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Actuators and Implementation Issues

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Demands on the knowledge and skill base of the modern engineer continue to increase as the rate of technological advancement steadily rises. However, the traditional discipline boundaries of mechanics, electronics, control, and software can impede the design and development of products, devices and systems. The integration of, and synergism with, these disciplines in the design process is said to differentiate the mechatronics practitioner from “mainstream” multidisciplinary engineering teams. In addition, a healthy balance between “across-the-board” breadth of knowledge and “specialist” depth of knowledge is required in engineering projects.

However, the rapid development and adoption of new technologies in industry are driving engineering courses toward curricula with considerable breadth of content, multidisiplinary approaches and based around working within teams. In many tertiary institutions the traditional mechanical engineering courses are already adopting more electronics, control and software development into their core – to the extent that there are only minor differences between the mechanical and mechatronic engineering disciplines.

It could also be argued that the above attributes should be implicit in any good design engineer and not specific to the mechatronics practitioner. The practising design engineer is faced with these issues on a daily basis. If this evolution of courses continues, the question must be asked: will mechatronics survive in the long term or will it be subsumed by a new breed of design engineers?

Actuators

The design and rapid development of actuators is central to the development of mechatronic systems. The power requirements, speed of operation, physical size issues and control difficulties often manifest themselves in actuator design. Considerable effort has been, and continues to be expended, in this vital area.

The use of magnetostrictive and shape memory materials in pulse-modulated pilot valve actuators for large fluid power values is proposed in the paper by *Vuorisalo and Virvalo*. Basic design calculations are presented that compare piezoelectric and magnetostrictive actuation in a sample valve. The use of such active materials provides relatively high speed, non-contact action, and as these materials become more readily available applications such as the proposed valve will be considered more often.

Kallenbach, Ströhla, Birli, Feindt and Kallenbach present a methodology for mechatronic design and demonstrate this with reference to the design of fast-acting magnetic actuators. Design is often referred to as an art underpinned by science, and can sometimes appear to be an ad hoc process based entirely on the practitioners past experiences. Attempts to define the mechatronic design design process are essential as the discipline matures.

There are numerous software packages available to assist in detailed analysis during the design process. In particular, commercial finite element, finite difference and finite volume packages dominate in all industries. Appropriate use of these tools can reduce the time to market and efficacy of product design. In an example of this, *Moosavian and Basu* present a transient stress analysis of a two-phase axial flux servo motor. The rotor-stator air gap spacing is considered for variations in geometry and rotational speed.

Implementation

The ultimate goal of any mechatronic design is to deliver to the client an effective product within the time and resources available. This is clearly more difficult than it sounds. The following papers have approached this task by various means.

The design of robotic joints that can be assembled to produce a modular robot is presented by *Mishra and Srikanth*. They are in the process of fabricating such joints and discuss the inverse kinematics of an assembled modular robot. The modular approach allows for a readily reconfigurable robot and inherently flexible implementation over conventional systems.

Chang and Halgamuge present a fuzzy-neural adaptive feedback control for a laser profiling machine. The application of FuNe is implemented as a regulator controller and the basic structure and learning algorithms are discussed.

Dunlop, Cree, Murphy and Phillips have developed a field-programmable gate array I/O board with an interface to the standard ISA bus on a personal computer. Applications for the FPGA include precision control of stepper motors, DSP, and high speed data acquisition. This system allows software developers low-cost real-time performance on a conventional windows PC by using the real-time extensions kernel.

Robot programming by demonstration for non-technical users is considered by *Chen and McCarragher*. They present an interface that can remove noise from the demonstrated trajectory and discuss the development of their configuration space based on simple regression analysis. A manual task is used to demonstrate the effectiveness of the method.

Smart material actuators for fluid power valves with different pressure mediums

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Abstract

Large fluid power valves usually have two stages: a pilot stage and a main stage. The pilot stage can be realized in various ways. In this paper a pilot stage is suggested to be realized with smart material actuated fast on/off valves. Principles of pulse modulation technologies are presented as well as differences between water and hydraulic oil as pressure mediums. Two different smart material actuators are introduced for the same pilot valve. As a conclusion smart materials are found to be suitable pilot valve actuators for a water hydraulic control valve.

Keywords:
On/off-control, pilot valve, water hydraulics, smart material.

1 Introduction

In the field of fluid power the main control components are valves. Electric control power can be kept low by using multi stage valves. The electric energy converter for a pilot stage of a hydraulic valve has traditionally been a solenoid or a torque motor, Figure 1.

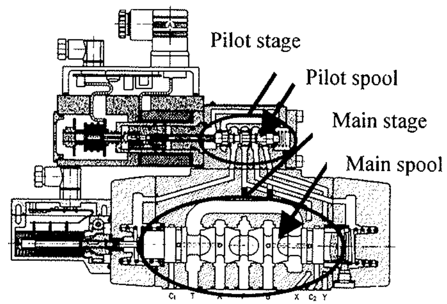

Figure 1 An example of two stage fluid power proportional valve [1]