Senior Design Projects, Summer 2018

Lear – Capture and Storage of EM Energy from Wire Shielding

Non-stable vehicle electromagnetic fields can potentially become energy producing source. These electromagnetic sources can be electrical/electronic circuits, lighting, RF transmitter, high speed data, electric motor, video displays, engine coils, high frequency PWM electronics etc.

In the past two semesters, SECS senior design groups have attempted to identify sources of EM energy in automobiles and to capture and store some of that energy. Their work has shown:

- An extremely small amount of energy could be harnessed but due to the electromagnetic shielding within automotive systems, the energy that was harnessed was far too small to offer any sort of advantage.
- The most available sources of EM energy are in communication signals such as the ISM band of frequencies but are not suitable for power capture due to the low power they possess and and the potential for interfering with sensitive information.
- The power acquired from the capture has not yet been able to power any sensor continuously nor efficiently.
- There are only minor differences between conventional and fully-electric vehicles in terms of EM energy available for capture.

This phase of the project will focus on an attempt to capture and store the EM energy within the circuit wire shielding itself. Since drain wires and aluminum wire shielding efficiently block and dissipate excess EM energy from interfering with other circuits, it may be possible to capture and store a portion of this excess, wasted energy.

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

Lear – Over-Molding Wire Harnesses with Polyurethane Foam (PUF)

The wire coverings approach in the automotive wire harness industry has not evolved past the traditional approach of tape, convolute, protective sleeves or troughs. However, the scope of the harness product has greatly grown in scale and complexity, creating ongoing challenges in product design and performance.

Lear patented the usage of polyurethane foam (PUF) as a wire harness covering back in the 1990's. The concept was to find a single covering that could replace the multiple options used throughout the entire electrical system. For many reasons the concept did not take off as expected.

With the success seen in the last two semesters of molding liquid silicone rubber (LSR) and other room-temperature polymers such as epoxy and urethane in 3D-printed molds, Lear has asked to explore over-molding wire assemblies with the following goals:

- Quick curing product: over molding with traditional tooling designs could take 10 mins or more for curing within the mold, this adds time and tooling infrastructure to our existing process which killed the original business case

- Ease of molding process: the mixing process today for PUR has the same limitation on infrastructure increases as well as tool maintenance that would add to our processing cost. Also, the nature of PUR is continuous expansion until it's controlled, material cannot enter the back of our connectors or it will cause harness malfunction.

- Covering performance: today we have many mixtures of tapes, sleeves and troughs to provide directional routing, noise suppression and abrasion resistance. Finding a 1-stop option to cover all these variables is the ultimate goal

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Development of a Novel Medical Pill Cutter/Crusher

The pill cutter is used to both cut and crush prescription medications. It is used by both medical professionals and individual patients. It consists of three parts:

- Section 1 is a plunger used to cut pills. When the center piece is pressed down it forces a sharp, recessed blade into the pill that is resting in Section 2. The blade is recessed to prevent it from being accidently exposed.

- Section 2 holds the pill in place when cutting (top) or crushing (bottom). The inside surfaces are rubberized, and it has two spring-loaded arms that slide to position the pill. The bottom surface is hard and smooth for crushing pills.

- Section 3 is used with Section 2 to crush pills. The bottom of Sections 2 and 3 have inverse radii to allow the controlled handling of the resultant pill powder.

All three sections must be of sufficient size and tactile feel to allow people with limited manual dexterity to separate the sections and either cut or crush pills with a minimum of force or movement.

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Prototype of a No-Bend Shoe for Persons with Disabilities

No Bend Shoes by Jay Shah (Leelayan, Inc., patent pending)

People with disabilities who cannot bend or feel their feet have difficulties inserting their foot in to a shoe. Others when wearing a loafer style shoes, must bend down to either use shoe horn or a finger to get it right. Some (often young boys) would try and wiggle their foot in. Over time, this breaks down the shoe backing around the ankle and destroys the shoes. People wearing boots have often difficulties in inserting their feet as well.

The No Bend shoe allows foot to get in to the shoe with ease. The shoe, especially the back which protects the ankle, stays in good working condition for a long time. This is made possible by allowing the heel of the shoe to flex in two different ways.

1. Shoe heel portion and the sole remains integral however it flexes and pivots up to 10 degrees around a ½” hinge button in the sole. This mechanism allows heel portion to pivot, allowing the foot to slide inside the shoe. Once the foot is in the shoe, the wearer stands straight or gently thumps his foot enabling the heel to rotate and attach on the foot ankle. The wearer could then press a hinge button to lock it in.

2. Shoe heel portion moves horizontally about ½” allowing wearer to insert the foot in the shoe. In this case, the sole moves separately with the heel portion. Two self-locking mechanisms are provided on either side. Once the foot is in the shoe, the wearer thumps on the shoe heel making the heel portion move and lock in to place. A mechanism can be unlocked allowing removal.

The tasks for this design project are as follows:

- Pivot Mechanism
    - Create a prototype using 3D printing with various spring strengths to close and lock heel
    - Design a remote to unlock the spring to open the heel, either electronic remote or magnetic mat
- Horizontal Heel Mechanism - Create a prototype using 3D printing with various spring strength to close & lock heel

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Non-continuous Electrical Generation from Water Waves or Wind

There is a great need for low-cost, efficient sources of electrical power in remote or disaster areas. Over the last several semesters, SECS senior design groups have modeled and prototyped systems to capture the motion of water waves, convert that motion into electricity and store it. The challenges with all such systems are great, and most of them stem from low-power, low-speed sources of mechanical energy such as water waves or wind. Continuously generating electricity from a low-speed sources (water waves are typically 6-12 cycles/min) requires large increases in speed to efficiently spin generators (typically 1000 rpm for efficient operation). This speed increase comes with a proportional decrease in torque, which in turn requires very large input torques, internal forces and massive components.

It has been suggested that instead of attempting to continuously produce electricity, it may be more advantageous to collect and store mechanical energy for a period of time, and generate electricity when enough mechanical energy has been accumulated to make that conversion efficient. For example, the motion of several water waves can be used to accelerate a flywheel. When that flywheel has accumulated a sufficient amount of kinetic energy, a relay is closed to an attached generator, which acts as a brake on the flywheel as it generates and stores electric power. Once the flywheel slows to the point where the generator is not efficiently producing power, the charging circuit is disconnected and the flywheel is again allowed to accumulate kinetic energy through the action of several waves.

This project will involve the modeling and prototyping of a non-continuous water-wave electric generating system. The mechanical portion of the prototype can be configured from a readily-available single-speed bicycle, all of the electrical components including sensors are readily available, and the control system is very straightforward.

Serapid - Efficiency of Rigid Chain Technology

SERAPID has been working with linear transfer equipment since 40 years. Advanced lift systems and linear actuators are defined by Serapid and designs with our rigid chain technology allows us to transfer loads from few kilograms to several tons.

The technology is based on the principle of a "rigid chain" that operates by deploying its links into an expanding bar under forward thrust. Each link has an extension, the so-called "shoulder", which is form-fitting and force-locking with the shoulders of its neighboring links. Inside the drive housing, links are aligned exactly one after another by driving them through a guiding channel between two steel plates. The interlocking of the links makes the chain rigid and prevents bending.

Even though the technology has been proven through many successful projects, the fundamental efficiency of the rigid chain has yet to be demonstrated. To this end, the following multi-semester senior design project is proposed:

1. Project overview
    - Learning about Serapid products and applications (industry and theater activity)
    - Learning of boundary conditions and constraints impacting product efficiency.
    - Product that will be use for the project: LinkLift 30 and Chainlift 40
2. Technical study
    - Detailed functional analysis and modeling
    - Definition of the efficiency calculation on the product defined
    - Implementation of the calculations based on the model defined (ex: analytical or FEM)
    - Definition of the test protocols and equipment to validate the calculation (ex: current clamp on motor / torque wrench)
3. Technical validation
    - Implementation of the test with measurements record
    - Analysis and validation of the efficiencies with correlation of the experimental data
4. Additional features
    - Define the impact of the lubrication on the efficiency
    - Define the impact of the speed

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Smart Home for Healthcare Monitoring

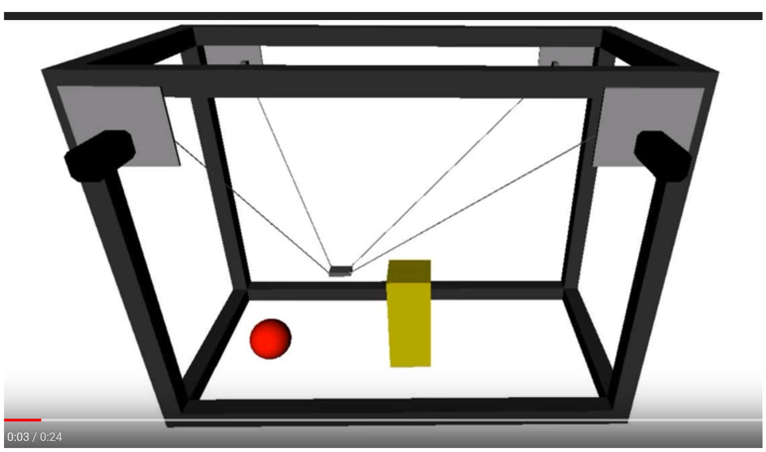
Delivery of in-home preventative care is challenging for healthcare professionals because of inaccurate self-reports, poor intervention adherence, and infrequent contact between patients and experts (due to long travel distances and a lack of healthcare workforce). This is disconcerting with a rapidly aging population because preventative care is especially important for maintaining the health of older adults to keep them living independently; improving quality of life (i.e. social, physical and mental); and reducing national healthcare costs. **This project aims to enhance the capabilities of healthcare professionals by developing a sensory system that focuses on enabling healthcare professionals to monitor older adult activities of daily living and key health indicators so that they can provide the personalized preventative care protocols.**

The undergraduate students participating in this project will focus on the research, design, implementation, and evaluation of a smart home-based sensory system for monitoring older adult health and activities of daily living. The system is expected to enable healthcare professionals to remotely monitor older adult health (e.g. heart rate, blood pressure, weight, sleeping patterns) and activities (cognitive, social, or physical) so that healthcare professionals can precisely track older adult long-term health and patterns of behavior. Such a system will assist healthcare professionals in making appropriate decisions for care.

Cable Driven Parallel Robot Demonstrator

Cable driven robots (called as cable-suspended robots and wire-driven robots as well) are a type of parallel manipulators in which flexible cables act as actuators. One end of each cable is reeled around a rotor twisted by a motor, and the other end is connected to the end-effector. One famous example of cable robots is SKYCAM, used to move a suspended camera in stadiums. Cables are much lighter than rigid linkages of a serial or parallel robot, and very long cables can be used without making the mechanism massive. As a result, the end-effector of a cable robot can achieve high accelerations and velocities and work in a very large workspace. (Source: https://en.wikipedia.org/wiki/Cable_robots)

There are many variations of cable robots. The simplest ones use 3 or 4 cables and provide 3 degrees of freedom (DOF). Eight cable robots have been developed to provide 6 degrees of freedom. Following is a representation of a 4 cable, 3 DOF robot).



(Source: https://www.youtube.com/watch?v=f_6GUW8ARss)

The dynamics and control of cable robots is quite challenging and has been the focus of many researches and technical publications. The main challenge stems from the fact that cable can only pull (not push) the effector of the robot. It required, therefore, that all cables are under tension at all times. To simplify the design, the controller should sense the tension in each cable and use it as direct feedback when controlling the motors/cable spools.

The applications for these robots are numerous and growing. These include 3D printing, industrial manipulation, 3D scanning, stadium camera control, etc. The goal of this project is to research, design, and implement a Cable Driven Robot that scaled to fit into an "EC 170 Display Cubby." The demonstrator robot should perform an interesting task that captures the attention of Engineering Center visitors and K-12 STEMP camp participants. Juggling a ball, as done by the B&R Automation's CableEndy (https://www.youtube.com/watch?v=7HNAL8ZKdyM), using the simplest possible 3 DOF robot would be ideal.

L&L - Robotic Auto-Packing

Observe and document L&L's current manufacturing processes to determine where the best opportunities lie to Auto-Pack. The benefits of Auto-Packing can include huge labor and ergonomic savings. The key L&L process areas to focus on are Injection Molding, Single Screw Extrusion & Twin Screw Extrusion. Parts & Packaging materials may be collected for development and experimentation.

1) Observe and videotape the current packing process for L&L's parts in the given areas
2) Analize the data to determine which parts are most viable
3) Perform appropriate robot reach studies to determine space requirements
3) Utilize OU's existing vision & robots equipment to develop solutions
4) Bring results back to L&L and demonstrate feasibility
5) Define steps that L&L can take to implement auto-packing and present the results

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L&L - High Accuracy Part Placement

Observe and videotape L&L's current process for placing metal fasteners in a mold.

These fasteners are made of Aluminum or Steel and can be 4 different designed shapes. They are typically fed via a Bowl or Vibratory Feeder. Up to 8 individual fasteners are robotically picked-up with vacuum and placed into a 'Mock-Mold' fixture. A second robot then grabs all 8 fasteners at once and places them all into an Injection Mold. If, for any reason the fasteners are not in the correct position, the mold can be damaged when closing on a misplaced fastener. Once the mold has been damaged, all future parts have 'flash' on them from material that migrates into the damaged mold areas.

Develop several different options for improving accuracy & repeatability. Recommend the best solution and showcase feasibility.

1) Observe and videotape the current process
2) Determine how to improve accuracy & repeatability
3) Outline several different solutions and their feasibility
4) Determine the optimal solution and present the results

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L&L - Cycle Time Improvement

Observe and videotape L&L's current injection molding cycle times. The target of this project is to remove all inefficiencies from our total cycle. By reducing cycle times, we can open up additional capacity on our lines and improve profitability.

The Injection Cycle is made up of 'Mold Open Time' in which the robot enters, inserts features and leaves the mold, and also 'Mold Closed Time' when the mold is being filled and plastic parts are being created. Each of these areas have opportunities for improvement.

Develop a complete list of improvement ideas and highlight the total amount of time saved. Every tenth of a second counts! Demonstrate capability by modifying a current program.

1) Observe and videotape various injection mold cycles
2) Breakdown the cycle into steps to identify opportunities
3) Estimate how much reduction can occur in each step and total
4) Create altered programs that reduce the cycle yet still make a good repeatable part
5) Present the results

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