Hydraulic Exoskeleton Project

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The first phase of this project began in Fall 2003 with a team of 5 senior students designing and constructing a hydraulically actuated pick and place machine that can pick up 100 lb objects by hydraulically amplifying the human force. Although the prescribed use of the machine is for landscaping use, the machine is actually intended to be the upper extremity portion of the exoskeleton system.

The design is a four degree of freedom powered oar, which pivots up and down, swings horizontally, pulls in and out, and has a gripper for gripping objects. The up-down and in-out motions are hydraulically assisted. The human user interacts with the oar via a handle and a mechanical gripper trigger. The machine can be powered completely by the human, but in normal operation, the force that the human applies to the handle is sensed and amplified by the hydraulic actuators by a certain factor. This allows the human to lift and move heavy objects (100 lb) using a fraction of the force and power, while physically connected to the task to ensure a good sense of haptics.

The machine in Fig. 1 has been constructed, its actuators and sensors have tested, and system has been mathematically modeled. A preliminary set of control algorithms have been designed, mathematically proven, and simulated. Actual testing of the control with the hardware will proceed in early 2004.

The second phase of the project will involve developing a hydrostat operated mobile platform with intuitive and direct human interface similar to a Segway human transporter.

In this project, we have received donation of components (actuator, motor and hoses) from Eaton Corporation. Servo-valves used were those salvaged from an old hydraulic robot donated by MTS Systems a number of years ago. TORO company has donated several partial hydrostatic vehicles to be modified for the mobile platform base. Funding from NFPA has been used to purchase non-hydraulic components e.g. force sensors, electronics, mechanical parts, raw materials.

Two undergraduate students have been recruited to continue with this work in the Spring 2004 semester. The project is supposed to be in continuous development afterwards. The kickoff phase (funded by NFPA) will end in Summer 2004 when a first generation of the exoskeleton will be completed.

Fig. 1 The Powered Oar and the partial "Powered Oar" team (Left to right): Aaron Hicks, Zaki Hussein, Professor Will Durfee, Russell Ryan, Husaini Hashim, and Professor Perry Li (Not present: Toni LaPlante)

A *video* of the machine can be viewed at: http://www.me.umn.edu/~pli/fpcl/
Go to the VIDEOS section near the bottom of the page.