made from a non-ferrous material
2. Pendulum will be able to trap and recover the projectile, without causing deformation to the projectile.
3. Pendulum will be able to withstand large forces associated with the high-speed collision of projectiles.
4. Pendulum will have electronic components that measure impact and store the data.

Dice Tester

The project would involve a machine rolling dice and recording the dice rolls. To see the dice, there will need to be cameras able to view the dice and recognize which rolls correspond to which number. The robot will need to be able to understand and read the rolls regardless of the angle that the dice land when rolled. The individual dice must also be recognized and able to be differentiated from the other dice in the vision area. These rolls will be recorded in a database before going on to the next roll.

The machine would also need a way to physically roll and collect the dice. A cup will be designed to hold the dice being rolled, and an arm will be designed to hold the cup and roll it. A method of fair rolling will need to be designed as well. There must be a second arm or some other mechanism in order to collect the dice back into the cup for re-rolling.

Additionally, there should be walls so that the dice stay only in a designated spot for the camera to read them. Additionally, several dice would be 3D printed for the project, with custom designs. This will allow the machine to recognize unique symbols and correlate them to different numbers. The ultimate goal is to make a robot capable of testing any dice for fairness by rolling them several times repeatedly.

Experimental Electroplating Setup and Material Characterization

In this project, students will design a semi-automatic electroplating apparatus for reel-to-reel application in laboratory environment. The setup include a plating bath and mechanism for handling and position control of electrical connector reel to be plated. No electroplating chemical is involved in the project.

To characterize the plated metal layers, microanalysis tools, including scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS) will be used. Grain size, crystal structures of the intermetallic compound (IMC) between the plated layers will be studied.

The project will help student in understanding some electrical components necessary for electrical vehicles. Involved students may have opportunity for internship and job position.

Challenge project – Electronic Push-Button Padlock

Electronic padlocks exist that are fingerprint or Bluetooth operated, and both are fairly expensive ($60 and up). There is a need for a small padlock (gym locker, common Master combo lock, size) that has a small keypad (like an old flip phone, or smaller) to input the combination.

Specifications:

- Should draw power only when locking or unlocking, that is, no power consumption idle.
- User should be able to change lock combination whenever the lock is open, perhaps with a password.
- If the electronics lose power, are damaged or even completely torn off, the mechanical portion should remain physically locked until it is cut open.
- If the lock is able to be mass-produced in lots of 5000 for $2 or less, it is a viable product in the marketplace.
- Budget of $200/group to design, 3D print and demonstrate a prototype.