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Newsletter

Contents:

IFAC Council and Related Meetings
in conjunction with the
IFAC Conference on Manufacturing, Modelling, Management and Control – MIM 2000
Athens/Patras, Greece, 10 – 14 July, 2000

This year's Council meeting took place in Patras, Greece on July 14, 2000 in conjunction with the IFAC Conference on Manufacturing, Modelling, Management and Control – MIM 2000. The invitation to hold the Council meeting in Greece was extended by the Technical Chamber of Greece as the Greek NMO and the Technical University of Patras. The Council meeting was preceded by meetings of the Technical Board and Coordinating Committees and of the Executive Boards and Executive Committees. Also the IPC for the next IFAC Worlds Congress in Barcelona in 2002 was convened in Patras.

A detailed report on the Council and Related meetings will be published in the next issue of the IFAC Newsletter.

The Council- and Related meetings were preceded by a one-day Workshop in Athens, which was organized by the Technical Chamber of Greece, the Greek NMO of IFAC. It had the title: "New Technologies at the Turn of the Millennium: The Role of Control". After some words of welcome by Prof. Peter Groumpos, University of Patras, Prof. Albertos made a statement on "Control and Society". After a brief address by a representative of the Greek Technical Chamber, presentations were made by Dr. Nikos Pronios, Manager R&D Division, INTRACOM S.A. and by Dr. A. Ikonomopoulos, President of ZENON Ltd on "Mobile Robots Challenge the Scientific Community". Following these statements and some interesting questions and comments, a panel discussion was scheduled, with panelists coming from IFAC and from Greek institutions. The panelists were AssProf. Lena Martensson (Royal Institute of Technology, Sweden, member of the Technical Board), Dr. Michael Masten (Texas Instruments, USA, IFAC Council member and Vice-Chair of the Technical Board), Prof. Uwe Kiencke (Universitat Karlsruhe, Germany, member of the Technical Board), Prof. Spyros Tzafestas (National Technical University of Athens), Prof. Kostas Kyriakopoulos (National Technical University of Athens), Prof. Panos Antsaklis (University of Notre Dame, USA, IFAC TC Chair). Their initial statements were followed by a very lively discussion on the role, situation and future of automatic control. Although part of almost every application, automatic control is not always ranked as high as it ought to be. It is also very important that educators strike a balance between the requirements of industry and the need for basic research and overall and broad training of control engineers.

It was very stimulating to hear these panel statements and the sometimes even controversial exchange of opinions, which is important and fruitful and will promote our field.

Gusztav Hencsey, NL Editor

Lagrangian and Hamiltonian Methods for Nonlinear Control
IFAC Workshop
Princeton, NJ USA
March 16 – 18, 2000

A workshop on new approaches to nonlinear control that make use of physical system structure, in particular, Lagrangian and Hamiltonian structure, was held at Princeton University, Princeton, NJ, USA, March 16-18, 2000. In attendance were 65 people from academia, industry and government representing 13 countries. There was a total of 11 regular sessions, all in series, and one poster session. The regular sessions included 19 invited paper presentations and 10 contributed paper presentations. The poster session included 13 poster paper presentations. Sponsors of the workshop included the IFAC Technical Committee on Nonlinear Systems, the American Automatic Control Council, the U.S. National Science Foundation and the U.S. Army Research Office. Breakfast, lunch and coffee breaks were provided each day. An opening reception was held the evening of March 16, a banquet the evening of March 17 and a closing reception in the late afternoon of March 18. A laboratory tour was offered each day during lunch. A preprint volume of all of the papers was provided to the attendees at the workshop and a proceedings volume to be published by Elsevier is in press.

The workshop included papers on new developments in nonlinear control theory, design methodology as well as a wide range of applications. Several papers addressed optimal control theory in the context of mechanical systems. An exciting new research area on optimal control and the utilization of global dynamical structures for the purpose of planning trajectories for space missions (e.g., halo orbit space missions and low-energy transfers from the earth to the moon) was introduced in a couple of papers. Another new theme emerged in a couple of papers on control of groups, notably clusters of satellites, offering challenging nonlinear control problems and solutions based on Lagrangian and Hamiltonian

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Real-Time Programming WRTP'2000

IFAC Workshop
Palma de Mallorca, Spain
17 – 19 May, 2000

Since 1971 the IFAC Workshop on Real Time Programming (WRTP) has consolidated as a forum to exchange information and experience about the relevant topics of real time systems. This year, the WRTP Workshop took place for the 25th time and was organized in the same place and week as the 6th Workshop on Algorithms and Architectures for Real-Time Control (AARTC2000). Both workshops were scheduled sequentially to provide an opportunity to researchers and practitioners to attend both events covering most of the topics relevant to real-time systems. One day (May 17) was designated for common activities (industrial presentations and social activities). The Workshop provided an opportunity to assess the state of the art, to present new results, and to discuss possible lines of future developments and was structured in 9 sessions in the following topics: industrial presentations, embedded systems, real-time operating systems, dependable systems, real-time scheduling, formal methods, object orientation in real-time systems, verification and validation of real-time systems, distributed real-time systems and applications.

There were 48 paper submissions from 16 countries. The contributions came from Europe, North America, Australia, and the Far East. Each paper was reviewed by at least three referees, who gave marks. The highest scoring 31 papers were selected for acceptance and assigned to be presented in 9 sessions. A special session (jointly with the AARTC2000) was dedicated to three industrial experiences presented by authors from the industry. The workshop was attended by 65 participants from 17 different countries. 35 participants attended both workshops.

The Workshop was jointly organised by the Universitat Politècnica de Valencia and the Universitat de les Illes Balears. The Workshop was very well organized in a family-style atmosphere which stimulated intensive and successful discussions. The many positive comments made by the participants of this workshop confirm its success in meeting its objectives. The organization of both Workshops was considered an excellent opportunity to put in common experiences of both communities.

Alfons Crespo
Workshop Chairman

Algorithms and Architectures for Real-Time Control (AARTC'2000) 6thIFAC Workshop

Palma de Mallorca, Spain
15 – 17 May 2000

The Universidad Politécnica de Valencia and the Universitat de les Illes Balerars were the hosts of this IFAC Workshop held at Melia Confort Atenea Hotel, Palma de Mallorca, Spain.

This Workshop was the sixth in the series. Previous Workshops in this area were held at Bangor, UK (1991), Seoul-Korea (1992), Ostend-Belgium (1995), Vilamoura-Portugal (1997) and Cancun-Mexico (1998).

The objective, as in previous editions, was to show the state of the art and to present new developments and research results in software and hardware for real-time control, as well as to bring together researchers, developers and practitioners, both from the academic and the industrial world.

This year, the 25th edition of the Workshop on Real-Time Programming 2000 (WRTP) took place during 17-19 May in the same place as the AARTC'2000. Both workshops were scheduled sequentially to provide an opportunity to researchers and practitioners to attend both events covering most of the topics relevant to real-time systems. A common day (May 17) was designated for common activities (industrial presentations and social activities).
An important novelty in the organisation of the workshop was the use of Internet for submission and review of papers. In particular, the review process was carried out through the web. Each reviewer was provided with a password in order to retrieve papers and communicate the review results.

The AARTC'2000 Technical Program consisted of a total of 38 papers, previously selected from high-quality full draft papers and late breaking paper contributions (consisting of extended abstracts). 35 papers were presented in 11 sessions, covering the major areas of software, hardware and applications for real-time control. In particular, sessions addressed robotics, embedded systems, modeling and control, fuzzy logic methods, industrial process control and manufacturing systems, neural networks, parallel and distributed processing, processor architectures for control, software design tools and methodologies, and SCADA and multi-layer control. 59 participants from 15 different countries attended this workshop and 35 of them attended also WRTP'2000.

The technical program also included two plenary talks given by invited leading experts in the field: Roger Goodall (Loughborough University, UK), who presented a talk on *Perspectives on Processing For Real-Time Control*, and Ricardo Sanz (Universidad Politécnica de Madrid, Spain) who focused his talk on *CORBA for Control Systems*.

Another highlight in the program was the final session on industrial presentations which was successfully held in common with the WRTP'2000. In this session, Abel Jiménez (Industria de Turbo Propulsores S. A., Spain) presented the *Thrust Vectoring System Control Concept*, Ulrich Schmid (Technische Universität Wien, Austria) made a presentation with the title *Applied Research: A Scientist's Perspective*, and Harold W. Lawson (Lawson Konsult AB, Sweden) addressed *Systems Engineering of a Successful Train Control System*.
The next IFAC global event, IFAC Conference on New Technologies of Computer Control 2001 (NTCC 2001), will take place in Hong Kong China, November 19-22, 2000. It will be organised by the Control, Automation and Instrumentation Division of the Hong Kong Institution of Engineers (http://starship.mech.hku.hk/NTCC2001). 5 IFAC Technical Committees (including AARTC) will sponsor the event. Those readers who are interested in NTCC 2001 please contact K. C. Cheung (conference secretariat) at ntcc2001@starship.mech.hku.hk.

Vicente Hernández
Workshop Chairman.

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Accelerator and Large Experimental Physics Control Systems ICALEPS 1999

EPS/IFAC International Conference
Stazione Marittima, Trieste, Italy
4 – 8 October 1999

ICALEPCS'99, was organised by Sincrotrone Trieste and co-organised by the European Physical Society's (EPS) Interdivisional Group on Experimental Physics Control Systems (EPCS) and the Istituto Nazionale di Fisica Nucleare (INFN). The event was chaired jointly by Dr. Daniele Bulfone of Sincrotrone Trieste and Dr. Axel Daneels of CERN. A committee from Sincrotrone Trieste and "*the office*" company endorsed the local organisation.

Almost 400 control specialists from 32 different countries covering Africa, America, Asia and Europe and representing 116 organisations (scientific institutes and industries) came together to exchange their views on the latest developments and new trends in control systems for accelerators and large Experimental Physics facilities. In the spirit of extending participation to the Conference, 38 participants coming from industrially emerging nations were given financial support to partially/totally cover participation expenses including hotel and living subsidy, travel costs and Conference fee.

The series of ICALEPCS conferences started 12 years ago in 1987 in Villars-sur-Ollon, in Switzerland. The ICALEPCS circle around the world. In 1989 the Conference was held in Vancouver, the 1991 event was held in Tsukuba, in 1993 it took place in Berlin, in 1995 in Chicago and in 1997 in Beijing. The Conferences saw the number of participants increasing as well as the number of Institutes and countries.

The ICALEPCS'99 Scientific Programme

General Overview

The scientific and technical programme of ICALEPCS'99 covered the field of controls of particle accelerators, detectors, telescopes, nuclear fusion devices, nuclear reactors, etc. Traditionally dominated by the particle accelerators, ICALEPCS'99 saw an increased number of contributions from the plasma physics and astronomical community and also, although to a lesser extent, from the particle detectors community.

All aspects, hardware and software, of Experimental Physics control systems were considered.

ICALEPCS'99 concentrated more specifically on how controls can contribute to the overall success of an Experimental Physics project. With this objective in mind, different technology and engineering issues were studied. State-of-the-art software and hardware technology was reviewed in terms of the possibilities it offers to deal with systems of increasing complexity and sophistication within restricted budgets and human resources.

The Conference Scientific Programme involved *ex cathedra* invited oral contributions, oral contributions and poster presentations, four tutorials and a round-table discussion. Two pre-Conference workshops were also organised. The ICALEPCS'99 Proceedings are already available on the WWW at

http://www.elettra.trieste.it/ICALEPCS99.

Oral and Poster Presentations

On the basis of the abstracts that were received, the Programme Committee defined nine topical sessions. These were organised

into thirteen oral session "slots" of about ninety-five minutes each and three poster sessions. Parallel oral sessions were limited to Tuesday and Wednesday morning only; overlaps between oral and poster sessions on the same topic were carefully avoided.

Status Reports

The oral and poster presentations of this session covered a variety of control and data acquisition projects of new Experimental Physics facilities that are either at the stage of a technical proposal or being constructed. It also covered installations that reached a mature level of operation but are considered for re-engineering.

Of the accelerator facilities reports were given of the Swiss Light Source (SLS) that is being built at the Paul Scherrer Institute in Villigen (Switzerland) and the Spallation Neutron Source (SNS) to be built in Oak Ridge (USA).

Controls of experiments, typically particle detectors, involve different components. There is the so-called "slow control" that is responsible for "slowly varying" parameters such as temperatures, power supply voltages or currents, vacuum pressures, etc. These parameters vary at a rather low frequency, but are characterised by the large number of input/output points. In addition there is the "detector control" or "run control" that is in charge of the front-end hardware and of the detector calibration. Eventually there is the actual Data Acquisition System (DAQ) that collects all the data on the occurrence of an event and that has to reconstruct the phenomenon that has happened in order to extract data that may be significant for physics. Experiments that were discussed in terms of their different control components were the ATLAS experiment, one of the four large LHC experiments at CERN, the RHIC STAR experiment at Brookhaven National Laboratory (USA) and the HERA-B at DESY (Hamburg).

Project Engineering and Management

The importance of engineering in general, the use of engineering standards and the need for project management practices were explained at length in this session.

It was recognised that control projects often suffer from poor engineering, management and planning. This should be no surprise as project engineering and management has much of a "multivariable" system involving product-people-process-technology. And the complexity of this "multivariable" system is enhanced by the fact that one of the variables concerns "People". Whereas technical difficulties generally have solutions, human problems are far more delicate.

Those attending this session were warned of mistakes to avoid and given valuable tips for improving productivity, reliability (e.g. by applying configuration control, making procedures and automatic tests to improve the quality of the delivered system) and team motivation.

Examples were also given of modern, industrial style, project management practices that were applied for the development of control software for accelerators and telescopes, as well as in industry. Such practices proved to be a determining factor in the successful commissioning and operation of any modern project, including control systems. It was again stressed, however, that inadequate requirements and bad time estimates put a heavy mortgage on the design, development and maintenance of control systems for Experimental Physics facilities too.

Selecting and Integrating Industrial Systems in Experimental Physics Controls

Industrial systems, hardware and software, are increasingly used for the control of sub-systems needed by experimental physics facilities.

SCADA systems in particular have demonstrated their effectiveness for controlling systems such as the cryogenics, vacuum, personnel access, etc. They are now also being analysed in the light of their possible use for accelerators and large particle detectors. Besides technical aspects, these systems tend to impose standardisation - SCADA abide to most industrial software and hardware standards - while closely following the evolution of the technology. These products run mostly on NT and contribute to its adoption also in Experimental Physics controls.

Software: Configuration and Databases

The successful implementation of today's control systems and the subsequent successful operation of the associated Experimental Physics facility depend heavily on the availability and integration of numerous categories of data and information throughout its lifecycle. Control systems are increasingly built within a framework of industrial off-the-shelf components (hardware and software) standards and generic applications. In the design and implementation phase access is needed to engineering and manufacturing data, technical documents, naming convention, as well as layout information. For operation, trouble shooting and maintenance, information related to run-time configuration, device settings, feedback and alarm parameters, logging of all signals that might help in identifying the source of degraded performances, archived data, process history related data as well as for example cabling listings, are indispensable.

This session thus emphasised the crucial role played by well-integrated centralised data repositories. Presentations focused on configuration management using databases containing reference data as well as on the archiving of diagnostic data.

Indeed, controls are no longer stand alone systems but rather part of a web which ties physics to other areas, both technical and administrative, of the organisation in a so-called Computer Integrated Manufacturing (CIM) environment. Databases are the logically central repository not only of operational information, but also for administration. Their reliability and scalability are considered of paramount importance.

Software: Distributed Computing Software

The Distributed Computing Software session covered innovations in many areas of controls, from accelerators to large physics detectors, from astronomy to fusion and medical applications. It gave opportunity to learn about these novel technologies in distributed computing e.g. Java, CORBA, the WWW and more.

Examples were given of distributed Object-Oriented control systems, many of which are based on CORBA and CDEV. DYNACORE deserved special attention. It is a European Union (EU) funded project that aims at developing a tele-operation system. It is based on a component-based Object-Oriented approach where CORBA ensures the high level infrastructure for the interaction of the components. The client software relies on Java applets. The system is used for the remote operation of large plasma physics experiments and telescopes.

The use of WWW based techniques for remote participation to experiments and platform-independent access to data archives was illustrated for the case of JET and LHC equipment test data.

Hardware Technologies

Advances in the performance and functionality of digital technology together with their decreasing cost allow considering ever more sophisticated applications to improve the performance of Experimental Physics equipment hardware.

A new generation of power supplies in particular is taking advantage of the available digital technology by the use of embedded DSP controllers, digital generation of high stability, high precision reference signals, real-time algorithms for regulation.

Digital techniques are also more and more adopted for the measurements of the accelerator beam parameters requiring higher precision and higher sampling rates.

Of particular concern are timing systems. Telescopes as well as Tokamaks and accelerators require high stability, high precision and highly flexible timing systems, both event timing and counter-based systems.

Modern control systems are highly distributed and thus heavily rely on the performances of the underlying networks. Increasing demand for more information exchange between the nodes of the network pushes laboratories to upgrade their networks which, although state-of-the-art when the system was designed, are now superseded by considerably more advanced technologies.

Issues relating to personnel safety systems and radiation-damage problems of Commercial Off The Shelf (COTS) electronic equipment were also given due consideration.

Process Tuning and Feedback Systems

Many interesting feedback systems from the different fields of Experimental Physics were presented. They exploit state-of-the-art technology for measuring sensors, processing of the algorithms and actuators.

Evolution of a Control System: Maintenance, Upgrading, Re-Engineering

Computer technology evolves very rapidly when compared to the lifecycle of most Experimental Physics facilities. This situation provides many opportunities for the upgrade or more fundamental re-engineering of the control systems of these facilities, both for improving their performance or to avoid becoming obsolete. A side effect is, of course, the impact on maintenance.

It is interesting to note that several re-engineering projects brought the introduction of PCs at the different levels of the control system architecture. They run NT or Linux, whose popularity is growing more and more.

Control systems also evolve to integrate "intelligent systems" which prove to be useful e.g. in fault detection where advanced techniques such as neural networks, fuzzy logic or even Multi-Agent Systems (MAS) are applied.

Along these lines one also witnesses a clear migration of increasing intelligence within the controlled devices, hence allowing the higher level controls to perform the more complex activities by delegating the detailed functionality to the front-end processors.

ICALEPCS 2001

The next International Conference on Accelerators and Large Experimental Physics Control Systems, ICALEPCS 2001, will be held in fall of 2001. For information, please contact:

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(CERN, Geneva, Switzerland)

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Survey Paper

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Papers

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Simultaneous Parametric Uncertainty Modeling and Robust Control Systhesis by LFT Scaling
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(E.H. Abed, D. Lindsay, W.A. Hashlamoun)
Robust Receding Horizon Predictive Control for Systems with Uncertain Dynamics and Input Saturation
(Young Il Lee, B. Kouvaritakis)
Predictive PI-control of Linear Plants under Positional and Incremental Input Saturations
(D. Angeli, A. Casavola, E. Mosca)
A Strategy for Controlling Nonlinear Systems Using a Learning Automaton
(X. Zeng, J. Zhou, C. Vasseur)
Calibration and Estimation of Redundant Signals
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(L. Jaulin)
The Application of Matrix Differential Calculus for the Derivation of Simplified Expressions in Approximate Non-linear Filtering Algorithms
(C. Bohn, H. Unbehauen)

Book Reviews

Modern Control Systems, by R.C. Dorf and R.H. Bishop
(P.-O. Gutman)
Robust Control: The Parametric Approach, by H. Chapellat and L.H. Keel
(A. Garulli)

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methods. A special session on control of quantum mechanical systems introduced the audience to a sub-field teeming with new nonlinear control problems of potentially great reward. Quantum control problems have a diversity of applications, for example, nuclear magnetic resonance (NMR) in medicine. A number of papers addressed the problem of control and stabilization of mechanical systems, namely under-actuated systems and interconnections of several mechanical subsystems. Solutions were found using energy-shaping approaches and exploitation of generalized Lagrangian or Hamiltonian structure, i.e., symplectic, Poisson and Dirac structures. The role of symmetry, reduction and integrability were identified and often emphasized. Applications included control of smart structures (e.g., mechanical structures with piezoelectric sensor and actuator layers), non-holonomic systems (e.g., wheeled systems), balance systems such as inverted pendula, (multi-body) spacecraft and underwater vehicles.

The technical level of the papers was outstanding and the relevance of the papers to the scope of the workshop was exceptionally strong. Discussions in and out of the formal sessions were stimulating and several new collaborations appeared to have emerged as a result. As the feedback from the attendees was overwhelmingly enthusiastic, the workshop was judged to be a success. The organization of a second meeting on this topic is now being discussed among the participants.

IPC Chairs: Naomi Ehrich Leonard, Princeton University
Romeo Ortega, SUPELEC-LSS

Control Engineering Practice

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(J.-S. Yee, J.L. Wang, N. Sundarajan
Self-tuning Control of Electromagnetic Levitation Systems
(S.-H. Lee, H.-K. Sung, J.-T. Lim, Z. Bien)
Sensor-based Fuzzy Navigation of an Autonomous Mobile Robot in an Indoor Environment
(H. Maaref, C. Barret)
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