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Business Name

Carrier Wave

Fluid Power and Tele-Robotics Research Facility (Part II)

Special points of interest:

- Fluid Power and Tele-Robotic Research Laboratory (Recent Research Projects)
- IEEE International Microwave Symposium 2012
- Check our website regularly for upcoming event information

I) Fault Diagnosis and Fault Tolerant Controls in Fluid Power Systems

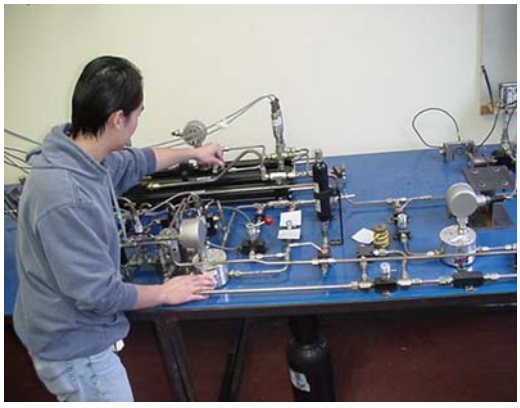
Hydraulic actuators, as key components in many complex systems, must perform under all circumstances and faulty conditions. Research is being conducted to improve reliability, by understanding complex failure mechanisms in hydraulic functions and, designing fault diagnosis and fault tolerant controls for hydraulic actuators.

The most recent projects of this laboratory, involve actuator leakage fault type and level detection using Volterra nonlinear system theory and Extended Kalman Filtering and, design of fixed-gain robust controllers to cope with hydraulic function uncertainty, faulty actuator piston seal, incorrect pump pressure, and malfunctioning position sensors. A hardware-in-the-loop simulator has also been developed to support objective evaluation of fault tolerant controllers within the context of the highly complex flight control applications.

Presently we aim at expanding the scope of the previous work by covering more faults. Specifically, relative impact of fault modes on the overall performance of hydraulic actuators is currently being analyzed to gain an insight into the mechanism of proper compensation through feedback control. Development of on-line procedures for isolating faults in hydraulic systems taking into account uncertain dynamics, dependency between fault types, and choice of measurements is also underway. Hardware-in-the-loop (HIL) simulator test facility for research on condition monitoring and fault-tolerant control design of hydraulic actuators. The HIL simulator integrates real hydraulic actuator hardware into the software simulation of a high-performance jet aircraft. The experimental hydraulic system consists of two independent circuits. One hydraulic circuit, the fault simulator, is used to represent a flight control actuator. The circuit is comprised of a servovalve controlled ram and has been equipped with additional hardware elements that enable the effects of various system faults to be simulated experimentally. The second servovalve controlled hydraulic ram, is employed as a dynamic load emulator.

II) ***Control Task of Interaction in Hydraulic Actuators***

Hydraulic actuators are often used to cooperatively move an object, or individually interact with environments.Thus, synchronization between the actuators and controlled impact prior to maintaining contact is of great importance. Contributions have



Hardware-in-the-loop (HIL) simulator test facility

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been made to the development of control concepts for hydraulic actuators targeting contact and cooperative tasks. A series of projects were conducted focusing on key issues (such as impact stabilization) that allow hydraulic actuators to come in contact with, and exert a desired force on environments. Lyapunov-based position and force controllers were combined, using a switching scheme and the stability of the entire non-smooth system was studied using the concept of Lyapunov exponents.

We have also designed controllers to allow multiple hydraulic manipulators to cooperatively move an object along a desired trajectory. Nonlinear hydraulic functions, parametric and model uncertainties, friction, load sharing, internal force regulation, measurement issues were all addressed. Our current interest is to expand the previous work to allow multiple hydraulic arms to cooperatively move a common object while controlling the interaction force with the environment.

III) Impedance Control in Hydraulic/Pneumatic Manipulators

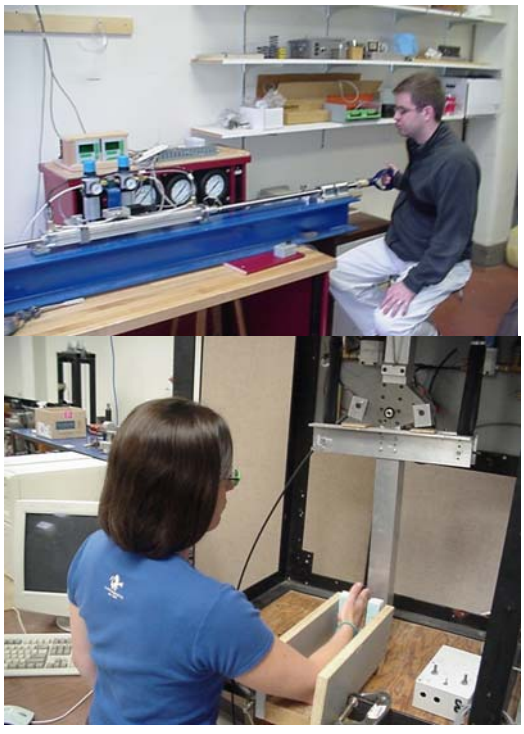
Position-based impedance control (PBIC) formulation has been established as a suitable framework for considering both unconstrained and constrained motion control problems in hydraulic robots. To meet the demanding position-tracking requirements of PBIC, a nonlinear PI-type position controller was developed first. Next, systematic analyses supported by experiments were conducted which identified the form of the PBIC-equivalent explicit force controller, and revealed an important constraint for long-term static force regulation in PBIC formulation.

A very accurate (2 encoder resolution widths of error) position controller was developed, which overcomes the control problems associated with deadband, stiction and saturation in hydraulic robots. A position-based impedance technique incorporating the above position controller was implemented on a Unimate hydraulic robot. Current research focuses on enabling pneumatic actuators to interact with dynamic environments through the design of an appropriate PBIC scheme. The current interest also lies in investigating how the property of superposition in impedance control can be effectively utilized to define a number of impedances, each corresponding to one objective in complex composite tasks. These devices consist of various types of pneumatic actuators controlled by specialized valves via a computer and operate under the concept of position-based impedance control. The actuators are of low stiffness, by nature, enabling smooth compliant motion. They also offer good power-to-weight ratio. Provision for live video and audio with a remote computer is also possible. The force-deformation profiles are displayed on both computers with a built-in strip chart display. The goal is to develop portable devices capable of administering various forms of physiotherapy, tracking recovery, and communicating the information with a therapist.

IV) ***Tip-Over Monitoring of Heavy-Duty Mobile Hydraulic Machines***

Excavators, forklifts and cranes are extensively used in industry. Incorrect maneuvering the implements would cause these machines to tip-over, causing potential hazard to the operators and the people around. We have been studying heavy-duty hydraulic machines to understand the mechanism of tip-over and

A position controller with two encoder resolution widths of error



Interaction of pneumatic devices with a human upper limbs, wrists or fingers

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prevention in operation of such mobile machines. Software tools for stability measure and tip-over simulations were developed. Particularly, a complete simulation model of a crane carrying a clamming device including tip-over dynamics was developed. Detailed information about the effect of the flexibility between the base and the ground, the effect of the friction between the tires and the ground, and the interaction between the vehicle and the movements of the crane links was considered. This work allows us to obtain further insights into the necessary limits on loads, velocities and crane configurations to ensure sufficient stability in dynamic situations.

Real-time simulator for clamming device mounted on a mobile crane. Users control the virtual machine with a set of joysticks in the same way as they do on a real machine.The users are placed in the loop of a real-time simulation, immersed in a world both autonomous of and responding to their actions.

V) ***Robotic System for Remote Ultrasound Diagnosis***

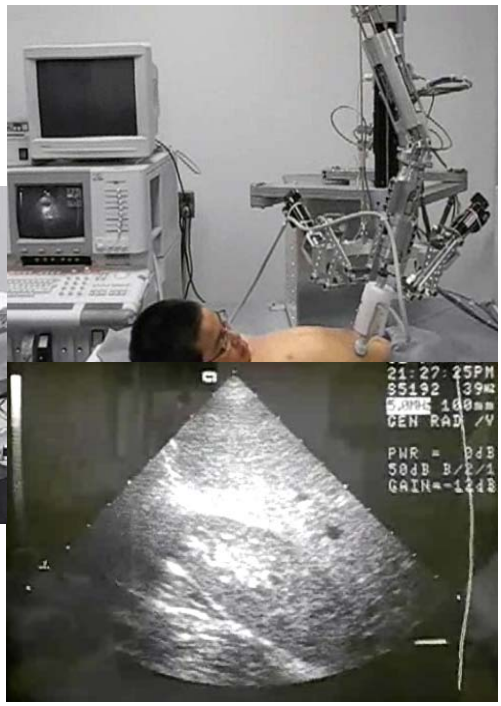
Diagnostic ultrasound is a vital component of health care. The reality of ultrasound, however, is that it requires a trained physician or radiologist with an understanding of how to manipulate movements of the ultrasound probe. For situations where a bedside expert is not available, an alternative solution is to allow a clinical expert at the remote site, operate the probe through a robotic device via a hand-controller with force feedback capability.

A research has been carried out at the University of Manitoba which resulted in the design and construction of a robotic system for ultrasound diagnosis by a trained physician who is distant from the patient. This could be a situation not only in rural areas but also across the city or health complex where the patient and the clinical expert cannot be 'in the same place at the same time'. A novel compact four degree-of-freedom wrist mechanism has been prototyped, capable of holding and maneuvering an ultrasound probe similar to a clinical expert's wrist movement over the abdomen. A companion hand controller has also been prototyped for use by the clinical expert over distance, to execute typical functions and movements that would ordinarily be performed as if she/he was present at the patient's bedside. Both mechanisms are novel in their design and performances.

VI) ***Robotics-Assisted Generation Maintenance and Live-Line Work***

This research aims at assisting Manitoba Hydro to improve its services related to generation maintenance and transmission line work. Such operations are often complex, hazardous and labor intensive. There is certainly a need for adopting new technologies to further improve productivity, working conditions and safety. In this project, we are work closely with Manitoba Hydro, to examine existing techniques and further develop new tools that allow robots to partially substitute for, and work cooperatively with crew directed at live-line operations. Actual experimentation is extremely beneficial to substantiate the

Real-time simulator



Remote ultrasound examination of kidney and liver

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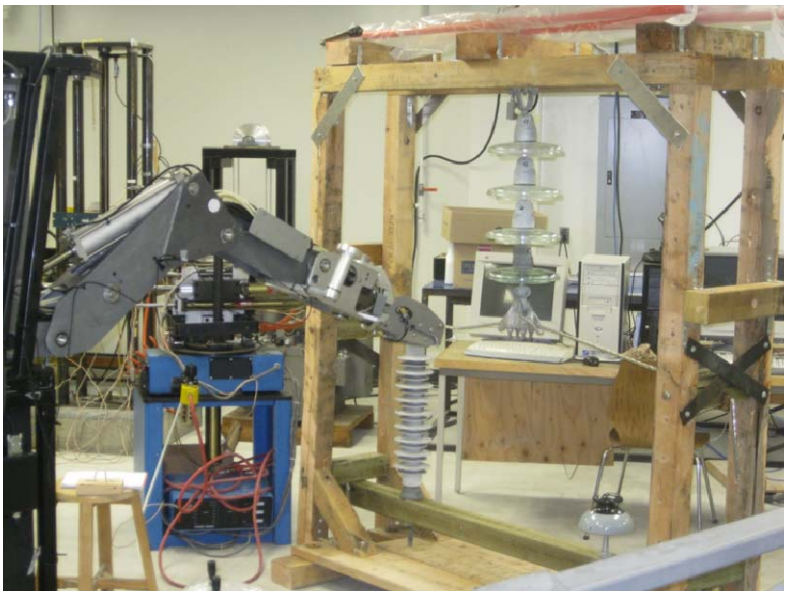
the ideas and approaches developed and to bring the technology closer to actual implementation. Thus, a suitable large-scale human plus robot-in-the-loop simulator has been constructed to allow human-robot collaborative control of tasks in unstructured environments to be studied.



A state-of-the-art Human plus robot-in-the-Loop simulator is being constructed. The simulator will be a fully integrated system consisting of an industrial hydraulic slave manipulator, two master arms (one with force feedback and the other one without force feedback, a motion simulator (representing elevated platforms), and human interfacing and display systems. Using the simulator, new concepts and ideas will be validated through examining tasks that relate closely to Manitoba hydro generation maintenance and live-line work.

IEEE International Microwave Symposium 2012

IEEE International Microwave Symposium 2012

Date:
June 17-22, 2012

Location:
Montreal, Canada

Abstract:

Join us in Montréal to celebrate the 60th anniversary of both the Microwave Theory and Techniques Society (MTT-S) and the International Microwave Symposium (IMS2012). The IEEE Microwave Theory and Techniques Society's 2012 International Microwave Symposium (IMS2012) will be held on June 17-22, 2012 in Montréal, Canada as the centerpiece of Microwave Week 2012. IMS2012 offers technical sessions, interactive forums, plenary and panel sessions, workshops, short courses, industrial exhibits, application seminars, historical exhibits, and a wide array of other technical and social activities including a guest program. Co-located with IMS2012 are the RFIC symposium (www.rfic2012.org) and the ARFTG conference (www.arftg.org), which comprise the Microwave Week 2012 technical program. With over 12,000 attendees and over 800 industrial exhibits of the latest state-of-the-art microwave products, Microwave Week is the world's largest gathering of Radio Frequency (RF) and microwave professionals and the most important forum for the latest and most advanced research in the area.

Contact: For questions or more information:
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The Winnipeg Section of IEEE strives to meet the needs of its members in the province of Manitoba by providing continuing education, conferences, and special meetings in the areas of electrical, electronics, and computing, to its members in Winnipeg and the surrounding area.

For information on IEEE and how to join, please visit our website at www.ieee.com.

"It is through science that we prove, but through intuition that we discover."

Henry PoinCaré (1854-1912)

We're on the web!!
http://sites.ieee.org/winnipeg/

Message from the Editor

I would like to take this opportunity to extend a warm welcome to the 2012 IEEE Winnipeg Section's executive members: Chair: Dr. Vajira Pathirana, Vice-Chair: Dr. Sherif Sherif, Treasurer: Mr. Samuel Kovnats, and Secretary: Mr. Jordan Hievert.

Also, my special thanks go to Dr. Sepehri for providing tele-robotic information.