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Contents

Part I

mechanisms and controller and acquisition algorithms. This paper describes the design and development of the FBSIMU and the incorporation of the tool in the mechatronic engineering laboratory curriculum of Eng. School of São Carlos.

A methodology for control education is presented, focused in student motivation and making use of a simulation environment. The goal is to increase the number of practice sessions, making them attractive to the student and avoiding costly laboratory equipment. As a difference to other approaches like virtual laboratories, the proposed methodology is based on a combination of computer sessions and laboratory sessions, which should be complementary. The main idea is to simulate some interesting, well chosen real system in a preliminary computer session; and then performing a practical experiment with a simple low-cost laboratory equipment working under the same physical principles. This methodology reduces costs, multiplies the number of different experiments, and allows the student to manipulate and control real physical systems. The MATLAB environment is used for the development of the simulation programs. The structure followed allows an easy development of new programs, by keeping independent the user interface, the process simulation and the graphical representation modules. Two examples of simulation programs (linear and nonlinear systems) are given, and full source code is available for both of them. The methodology is being used at present at the Industrial Systems Engineering Department of the Miguel Hernandez University for two introductory subjects of control theory.

In control engineering education, laboratory work is an important component for a holistic learning experience. In this paper, a survey of the e-learning related research and technologies is first presented. Then, the unique features needed for lab-based teaching and learning are highlighted. Based on this study, a lab-based learning model (LLM) is proposed to extend the e-learning framework for lab-based courses. Details of the LLM, which includes components such as the Apparatus Virtual User Interface, the Apparatus Run-time Environment and the Apparatus APIs, are discussed to illustrate how the goal of lab-based e-learning can be achieved. Finally, two example lab experiments in the teaching of control engineering courses using the proposed framework are given.

Control Engineering is an essential part of university electrical engineering education. Normally, a control course requires considerable mathematical as well as engineering knowledge and is consequently regarded as a difficult course by many undergraduate students. From the academic point of view, how to help the students to improve their learning of the control engineering knowledge is therefore an important task which requires careful planning and innovative teaching methods. Traditionally, the didactic teaching approach has been used to teach the students the concepts needed to solve control problems. This approach is commonly adopted in many mathematics intensive courses; however it generally lacks reflection from the students to improve their learning. This paper addresses the practice of action learning and context-based learning models in teaching university control courses. This context-based approach has been practised in teaching several control engineering courses in a university with promising results, particularly in view of student learning performances.

In this paper, the findings based on a graduate electrical engineering course titled 'Real-Time Control Systems Design' are analyzed and reported. This course is comprised of a lecture and laboratory component where the students are expected to transform their theoretical knowledge into a viable team laboratory design and present the results to the entire class. Administering the Myers-Briggs type indicator (MBTI) to the class provides an extra analytical dimension. From the MBTI test data and course grades, it is concluded that the 'learning patterns' play a significant role in student performance, team success and overall laboratory experience. Based on the combined results, a number of recommendations are brought forth for improving curriculum design and student assessment at the graduate level.

Simulation plays an increasingly important role in electronic learning. With computers readily accessible by the students in the modern campus, many courses have an assimilated simulation content. Simulation is especially prominent in engineering courses (such as control engineering), whereby complex mathematical equations alone often elude a good understanding. With the help of a simulation study, students are able to make changes to the parameters of a model and observe the impact of the change on the system performance. This helps to improve their understanding of the system model. Advancement in wireless technology has transmuted electronic learning into mobile education. Mobile education in essence allows the learner the flexibility of time and space to access education resources. In order for mobile education to be pervasive, especially to people on the move, the system has to be adaptable to include affordable handheld mobile devices (e.g. cellular phones). Unfortunately, handheld devices typically have small display units and limited memory space. Running simulation on these handheld devices will be unthinkable if not impossible. In this paper, we propose an innovative method to run simulation on handheld mobile devices. We present the development of a system which will allow the learner to access a remote personal computer (PC) that houses an Excel simulator, and converts the results to a standard picture file format which can then be viewed via cellular data technology (e.g. GPRS). The methods and difficulties involved in the construction of the system will be duly discussed.

The laboratory designed and implemented at the Politecnico di Milano for the experimental activity on control structures is presented. Different structures can be experimented, at reasonably low cost, by means of a single apparatus, easy to use and maintain, and suitable for a large number of students. The pedagogical importance of experimenting with control structures is discussed, highlighting the originality of the experimental setup presented. An overview of the setup is given, and laboratory assignments are described.

Improvements in control systems have long been reflected through continuous study, research and developmental activities. This paper presents a citation of control-related interdisciplinary disciplines (ID) that falls in the field of macro and micro automation and machine control systems. The paper first stresses the need for an interdisciplinary approach towards control engineering education. Then, it focuses on the subject contents for control related interdisciplinary topical domains. The scopes of various interdisciplinary domains such as microelectromechanical systems, mechatronics and micromechatronics, computronics and photonics, micro instrumentation and control, convergent networks, nanotechnology, real-time machine control, HILS, etc., will be highlighted in appropriate order. The impact of these emerging disciplines on control engineering will be elaborated in the last section.

The scenario for control education is changing and we must adapt to the new situation. Information technology opens a whole new world of real opportunities. Computers show a great potential to enhance student achievement, but only if they are used appropriately as part of a coherent education approach. Computers do not change in the way books or labs do—they allow us to go deeper and faster. This paper presents the personal experience of the authors in the use of interactive tools in order to make students more active and involved in their own control engineering learning process. Some examples, with different degrees of complexity, have been selected in order to show how we can use the control visualization concept in a new family of interactive tools for control education.

The architectural requirements of an effective Virtual Control Laboratory (VCL) are described from a generalized perspective that takes into account the objective of supporting flexible, active, and discovery learning. It is argued that a Web-publishable VCL accessible via standard browsers maximizes flexibility. A realization of the proposed architectural paradigm is presented in the form of a VCL specialized for the control of a DC motor, organized in a modular fashion in terms of an animation panel that provides a visual sensorial perception of the evolution of the state of the plant, an interaction panel that allows the student user to change key parameters of the plant and controller, and a navigation panel that consists of five tabbed windows. The windows can be selected one at the time, and they present to the student a users' guide, information about the plant, a description of the controller, as well as analysis and time-domain simulation results. The analysis window includes all the classical results of linear control theory, including the characterization of dynamic features such as the time-domain step response, the frequency-domain Bode plots, and the location of poles and zeros. In addition, the DC-Motor VCL is able to yield analysis and simulation results for open-loop as well as closed-loop configurations. A number of pedagogical scenarios where the VCL can be used to the benefit of the students' learning experience are discussed.

Part II

The Smith College Picker Engineering Program has partnered with the college's Department of Education and Child Study and Office of Educational Outreach to develop a learner-centered approach to engineering education, central to which is the integration of engineering and the liberal arts in the service of humanity. This paper presents the results of applying these educational strategies to Continuum Mechanics I, a sophomore-level engineering course including topics from engineering statics, dynamics, and mechanics of materials. Pedagogical elements used in this course include a variety of strategies designed to help learners engage their preconceptions, construct knowledge meaningfully, and take control of their learning. Assessment data demonstrate that the implementation of these strategies leads to increases in student satisfaction, confidence and commitment towards engineering, while also achieving the technical learning objectives of the course. The significance of these strategies for effectively engaging students, particularly women and other underrepresented groups, in the field of engineering is discussed.

The imminent introduction of Personal Development Plans and Personal Development Planning into higher education has led to confusion among academics over how best to implement such measures. There are many guidelines available on what Personal Development Plans should achieve and the activities students should be involved in. This paper provides details of an assignment designed to help students develop the skills and knowledge they need to successfully engage in Personal Development Planning and meet QAA requirements. The module has also been successful in changing student attitudes and perception of Personal Development Planning. This paper would be useful for academics seeking to design a PDP process that engages students to successfully meet PDP requirements with limited resources.

Students learn and retain more as they become increasingly engaged with instructional materials. We describe active-learning teaching methods that we used to develop computer-based instruction modules for introductory thermodynamics. These methods, which can be generalized to other topics in engineering, include the use of interactive exercises, immediate feedback, graphical modeling, physical world simulation, and exploration. Ongoing assessment of the effectiveness of these materials has been carried out in parallel with development, in part, to assure that students have access to the required technology and sufficient time outside of class to use the materials. The assessment data include behavioral and cognitive variables that were used to examine the usability and impact of the computer modules.

Power electronics technologies will play a vital role in the aerospace industry in the years to come and all emerging technologies are already an important part of the industry either at R&D or in many cases production level. It is recognised that aerospace engineering and avionics students need to be aware of these technologies and in a position to work as a team member with development of power electronics technologies addressing specific needs. The paper discusses pioneering initiatives undertaken and the newly introduced course of power electronics and related technologies into the undergraduate aerospace engineering curriculum at the University of Glasgow, UK. The various components of the course are described in detail, along with the laboratory programme, which is based on a "closed-loop" approach for the understanding of the various concepts. The pre-laboratory/post-laboratory questions and the course assessment are given. A sample final exam question is also provided to introduce the industry relevance requirement component of the course. The views of the students regarding their experiences, especially in the laboratory environment, are critically discussed.

Multiple-choice question (MCQ) tests are not used widely in engineering subjects as a summative assessment methodology, largely because of the poor compatibility between the MCQ scores and conventional percentage marks. This paper develops algorithms for converting raw scores of MCQ tests to conventional marks based on probability theory. The algorithms are independent of class size and historical data and can be easily implemented in a spreadsheet programme by using a conversion table. The converted marks are compatible with the conventional marking scheme and can therefore be used standalone or as assessment units of a course. The algorithm for four-choice questions has been applied for a course with a satisfactory outcome. The issues concerned with the applications of the algorithms are discussed.

Project control is an essential task of management of construction projects and good planning and control have long been recognised as having beneficial effects on the success of a project. However the efficacy of control techniques that are widely taught in management courses is almost impossible to prove. It is also very difficult on a theoretical basis to help students to understand the effects of their decisions and thereby enable them to learn the mixture of science and art which is project control. The use of management games for teaching in construction has the advantage of enabling participants to be put into complex, realistic project situations without incurring the financial and time penalties which would accrue if real projects were used. This paper describes a simulation model of an earthmoving project, which is used as a management game, to provide players with experience in the management and control of construction projects. The model contains many of the aspects of a real project including planning, decision-making, uncertainty, environmental effects, finance and a realistic physical model of the project and resource operation. The paper draws conclusions both on its effectiveness for control and on its use for teaching and learning.

A. Elshorbagy

1203–1213 Learner-centered Approach to Teaching Watershed Hydrology using System Dynamics

The use of the system dynamics approach, implemented within an object-oriented simulation environment, is presented as an effective tool for learning watershed hydrology. This approach has the potential to enhance students' understanding of watershed hydrology through experimenting and self-guided learning on their own. The approach could also motivate students to conduct further research in the area and go beyond the material taught in the classroom.