Fluid Power Mechatronics Demonstrator for Education and Outreach

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The Portable Fluid Power Demonstrator (PFPD) is being developed for K-12 classrooms, with an initial focus on middle and high schools. The kits can enhance current and enable new activities for organizations that include PLTW, FIRST Robotics, science museums, children's museums, and many others. The PFPD is being used to promote awareness and/or increase interest of fluid power education in high school grades 8-12. Through the addition of microcontrollers the PFPD can be used to teach robotics and mechatronics.

Achievements

Progress has been made on the new multi-actuator smaller educational tool that can be easily transported, doesn't require any setup or water, can be plugged into any 110/220V outlet, and introduces students to fluid power and the interaction of electronics, microcontrollers, and actuators in fluid power systems. The original pneumatic and water PFPDs are still being utilized at Purdue various K-12 outreach programs, museums, high schools, conferences, and distributed to CCEFP member universities. The previous demonstrators have been successful in classrooms, science museums, on campus programs and other engagement activities. However, their size, weight and large loose components make long-range travel, shipping, and transporting as baggage on airlines unnecessarily difficult.

The new demonstrator is much more compact and designed to meet the requirements for carry-on luggage in size, weight, and content. This design still features all parts of a pneumatic circuit clearly showing the flow source, control valves, reservoir, and actuators. Rapid setup, simple circuitry, and easy transport makes this device ideal for conferences, teach training visits, and other such pre-existing opportunities that the current trainers do not work well for.

A careful analysis of learning objectives and other goal related limitations along with the mechanical design of the system resulted in the design of a pneumatic cantilevered gantry crane with position feedback and an electro magnet gripper at the end of a small, guided electric winch. The position feedback comes from an ultrasonic distance sensor and variable resistance position sensor. Additionally, a camera was mounted below the winch to allow for contrast recognition. The device is controlled by an Arduino micro-controller allowing students to interact with the code to change controls or develop their own functions. There are several games which could be developed either for or by students to enhance their education of fluid power and mechatronics. Currently, 3 different modes have been programmed for the demonstrator, a user controlled manual mode, a shape tracking mode, and a shape identification mode.

The small portable device demonstrates pneumatics, robotics, and programming in environments where these topics were previously only discussed.

Recently, the design of the demonstrator has been streamlined and improved to provide better and more consistent operation. The camera used for object recognition modes has been mounted to the end effector itself allowing for a more functional following mode and allows all current methods to function without the need to change hardware configurations when switching between them. The electrical and pneumatic wiring has been completely redone to ensure secure connections and to avoid any interference with moving parts. The hardware board used to control the solenoids and electromagnet has been redesigned to help interested observers better understand its operation and to present an overall cleaner look. An issue with the chosen board is preventing operation currently but the proposed circuit modifications have been tested and are sound for the operation of this demonstrator and should be

implemented without too much delay. The electromagnet has been upgraded and mounted to a slide which constrains its motion to up and down only as opposed to its free swinging predecessor.