Editorial

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1 Introduction

As part of academic activities of the China-EU Science and Technology Year, the first Sino-European Workshop on Intelligent Robots and Systems (SEIROS'08) was held in Chongqing, China on 11–13 December 2008. The workshop was jointly organised by the Chongqing University of Posts and Telecommunications (CQUPT), the University of Essex, Staffordshire University, Chinese University of Hong Kong, University of Hamburger, etc. and was

financially sponsored by the Ministry of Science and Technology, China and CQUPT.

The SEIROS'08 received around 300 papers from China, Europe and India, and only 70 papers were accepted for presentation. Ten keynote talks and three parallel sessions were held during the event. This special issue contains ten invited papers, mainly from SEIROS'08 through a rigorous review process. The emphasis of this special issue is on sharing the experiences of researches on human adaptive mechatronics (HAM). Here we would like to express our sincere appreciation to all authors and reviewers.

The concept of HAM was first proposed in the Center of Excellence Project of Tokyo Denki University (TDU) (Furuta, 2003). HAM is a new discipline that integrates mechanical, electrical and information technologies to various human related sciences. These biological sciences include medicine, neuroscience, cognitive science, psychology and evolutionary systems. It is important to notice that in HAM studies, humans are considered part of closed loop control systems. This systematic approach brings human activity a distinctive feature distinguishing the new discipline from standard engineering. This special issue covers three areas of research in HAM:

1 intelligent control

2 human machine systems

3 advanced mechatronics.

2 Intelligent control

There are two papers in the area of intelligent control.

Owens and Chu contributed the first paper, 'Accelerated norm-optimal iterative learning control'. This paper presents a novel technique for accelerating the convergence of the previously published norm-optimal iterative learning control (NOILC) methodology made by Owens, namely that the NOILC algorithm is equivalent to a successive projection algorithm between linear varieties in a suitable product Hilbert space. This leads to two proposed accelerated algorithms together with well-defined convergence properties. The results show that the proposed accelerated algorithms are capable of ensuring monotonic error norm reductions and can outperform NOILC by more rapid reductions in error norm from iteration to iteration. The paper developed theoretical foundation which will build up the confidence in applying the iterative learning control methods in mechatronics and robotics.

Chen, Xu, Yang and Wang provided the second intelligent control paper, 'Minimum entropy control for a class of macro-micro robot based on ILC frame'. This paper considers the closed loop randomness issues for a kind of intelligent welding robot systems. Based on bounded random disturbances, the parameters of the iterative learning controller have been optimised according to a minimum entropy index function by using the minimum entropy control method. In addition, the effectiveness and feasibility of the proposed iterative learning control schemes are verified by using an experimental robot.

3 Human machine systems

There are four papers in the areas of human machine systems.

Geng, Gan and Hu wrote the first paper on human machine systems, 'A self-paced online brain-computer interface (BCI) for mobile robot control'. This paper conducts the design and online experiments of a self-paced online BCI for controlling a simulated robot in an indoor environment. Three one-vs-rest linear discriminant analysis (LDA) classifiers are combined to control the switching between automatic control and subject control modes. The hierarchical structure of the controller allows the most reliable class (mental task) in a specific subject to play a dominant role in the robot control. A group of simple rules triggered by local sensor signals are designed for safety and obstacle avoidance in the automatic control mode. Due to the intuitive nature of the controller and the small number of automatic control rules, a subject has much flexibility and full control of the robot. Online experiments have shown that subjects successfully control the robot to circumnavigate obstacles and reach some specified targets in separate rooms by motor imagery of their hands and feet.

Yang, Xiao, Shen, Bian, Zhao and Cui provided the second paper on human machine systems, 'Design and implementation of a BCI based on virtual instrumentation'. The paper studies an online BCI based on visual evoked potential P300. The BCI is applied to control a multi-DOF manipulator. The proposed BCI system includes five modules which are visual stimulator, signal acquisition, data processing, communication and motion control of the manipulator. The manipulator is self-designed and developed with the ability of six-direction-free moving and simple two-direction operation. The manipulator can move forward and backward, go up and down, turn to left and right. Also the manipulator can grasp and release a little pot. In the experiment, the subject chooses the right oddball on a CRT/LCD displayer with eight blocks which are corresponding to the directions and the operations, and gazes at it. The electroencephalography (EEG) of the subject is sampled to extract P300 feature. The algorithms of peak extraction, correlation analysis and wavelet transform are used to analyse EEG. Based on comparison of the algorithms, wavelet transform is the best way to extract P300. The manipulator is controlled to move or operate by the subject's EEG with wire or wireless communication. The experiments show that the subject with little training can control the manipulator properly.

Tervo and Koivo produced the third paper on human machine systems, 'Towards human skill-adaptive manual control'. The paper reviews and investigates of human adaptive mechatronics and develops a general framework for development of a human skill adaptive control system to enhance the efficiency of human operated tasks in human-machine systems. The paper also proposes a skill

adaptive algorithm and a method on identifying the parameters of the control model of a human operator.

Zhao, Hou, Zhao and Tan contributed the fourth paper on human machine systems, 'Topological localisation based on monocular vision and unsupervised learning'. The paper presents a new method for mobile robots to recognise scenes with the use of a single camera and natural landmarks. In a learning step, the robot is manually guided on a path. A video sequence is acquired with a font-looking camera. To reduce the perceptual alias of features easily confused, the paper adopts a modified visual feature descriptor which combines colour information and local structure. A location features vocabulary model is built for each individual location by an unsupervised learning algorithm. In the course of travelling, the robot uses each detected interest point to vote for the most likely location. In the case of perceptual aliasing caused by dynamic change or visual similarity, a Bayesian Filter is used to increase the robustness of location recognition. Experiments are conducted to prove that application of the proposed feature can largely reduce wrong matches and performance of proposed method is reliable.

4 Advanced mechatronics

There are four papers in mechatronics and robotics.

Yu, Liu and Hasan provided the first of these advanced mechatronics papers, 'Review of modelling and remote control for excavators'. The paper reports the current progress of the ongoing project and investigates modelling and remote control issues of industry excavators. After reviewing the literature on the related work, architecture for remotely controllable excavators is proposed. The architecture covers actuators, modelling, sensors, image signal processing, communication networks, controllers, task and path planning, human computer interaction, optimal design, co-simulation, and virtual training environment. The details of modelling, communication and control of a remotely controllable excavator are provided.

Rao, Gao, Gong and Luo wrote the second paper on advanced mechatronics, 'Robotic small unmanned aerial vehicle system for disaster information gathering'. The paper investigates the development of a robot small fixed-wing unmanned aerial vehicle (SUAV) which has an enormous potential for low-altitude exploration applications. In order to develop a robot SUAV with high level of autonomy for disaster information gathering, the flight control and navigation system is presented, and the hardware and software development is described in details. The dynamic model of flight motion of SUAV is studied. As the kernel of the system, the architecture of flight control and navigation strategies are presented, and a variable universe fuzzy attitude controller and a mission path tracking controller are introduced in detail. The flight experiments for low altitude information gathering using this robotic SUAV are implemented, and the flight results are given and analysed.

Zhang, Zhang and Wang contributed the third paper on advanced mechatronics, 'From the biological model to a small climbing caterpillar robot'. The paper presents an overview of their ongoing project on a bio-inspired climbing caterpillar robot. The paper investigates locomotion kinematics adopted by climbing robots, reviews the natural creatures which can climb on vertical surfaces in different materials with a special attention on the natural caterpillars' locomotion mechanism, adopts a hybrid strategy which combines climbing techniques with a modular approach to realise a novel prototype as a flexible wall climbing robotic platform featuring an easy-to-build mechanical structure, a low-frequency vibrating passive attachment principle and various locomotion capabilities.

Fan and Bicker provided the fourth paper on advanced mechatronics, 'Design and validation of an FPGA-based self-healing controller for hybrid machine tools'. The paper proposes an field programmable gate array (FPGA)-based self-healing controller for hybrid machine tools (HMTs) to meet the high speed sampling rate requirement, and designs a circuit of self-healing controllers as well as velocity profile generators for HMTs using the very high speed integrated circuit hardware description language and implemented with an FPGA. A self-healing controller framework for HMTs is proposed, and incorrectly measured leg position faults and incorrectly measured leg velocity faults are considered as examples. Faults are detected by fault detection and isolation module considering the closed loop kinematics chain constrains of spatial hybrid mechanism utilising a sensor passive leg. When a fault is detected, the control system and the desired joint space trajectory are reconfigured according to the nature of the isolated fault, and the task is resumed to the largest extent possibility. Feasibility and performance of above self-healing controller are validated by experiments and simulation examples.

References

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