Editorial

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1 Introduction

The creation of this journal has been well discussed within a wide range of researchers. The three terms included in the title of the journal are in response to widespread requests from workers in many research and application fields. The prefix of the journal, 'International', is properly interpreted from its editorial board membership. No doubt *International Journal of Modelling, Identification and Control* (*IJMIC*) will be an excellent forum to reflect high-quality research work around the world. The focus of the journal will clearly be on innovative research results in which new ideas are presented, as opposed to incremental developments. Early stage results, yet to be fully formulated or established, are strongly encouraged. Submitted papers directed towards any or all aspects of modelling, identification and control are encouraged.

To celebrate the creation of the new journal, we are very pleased to organise this inaugural issue on Intelligent Robot Systems. As mentioned in the call for papers, we wish to focus on all aspects of modelling, identification and control, from theory to practice, as they are encountered in intelligent robot systems. This subject area includes, but is not limited to, smart sensors and sensor systems, adaptive actuators, mobile robots, collective/collaborative robot behaviours, autonomous robots and all other aspects of robot intelligence from learning through problem solving and task planning to application-specific focused software techniques. We are particularly interested in novel and innovative methods and robots for this first issue rather than mere extensions to previous procedures.

Some of the papers were invited and others were submitted from the call for papers. An attempt has been made to, as much as possible, cover a wide range of control, sensor and robot types and we believe that in this single issue, such a result has been achieved. The contents of the studies are briefly described as follows.

2 Control and experimentation of a personal robot tracking system, by I.C.B. Goodhew, B.D. Hutt and K. Warwick

In this paper, the discussion is focused on the concept of a personal robot system, which is capable of tracking and following a human operator. A prototype robot has been designed and constructed to function externally within a humancentric environment, and this is introduced. The main features of its operation are described and some specific problem areas, due to the nature of the robot, are considered. In particular, the robot's method of tracking is detailed, initially by considering the realistic options available before the final method was selected. Some important features of the robot's construction are outlined, again with reference to alternatives available and reasons for the final selection. The method of tracking control employed by the robot thus far is discussed and an indication is given to future possible procedures, which could be tried. Finally, some experimental results are given, with a particular focus on the robot's head tracking performance.

3 A communication-based multirobot rigid formation control system: design and analysis, by Lei Cheng, Yongji Wang and Quanmin Zhu

In this study, a system with cooperative formation control of group of mobile robots is presented to provide a framework to build-up complex systems through communication channels. An improved closed-up multirobot rigid formation control algorithm is developed to efficiently implement the systems without markers and other environment constraints under certain complex situations. Furthermore, a fault-tolerance mechanism for multirobot formation is firstly introduced, based on the hierarchy graph of formation theory. This study covers the design and analysis for the overall communication-based system. The results have been obtained via a series of virtual robot simulations and experiments of using three mobile robots, which have well demonstrated the efficiency of the proposed procedure.

4 A decoupled fuzzy indirect adaptive sliding mode controller with application to robot manipulator, by Hanène Medhaffar, Tarak Damak and Nabil Derbel

This paper presents a decoupled adaptive fuzzy sliding mode control for robotic manipulators. This controller is proposed for a class of MIMO systems with unknown non-linear dynamics. Indeed, an online fuzzy adaptation scheme is suggested to approximate unknown non-linear functions to design the sliding mode controller. Moreover, the proposed controller is replaced by a local decoupled controller for each arm. The stability of the proposed control scheme is proved. As an illustration, the trajectory control of a two degrees-of-freedom robotic manipulator is considered.

5 Safety in numbers: fault-tolerance in robot swarms, by Alan Winfield and Julien Nembrini

The Swarm Intelligence literature frequently asserts that swarms exhibit high levels of robustness. That claim is, however, rather less frequently supported by empirical or theoretical analysis. But what do we mean by a ‘robust’ swarm? How would we measure the robustness or – to put it another way – fault-tolerance of a robotic swarm? These questions are not just of academic interest. If swarm robotics were to make the transition from the laboratory to real-world engineering implementation, we would need to be able to address these questions in a way that would satisfy the needs of the world of safety certification. This paper explores fault-tolerance in robot swarms through Failure Mode and Effect Analysis (FMEA) and reliability modelling. The work of this paper is illustrated by a case study of a wireless connected robot swarm, employing both simulation and real-robot laboratory experiments.

6 State-PID feedback control with application to a robot vibration absorber, by Ge Guo, Junfei Qiao and Zi Ma

The pole-placement problem of linear systems by state-PID feedback is investigated. A general and efficient pole-placement solution for linear time-invariant systems with state-PID feedback is derived using the traditional procedures of full state feedback. The principle, called Separating Theorem, holds for pole-placement by state-PD, state-PI and state-PID feedback and is successfully applied to the control of a robot vibration absorber. These results open a new area for the design and tuning of state-PID feedback types of controller.

7 Non-linear robust control with partial inverse dynamic compensation for a Stewart platform manipulator, by Shaowen Fu, Yu Yao and Tielong Shen

This paper presents a non-linear robust control approach for a Stewart platform manipulator with partial inverse dynamic compensation. Firstly, the complete model of the manipulator’s dynamics is derived by using a Lagrange method that describes the motion of the upper platform and the six legs. Then, the coupling force caused by the dynamics of the legs is compensated using the Newton–Euler inverse dynamic formula, which makes the compensation algorithm much simpler without computing the complex forward dynamics. A robust tracking control approach is shown to cope with the uncertainties, including the modelling error and the remains of the partial compensation and the disturbances. The controller is designed based on the Lyapunov framework. It is shown that a simple feedback law that achieves the desired tracking performance can be designed by putting the physical property of the compensated system into the Lyapunov function. Finally, to verify the validity of the proposed approach, a simulation result is demonstrated.

8 Integration of a novel path planning and control technique in a navigation strategy, by Elie Maalouf, Maarouf Saad, Hamadou Saliah and Faysal Mnif

The purpose of the work presented in this paper is to present a novel optimisation approach for path planning based on dynamic programming and to integrate it into a proposed navigation strategy. The proposed navigation strategy is a finite-state machine that integrates three navigation aspects. This strategy falls in the category of hybrid architectures. The two aspects other than path planning discussed in this paper are path tracking and obstacle avoidance. Other aspects and behaviours can easily be added. For path tracking, a fuzzy control technique is suggested. The fuzzy controller is used to drive the robot through a set of waypoints leading to the destination. The curvature velocity method is proposed for obstacle avoidance. The testing was conducted on a P3-AT all-terrain mobile robot equipped with encoders, a gyroscope and sonar sensors for localisation and environment perception. The test results validate the theoretical analysis.

9 Coordinated control of mobile antennas for ad hoc networks, by Gianluca Antonelli, Filippo Arrichiello, Stefano Chiaverini and Roberto Setola

This paper investigates the implementation of a wireless mobile ad hoc network to guarantee that an autonomous agent, that is an autonomously driven mobile vehicle or a human, remains connected to a fixed base station while performing its own mission. To this purpose, the use of a platoon of mobile robots is proposed to carry a number of repeater antennas; these are suitably moved to dynamically ensure a multi-hop communication link to the moving agent, hence extending and adapting the area covered by the sole base station. Self-configuration of the robots' platoon is achieved by a singularity-robust task-priority inverse kinematics algorithm via the definition of suitable task functions. The obtained simulation results show the effectiveness of the proposed approach.

10 Global fast terminal sliding mode control for robotic manipulators, by Shuanghe Yu, Ge Guo, Zi Ma and Jialu Du

A Global Fast Terminal Sliding Mode Controller (GFTSMC) is proposed for *n*-link rigid robot manipulators by employing the fast terminal sliding mode control concept in both the reaching phase and the sliding phase. Under the control, the system states will reach the terminal sliding manifold in a desired finite time and then converge to the origin along the sliding manifold in a specified finite time, resulting in reduced steady tracking error in comparison with the linear sliding mode controller. The proposed sliding mode controller is continuous and therefore is chattering-free. An example is shown to demonstrate the effectiveness of the controller.