Volume 29 Number 3 2013 ISSN 0949-149X

The International Journal of Engineering Education

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Section I
Special Issue
Human Computer Interaction in Engineering Education

Guest Editors
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This paper proposes a novel e-learning system that incorporates human-computer interaction data to build a smart e-learning system. A supervised image segmentation algorithm is used to detect the face and hair of students in head posture images. A simple and effective human presence detection and gaze direction estimation method is then developed based on changes in the face and hair information. First, the proposed algorithm is tested using 10 different students with seven different head postures each and 92% of the head postures are identified accurately. Second, the method is applied to real time video sequences containing 80 frames that lasted 400 seconds, which are acquired using an integrated web camera, and similar results are obtained. Finally, human-computer interaction data, which is an indicator of student attention, is calculated based on the human presence and gaze direction over time. The experimental results show that the proposed approach enhances human-computer interactions for e-learning systems and helps us to evaluate student performance.

Keywords: engineering education; e-learning; human-computer interaction; machine vision

Advances in the technologies and evolving human computer interaction culture are adding new dimensions in the overall education customs. With the human-computer interaction model moving from traditional input methods to more natural, ubiquitous input techniques, there is a need for us to understand and increase the richness of the user experience with seamless integration and functionality of these types of technologies. The focus of this paper is on identifying aspects of the input technology that increases the impact of the device by enhancing the user experience with higher integration and functionality of these types of technologies. The paper also identifies aspects of social behavior and actions of social interactions for multi-modal input technology across different form factors.

Keywords: multimodal interactions; gesture interaction; engineering education

Recent years have brought important changes in engineering education, especially in electrical and computer engineering. Along with new equipment and modern electronics, there are new opportunities in the automation control. This paper presents a hand motion controller, which measures the orientation of the upper limb of a man in three dimensional space. The design assumes the use of microcontrollers from Texas Instruments, which will be responsible for communication between specific modules. It assumed the usage of two types of communication UART (Universal Asynchronous Receiver and Transmitter) and I2C (called Inter-Integrated Circuit). Microcontrollers will also be responsible for monitoring the voltage and simple calculations. The entire system has been sown in the glove acting module possible to connect to different devices, and communicating through the I2C bus with the master device. In order to visualize the controller a hand model was developed in an environment of OpenGL and 3ds Max. Subsequently, the control program which is responsible for calculating the rotation matrix, and the calculation (using data from the matrix) of degrees of freedom associated with the forearm and the arm, was implemented. This is a broader issue related to the large number of calculations which are not capable of microcontrollers (requires a large computational power), that was the reason which extorted the computer's calculations communicated with the controller wirelessly by Bluetooth. In order to present the results, a physical manipulator, which mimics the trajectory of hand movement, was connected to a personal computer. Presented system is used on the experimental laboratory education on Chair of Computing Engineering at Poznan University of Technology in Poland. The objective is to present remote laboratory kits for teaching and learning some aspects of control systems. Additionally, the effectiveness of the platforms in educating students is discussed.

Keywords: hand motion controller; three-axis gyroscopes model; wireless navigation controller; rotation matrix

The introduction of human computer interaction (HCI) technology has made the teaching curriculum for engineering far more stimulating and approachable. This study proposes the use of a graphical human interface to facilitate learning in an experimental module in mechatronics. Students learn the principles, function, and application of mechatronics via the interface to demonstrate

the use of technology in human-computer interaction. This study focused on five main elements: (1) The development and testing of a learning platform for the mechatronics module; (2) learning exercises specifically tailored to laboratory objectives; (3) the convenience and user-friendliness of the proposed system; (4) the technical aspects of the platform in question; (5) the development of approaches to further enhance learning. This paper makes two fundamental contributions to the field of mechatronics education. First, we have developed a system that provides greater flexibility, accessibility, and ease of use for students. Second, we present an approach to curriculum development that is demonstrably faster in its progress from design to process planning.

Keywords: human computer interaction (HCI) technology; mechatronics; monitoring; control system

The major question addressed in this paper is influence of different screen aspect ratios on reading electronic material. In order to examine differences, we performed a research that included two of most popular aspect ratios: 4:3 and 16:9. Both aspect ratios were represented in desktop and handheld variant. The research referred to engineering students as readers. Engineering students were very interesting population for this research due to the fact that they spend most of their time reading electronic materials, during their education. Logically, it is necessary to measure how effective this way of reading educational material is. The general hypothesis of this study was that there is difference in usage of electronic reading material on screens with different aspect ratios, and that the current hype for widescreen displays is unjustified when it comes to reading electronic material. Reading time, amount of interactions and knowledge test scores were used as measures in experiment. Our results speak in favor of the hypothesis and suggest why proposed screen aspect ratio is the most suitable for reading electronic materials.

Keywords: screen aspect ratio; electronic reading material; engineering education; Human Computer Interaction (HCI); usability testing

The application of Information and Communication Technologies to learning and teaching processes has caused several effects, such as the emergence of new educational software systems or the use of different technologies to carry out educational activities. One of the most popular trends on this sense is the use of mobile devices to learn, in which is known as mLearning. It facilitates the participation and the interaction of students anywhere and anytime through such kind of devices. However mLearning should not be considered as a replacement of eLearning (understood as the Internet application to learning). It supports eLearning; therefore it should take into account the existing eLearning landscape. This implies that it is necessary to take into account the application of 2.0 Web tools, which enables an online implementation of the student-centred learning paradigm, where the learner happens to have a more central role in her training. This, joined to the necessity to take into account the learning obtained not only in the institutions, leads to definition of the Personal Learning Environments that need to coexist with the traditional learning platforms, the Learning Management Systems. So, in this case mobile learning should facilitate the use of mobile devices to support these two learning ecosystems.

To do so, this paper describes a service-based framework approach to implement a mobile Personal Learning Environment, which allows the integration of functionalities from the institutional learning platforms. With such system the learner can combine institutional tools with others she use to learn in a mobile system and reflect the activity carried out on them into the institutional side. This system is implemented and validated through its application into a Computer Science subject. The paper will show the difficulty of such application and some of its benefits such as the increase of student motivation and participation because of the use of the PLE and the mobile tools.

Keywords: mLearning; mobile devices; personal learning environments; interoperability; computer science; validation

This paper presents personalized game-based modules for Computer Architecture eLearning (CoAeLearn Modules) which integrates personalized learning based on students' learning styles and preferences (individual properties, goals and needs) with elements of multimedia games. Modules are intended for effective and efficient learning on the Computer Architecture Course by means of entertainment incorporated into interactive game-based applications. Furthermore, the CoAeLearn Modules should motivate the students and provide them with challenging games, action and victory. Moreover, the modules allow a visualization of computer architecture elements as well as a traceability of actions stored in the memory registers. The challenge for educational researchers is to determine how to design games which would achieve the instructional objective. Here we present an idea of making the components, integrated in CoAeLearn Modules, which explicitly support learning goals via guidance, directive feedback and multimedia presentation essential for efficient learning. Presenting the modules by entertaining interactive approach, along with a visual indication of the task execution flow, enables the students to master the methods of solving the tasks in various subject areas and surmounting different levels of complexity of teaching material. Multimedia Modules are presented in the form of a software package and Adobe Flash CS4 is used to create multimedia content. The Modules can be distinguished by pedagogical parameters such as: the degree of guidance in the module, a module support by HELP and feedback information about the correct answers.

Keywords: game based-learning; personalized multimedia modules; e-learning system; teaching strategies

This paper presents the auxiliary learning tools, created as an educational game for a number of topics in financial engineering. The aim of this educational game is primarily to improve the students' understanding of financial engineering using the principle of situational learning. The game is conceived as a simulation of a small scale financial market, where students act as participants in the market transactions, with their own virtual capital. In a defined space of time the students build their portfolios, which contain only shares at the beginning of the game, and they make decisions using the methods and techniques from the given teaching unit. Changing the initial conditions, throughout the game, the students can expand their portfolio acquiring bonds and derivatives such as options, in order to better diversify their portfolios. This educational game has a twofold use, as an auxiliary teaching tool and as a tool for testing the students' achievement. In comparison with completing classic-type tasks, this game can help test the students' competence to apply the acquired knowledge in close-to-reality situations.

Keywords: Financial engineering; education; asset pricing models; games

While collaborating using social networks, software developers are stimulated not only to consume content but to create it as well. Software developers are often geographically dispersed and therefore work in different time zones. Besides collaborating using

standard means of communication they are often engaged in a very interactive process involving not only their immediate colleagues but also other members of social networks as well. HCI aspects of social media in collaborating environments are still to be explored. Latest mobile devices (smart phones and tablets) with high-resolution displays and impressive specifications offer possibilities for HCI change when it comes to social media and Web 2.0 applications. Software developers began using forums then Wikis and now are relying more and more on micro-blogging and social networks. They are stimulated to consume as well as create new content and their status changes when they solve problems and help others.

Keywords: HCI; social media; collaboration; wiki

In e-learning systems, learners can have the same goal, but not necessarily the same predisposition, or the same knowledge. Therefore, an optimal pedagogical path for one does not necessarily fit the other. Thus, providing an interactive environment tailored to the learner's needs is one of the most important goals of e-learning environments. In our proposal, we make the adaptation of learning our main objective. Our theoretical framework stems from the fact that HCI is a combination of cognitive, behavioral and computer sciences. On the cognitive and behavioural scope, we have opted for adaptive formative assessment so as to identify the learner's competence level and, thereon, to guide the learner to reach the educationally drawn output profile. The aforementioned assessment highlights the learner's real time competence. The latter and the learner's prior knowledge are pivotal elements in adapting the learning process. On the computing scope, this process is carried out via an e-learning system in which the proposed assessment is implemented through Services Oriented Architecture (SOA).

In this paper, it would be prominent to individualize the learning path by adopting formative assessment by proposing an adaptive test which offers a selection of optimal items in a sequence taking into account the profile and the progress of the learner. To implement the proposed system, first, we modelled learner and items according to competency based approach (CBA). Then, modelled the formative assessment in an adaptive approach using the Item response theory (IRT), this will provide a series of consecutively selected items. The answer to an item determines the selection of the next one taking into account the previous responses and performances recorded in the learner model.

Keywords: E-learning; human computer interaction; adaptive formative assessment; item response theory; services oriented architecture

The main objective of this study is to assess face-to-face and online project based learning environment in various dimensions according to the opinions of students and their success. The study is designed as a qualitative study. Total 77 under-graduate students participated in this study. Data were collected with focus group interviews, observations and performance evaluation scale (rubric) during this study. Data gathered as a result of the study was analyzed with the descriptive analysis methods. Affirmative and negative opinions of the students on project based Human Computer Interaction (HCI) course and online project based HCI course have been emerged. The success of the students both in project based HCI course and online project based HCI course were found to be high. Furthermore, the opinions of the students also determined the problems on the graphical interface design of Moodle LMS.

Keywords: human computer interaction; project based HCI; online project based HCI; Moodle LMS for HCI course

Human-Computer Interaction is a discipline that is getting more interest nowadays, not only because the proliferation of computer science but also due the proliferation of new technological devices that require user-friendly interfaces. Furthermore, new technology is enabling us to attend needs of special groups with specific impairments, such as autistic users. Most efforts have been made in order to integrate curricula for this discipline; also most efforts have been made in the teaching context of these themes. However, it is necessary to continue improving teaching practices, integrating research and good practices from real environments. In this paper we present some experiences in teaching Human-Computer Interaction and Usability Engineering in conjunction with Software Development. Our teaching experiences involve real projects in collaboration with a specialized organization in autism. This teaching environment allows students to interact with end users, making sense of how useful is applying user interface design principles in order to facilitate the life of users with special capabilities.

Keywords: collaboration between academia and autism organizations; user-centered design; teaching Human-Computer Interaction.

The mainstream in undergraduate data mining algorithm education is using algorithms as black-boxes with known inputs and outputs, while students have the possibility to adjust parameters. Newly proposed white-box algorithms provide students a deeper insight into the structure of an algorithm, and allow them to assemble algorithms from algorithm design components. In this paper a recently proposed data mining framework for white-box decision tree algorithms design will be evaluated. As the white-box approach has been experimentally proven very useful for producing algorithms that perform better on data, in this paper it is reported how students perceive the white-box approach. An open source data mining platform for white-box algorithm design will be evaluated as technologically enhanced learning tool for teaching decision tree algorithms. An experiment on 51 students was conducted. A repeated measures experiment was done: the students first worked with the black-box approach, and then with the white box approach on the same data mining platform. Student's accuracy and time efficiency were measured. Constructs from the technology acceptance model (TAM) were used to measure the acceptance of the proposed platform. It was concluded that, in comparison to the black-box algorithm approach, there is no difference in perceived usefulness, as well as in the accuracy of produced decision tree models. On the other hand, the black-box approach is easier for users than the white-box approach. However, perceived understanding of white-box algorithms is significantly higher. Evidence is given that the proposed platform could be very useful for student's education in learning data mining algorithms.

Keywords: white-box algorithms; decision trees; perceived usefulness; perceived ease of use; perceived understanding

In this paper, Usability Engineering (UE) is used to explore geospatial data at the School of Earth Sciences and Engineering, Hohai University, China. In geo-spatial data presentation, exploration and analysis, knowledge is disseminated, accumulated or accentuated. For learning purpose, this knowledge needs to be evaluated. The increasing use of the computer and multi-media to disseminate geographical information place their own specific demands for the final user. By visual presentation, exploration and analysis users are able to identify features in their minds, since visualization qualifies results and not quantification of results. In the Engineering Education (EE) setup, students create Geoinformation related applications which are archived for later use. The spatial knowledge accumulated is sometimes difficult to apprehend when retrieved. Thus a procedure, such as VPA Archival Management System (VAMS), is needed to recall the ideas embedded in the archived datasets. The test method used is the Verbal

Protocol Analysis (VPA). In addition, use of explicit structured questionnaire, video recording, onscreen capturing, and formative evaluation and case study frameworks were used to efficiently, effectively and satisfactorily determine the spatial cognition taking place in user's minds.

Keywords: VPA Archival Management System (VAMS); Human Computer Interaction (HCI); Usability Engineering (UE); Engineering Education (EE); Geoinformation

Section II
Contributions in: Engineering Skills, Ethics, Interdisciplinary Skills, First Year Students, Spatial Ability, Active Learning, Power Electronics, Robotics, Remote Laboratories

Engineers of the future are expected to possess a range of competencies in addition to math and science skills. This paper turns to engineering students to explore what they think it takes to become a good engineer. Profiles are identified by means of a large-scale survey-based investigation of the perceptions of first year engineering students in the US and in Denmark with respect to the importance of math/science skills and interpersonal and professional skills for successful engineering. Four groups of first year engineering students are defined according to combinations of high and low importance assessments of each of the two skill types in both countries. This leads to analytically derived groups emphasizing math/science skills, interpersonal and professional skills, both skill types, and none of the skills. Differences and similarities between these groups are explored in terms of relative group sizes and gender composition, levels of confidence, and motivation to study engineering. The findings show that the four engineering student groups have distinct profiles with different characteristics in terms of motivation and confidence and which may each require different educational approaches to become broad thinking engineers. Apart from the exploratory investigation of group differences within each country, the paper also examines whether the four group profiles are nationally confined or if common tendencies shared by engineering students in both countries exist. The paper contributes to the literature on engineering education and serves to inform engineering educators and institutions worldwide with new insights into the expectations and perceptions of actual students who are at the very beginning of their pathway to an engineering education.

Keywords: engineering skills; broad thinking, engineering education research; comparative survey analysis

The extant research on engineering ethics instruction shows that students receive ethics instruction within the engineering curricula. Unfortunately, the methods used in engineering undergraduate classrooms are described as "abstract" and have mixed results related to impacting students' ethical development. Thus, exploring how out-of-classroom experiences—as a curricular alternative—influences students' ethical development is warranted. This is an exploratory investigation to determine how out-of-classroom experiences influence students' ethical development. The authors define ethical development using three constructs: knowledge of ethics, ethical reasoning, and ethical behavior. We draw upon a conceptual model that suggests students' ethical development is impacted by what takes place inside and outside of the classroom. As the first phase of a multi-year, national study to holistically assess the ethical development of engineering undergraduates in the United States, we conducted focus groups consisting of faculty members and students at 18 institutions. All focus group participants were asked questions related to campus climate, ethics, and involvement in out-of-classroom experiences. Our data suggest that participating in out-of-classroom experiences: served as a complement to the classroom instruction on ethics; helped students connect learning about ethics to the engineering workplace; and, influenced students' ethical development. Given what we learned about the engineering undergraduates' involvement in out-of-classroom experiences, we suggest that engineering faculty members use classroom instruction to connect out-of-classroom experiences to ethics and encourage reflective practice in ethics instruction.

Keywords: out-of-classroom; ethics; qualitative

Calls for greater investments in interdisciplinary education and a shift to outcomes-based accreditation criteria in engineering have led to a need for a measure to assess interdisciplinary learning. The present study describes the development and testing of a survey-based, self-report measure to assess the interdisciplinary competence of undergraduate engineers. Using a nationally representative sample of 5249 undergraduates from 31 institutions, three discrete scales related to interdisciplinary competence emerged from factor analytic procedures: Interdisciplinary Skills, Recognizing Disciplinary Perspectives, and Reflective Behavior. Construct validity of the metrics is demonstrated through a description of the rigorous research and development process for the survey items. Statistical analyses indicate that scales significantly distinguish groups of students (i.e., by engineering discipline and by class standing), thus demonstrating the metrics' concurrent validity.

Keywords: interdisciplinary skills; learning outcomes; assessment

This paper describes and analyses the perceptions of students of the School of Engineering of Los Andes University (Colombia) regarding the new Mario Laserna (ML) building where an infrastructure of laboratories, halls and spaces has been developed with the purpose of promoting collaborative learning and research practices. The design of this new infrastructure for education in engineering is based on the study of some international examples (which will be succinctly presented) and also on the consideration of the role of space and equipment in teaching and learning practices and upon the desired structure of a modern engineering curriculum. The results presented were obtained through the analysis of a survey of the cohort of students who took courses in the old building (W), built in 1968, as well as in the ML building. The survey especially focused on how the new spaces affected the ways the students work and interact with their peers. In the concluding section, certain hypotheses derived from the results are presented with the intention of promoting further studies.

Keywords: engineering social building; engineering competences; active learning engineering; new learning practices

Teamwork is an important skill for the engineer. Numerous universities are designing and experimenting with training programs to develop this competency among their students. The aspects of teamwork that are practiced may vary depending on the methodology used and the context it is used in. But, what teamwork factors influence the effective working of a team? What strategies and activities can contribute to the development of efficacy factors among teams of students in a Project Based Learning context? Having undergone the experience, how important do the students think these efficacy factors are? An activity program was designed and implemented in a CAD subject to develop selected 14 teamwork factors. A pre-post test design was used to compare the level of compliance and to evaluate the importance that the students gave to each of them, using quantitative analysis. Questionnaires were also used with open-ended questions on the experience which were analyzed qualitatively. For all of the factors the level of compliance is higher than for previous experience. The students rated as very important all 14 factors included in the research. The students' perception of acquiring knowledge about efficacy in team working increased significantly. The students also rated positively the instruction they received. We conclude that the activity program and the strategies employed contributed to the smooth operation of the teams and helped to put into practice and develop factors that contribute to effective team working. The most important factors are those related to behaviour, interpersonal relationships and attitude.

Keywords: teamwork; efficacy factors; project based learning

While various spatial tests are available, the Purdue Spatial Visualization Tests: Visualization of Rotations (PSVT:R) has been commonly used to predict students' success in the engineering field. While many studies that used the PSVT:R exist, little attention had been given to its psychometric properties in measuring spatial ability and relationships to other academic indices. The purposes of this study were (a) to characterize the item- and test-level functions of the Revised PSVT:R for the use of incoming First Year Engineering (FYE) students, and (b) to investigate its relationship to academic-related variables to provide validity evidence. Approximately 2400 FYE students enrolled in the fall of 2010 and 2011 in a large Midwestern public university completed the Revised PSVT:R. Students' academic-related variables were also retrieved from the university archive. A variety of statistical analyses, including exploratory and confirmatory factor analyses as well as item analyses, were conducted on the Revised PSVT:R scores. Pearson's product–moment correlation coefficients between the Revised PSVT:R and other academic variables were also obtained. The Revised PSVT:R measures a unidimensional subcomponent of spatial ability. Cronbach's α was 0.84. Items were relatively easy and the test provides the most precise estimate for students whose ability level is at or below average. Weak to moderate correlations were found between the Revised PSVT:R scores and the aptitude test scores. The Revised PSVT:R is a psychometrically sound instrument. However, items are relatively easy, but it is still appropriate to measure spatial visualization ability of the FYE students.

Keywords: first year engineering students; Revised PSVT:R; mental rotation; psychometric properties

This paper describes a novel laboratory for experimental work in electronic engineering in the fields of power electronics and electric machine control. The learning methodology has been developed to improve the technical skills and motivation for experimental work and theory comprehension. The laboratory facilitates training with software and hardware elements in quasi industrial electronic systems: the main pedagogical objective through experimental work is the transfer of academic knowledge to professional practice. The addition of remote operation of these systems and the educational resources shared on its own web platform expands the learning activities out of the campus area. The possibility of total access to parameters and variables in the educational electronic converters proposed, which are difficult to manage in commercial equipment, promotes students interest and academic proficiency. A better use of the hands-on laboratory equipment and the simulation software in real designs are topics within the scope of the proposed laboratory.

Keywords: engineering education; power electronics; computer applications; control systems

Current proposals of virtual labs (VL) and remote labs (RL) do not either cover new needs properly or contribute remarkable improvement to traditional labs—except that they favor distance training. This paper poses a new reality and new teaching/learning concepts in the field of lab exercises in Robotics. The developed augmented reality-based lab system (which we have called augmented remote lab, ARL) enables professors and students to work remotely (Internet/intranet) in current classroom labs (CL), including virtual elements that interact with real ones. An educational experiment was conducted to assess the developed ARL in the lab component of the *Robotics and Industrial Automation* course, which is part of the new Electronic Engineering degree (adapted to the European Space for Higher Education). The labs were carried out by means of three different possibilities: CL, VL and ARL. Although the results are still preliminary and need further study, they seem to conclude that ARL remarkably improves the possibilities of current VL and RL. Furthermore, the ARL allows further possibilities when used online than traditional laboratory lessons completed in CL.

Keywords: robotics; augmented reality; virtual scenarios; online education; augmented remote lab

In this paper we will present the development and implementation of automation, regulation and measurement of heating energy consumption in the University auditorium, which could be used for training and education in different engineering fields (civil engineering, control engineering, process engineering and software engineering). Using a real remotely controlled system, educators are able to demonstrate the real-world principles of thermodynamics, fluid mechanics, and controls as well as to compare data from real systems and from models and software simulations. The presented system is in use at the Faculty of Mechanical Engineering in Kragujevac.

Keywords: HVA; heating systems; engineering education; energy consumption; buildings