RESEARCH

Hydraulic Haptics

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Hydraulic machinery has and will continue to play a large and critical role in agriculture, construction, forestry and other areas. These machines often have multiple tools, each with multiple degrees of freedom. Such complex machines demand that operators be extensively trained before being allowed to use one "in the field," and require even more experience before the operator qualifies as an expert.

The Center for Compact and Efficient Fluid Power (CCEFP) is a network of seven universities conducting focused research on advancing current fluid power technology. Current research thrusts at Georgia Tech focus on creating an augmented reality for the operator that uses haptics, sounds and other interfaces to improve operator efficiency on multi-functional hydraulic equipment. In the most recent work, a haptic joystick is used to control a variable displacement pump system that improves the machine's fuel efficiency. The test bed for this research is a small Bobcat excavator at Purdue University.

What is Haptics?

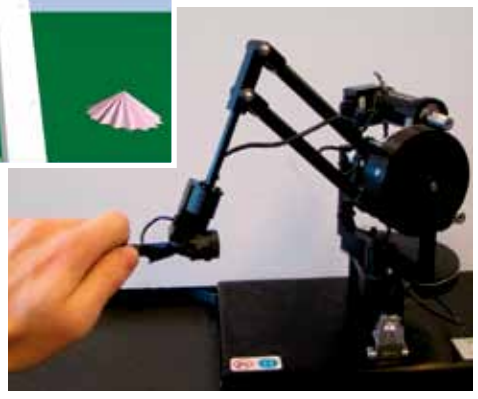
Haptics, from the Greek "Haphe," refers to the sense of touch. A haptic controller is a device that pushes, pulls, vibrates or otherwise engages the user's sense of touch. The controller being used in this research is a six-degree of freedom device that gives the user a three-dimensional force of up to 8 newtons (1.8 lbs). Haptic feedback, such as force reflection of the weight of dirt in the bucket or cues when the operator has reached the limit of joint travel of the excavator arm, have been shown by previous research at Georgia Tech and other institutions to improve operator efficiency.

A Throttle-Less Excavator

Current state-of-the-art equipment is outfitted with valves to regulate cylinder pressures. These valves function by dissipating energy in the form of heat. This energy could be saved by eliminating the valves and using a variable displacement pump to control cylinder pressures. Purdue researchers are currently outfitting the Bobcat excavator with four variable displacement pumps, one for the swing, boom, arm and bucket circuits. While the excavator is being re-outfitted, an excavator simulator has been created at Georgia Tech so that preliminary tests can be done to see how a new controller affects operator efficiency.

Goals

The goal of this project is to design and implement a haptic controller for a hydraulic excavator that controls the displacement of a block of variable displacement pumps. With haptic clues and other feedback, the operator should be able to complete the same task in less time, thereby saving on a host of other things such as fuel costs, equipment rental and maintenance, operator pay, etc. If the control scheme effectively manipulates the pump's displacement, the energy that would be lost in valve throttling could be saved, increasing the fuel efficiency of the excavator. This summer, the first tests on the redesigned excavator will be performed to measure the increase in operator and machine efficiency.



EDUCATION & OUTREACH

FIRST Robotics Team

The CCEFP and the University of Minnesota with support from the Fond du Lac Tribal and Community College, located in Cloquet, Minn., has initiated a rookie FIRST Robotics Team of 20 high school students from the Fond du Lac Indian Reservation community. This team will serve as the area's first robotics team to enter the FIRST Robotics competition.

The Center will continue to mentor students and provide funding opportunities that will assist in the development of the STEM initiatives within the American Indian community. The goal of this team is exposure to the exciting world of robotics. This team has received a $10,000 grant from the University of Minnesota Foundation to join the competition. The team has many commitments from local area mentors, including teachers and parents. The Center will be providing resources to the team to help them achieve their goals.

This team is new to the competition, the learning curve is steep, and the challenge is meant to stimulate minds, creativity and teamwork. To date, the robot has been successfully built and is currently being shipped to the Regional Competition Site at the University of Minnesota. Competition dates are March 28-29. The lead teacher involved will use the FIRST Robot as a model for pneumatic, programming, electronic and mechanical robotic curriculum to implement in his K-12 courses.

SCIENCE MUSEUM OF MINNESOTA

Science Museum of Minnesota

Youth Science Team

The Fluid Power Team was recruited in October 2007 and is composed of a diversity of students, many of whom are exploring the field of mechanical engineering for the first time and have already expressed interest in pursuing careers in this field. The hands-on fluid power activities they are creating will be used on outreach and in the Science Museum of Minnesota galleries to educate the general public about fluid power and its applications. Once the youth complete the exhibit display in collaboration with Science Museum staff, the exhibit will serve to disseminate the research and applications of the CCEFP to the general public.

Seven hands-on fluid power activities have been created to date:

- Air Cannons: shooting compressed air to explore the motion of fluid through a medium.
- Fluid Theater: creating theaters with syringes and vinyl tubing to explore the concept of the compressibility and motion of water and air.
- Fluid Toys: taking apart and putting together fluid toys to explore the concept of an accumulator.
- Lego Lifts: building Lego pneumatic kits to create elevators and dentist chairs to explore fluid power systems and circuits to move objects.
- Sand and Water Clocks: demonstrating the bottleneck effect when a fluid is forced through a small area.
- Straw Rockets: using air power to shoot a straw rocket at a target.
- Wind Tubes: using creative projects to fly, float or sink based on surface area in a wind tube (idea from PIE--Playful Invention and Exploration).

Every Saturday from 10:30 a.m. to 12:30 p.m., the Fluid Team works with Science Museum of Minnesota visitors in the Experiment Gallery. Team members choose the projects to bring and work with children and adults. In the month of January alone, the team helped over 150 visitors.

Student Leadership Council

The Student Leadership Council (SLC) is an active student group consisting of 14 representatives from the seven institutions within the CCEFP. The SLC has officer positions with bylaws governing the organization. The SLC is responsible for providing a face and a voice for the students within the Center as well as organizing several of the activities within the Center.

Vision of the SLC: The SLC shall benefit its members by promoting leadership, service and collaboration among members and by providing opportunities to enter into meaningful professional relationships with ERC institutional faculty and partner company representatives.

Mission of the SLC: The SLC will act as a liaison between the CCEFP and the CCEFP students; promote collaboration between the students at the CCEFP institutions; enhance communication between the advisors and students of the CCEFP; and encourage the study of engineering, math and natural sciences for the future benefit of fluid power.

Activities of the SLC: Bi-weekly webcast, alumni society, Facebook group, quarterly meetings, educational outreach, fluid power future employment survey, annual retreat, CCEFP SWOT analysis.

The SLC is currently in the planning stages of the next student retreat to be held August 7-9, 2008 at the University of Illinois, Urbana-Campaign. Industry project champions and all CCEFP students are invited to attend. Watch for more information!