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New Approaches in Intelligent Control

Techniques, Methodologies and Applications

Springer

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Preface

Recently various intelligent techniques, for example neural network computing, fuzzy reasoning, genetic algorithms, etc., have been developed in theories and practice, also applied to many intelligent systems all over the world. This volume is titled “New Approaches in Intelligent Control” and introduces some new approaches in intelligent control area from both the viewpoints of theory and application, which consists of 11 contributed chapters by prominent authors from all over the world including this introductory chapter. This volume also divides one dual side with another volume titled “New Approaches in Image Analysis” (Eds. Roumen Kountchev and Kazumi Nakamatsu). Each chapter in this volume constitutes one self-contained monograph, and includes summary, conclusion and future works in terms of its main themes. Some of the chapters introduce specific case studies of various intelligent control systems and others focus on intelligent theory based control techniques with small applications. The most remarkable specificity of this volume is that the last three chapters deal with intelligent control based on paraconsistent logics.

The rest of this chapter introduces the summaries of all contributed chapters.

Design of Fuzzy Supervisor-Based Adaptive Process Control Systems

The modern industrial processes are difficult to model and control by classical means for their nonlinearity, inertia, model uncertainty, and varying parameters. The adaptive fuzzy logic controllers (AFLCs) improve the system performance but are computationally hard to design and embed in programmable logic controllers (PLCs) for wider industrial applications.

In this chapter, a design approach for simple AFLCs is suggested, based on main controllers linear, FLC or parallel distributed compensation (PDC), and fuzzy logic supervisors (FLSs) for online auto-tuning of their gains or scaling factors. The effect is a continuous adaptation of the control surface in response to plant changes. Approximation of the designed AFLC to a PDC equivalent on the basis of neuro-fuzzy and optimization techniques enables the stability analysis of the AFLC system using the indirect Lyapunov method and also its PLC implementation. The AFLC is applied for the real-time control of the processes in a chemical reactor, a dryer, and a two-tank and an air-conditioning systems, decreasing overshoot, settling time, control effort, and coupling compared to classical FLC and linear control systems.

Intelligent Carpooling System: A Case Study for Bacău Metropolitan Area

Mobility is one of the most basic features of our modern society. People and goods move around the entire Earth in a continuous and broad attempt to fulfill economic, safety, and environmental goals. The Mobility Management or Transportation Demand Management is a collection of strategies for encouraging more efficient traffic patterns towards achieving specific planning objectives. For example, people can choose to switch from peak hours to non-peak time, or to cycle instead of using car. Administrative regulations could introduce incentives or reimbursements when alternative commuting modes are used. Governmental policies could include fuel tax increases or pay-as-you-drive freeway taxes or car insurances.

The goal of this chapter is to present several alternative travel modes, their social impact and their utility. As an example, we present two applications for shared-use mobility in the metropolitan area of Bacau, Romania. The applications integrate diverse computing languages with platforms, standards, and technologies. The experimental results are encouraging, allowing us to consider that seamless integration of hybrid management systems for transportation could have tremendous economic and social impact at global scale.

Naval Intelligent Authentication and Support Through Randomization and Transformative Search

The problem addressed, in this chapter, pertains to how to represent and apply knowledge to best facilitate its extension and use in problem solving. Unlike deductive logics (e.g., the predicate calculus), an inherent degree of error is allowed so as to greatly enlarge the inferential space. This allowance, in turn, implies the application of heuristics (e.g., multiple analogies) to problem solving as well as their indirect use in inferring the heuristics themselves.

This chapter is motivated by the science of inductive inference. Examples of state-space search, linguistic applications, and a focus methodology for generating novel knowledge (components) for wartime engagement for countering (cyber) threats (WAMS) are provided.

Big Data Approach in an ICT Agriculture Application

The advent of big data analytics is changing some of the current knowledge paradigms in science as well in industry. Even though, the term and some of the core methodologies are not new and have been around for many years, the continuous price reduction of hardware and related services (e.g., cloud computing) are making the application of such methodologies more affordable to almost any research area in academic institutions or company research centers. It is the aim of this chapter to address these concerns because big data methodologies will be extensively used in the new ICT agriculture project, in order to know how to handle them, and how they could impact normal operations among the project members, or the information flow between the system parts. The new paradigm of big data and its multiple benefits have been used in the novel nutrition-based vegetable production and distribution system in order to generate a healthy food recommendation to the end user and to provide different analytics to improve the system efficiency. Also, different version of the user interface (PC and Smartphone) was designed keeping in mind features like easy navigation, usability, etc.

Intelligent Control Systems and Applications on Smart Grids

This chapter discusses advances in intelligent control systems and their applications in micro-energy grids. The first section introduces a PID fuzzy model reference learning controller (FMRLC) implemented in the control loop of static VAR compensator (SVC) to stabilize the voltage level in the island mode microgrid. FMRLC performance is compared to the conventional PI controller. The introduced results show that SVC with FMRLC has better capabilities to compensate for microgrid nonlinearity and continuous adaptation for dynamic change of the microgrid's connected loads and sources. The second section discusses performance optimization of micro-energy grid. A recent heuristic optimization technique, called backtracking search optimization algorithm (BSA), is proposed for performance optimization of micro-energy grids with AC/DC circuits, where it is used for the selection of the scheme parameters of PWM pulsing stage used with a novel distributed flexible AC transmission system (D-FACTS) type called green plug-energy economizer (GP-EE). The following section includes simulation models and results to illustrate the merits of the proposed intelligent control designs and their use to achieve high-performance micro-energy grids.

Control Through Genetic Algorithms

Many real-world applications require automatic control. This chapter addresses genetic algorithms to achieve the control, based on their numerous advantages for the difficult problems. First of all, an unitary approach of the control through the perspective of the systems theory is presented. There are described examples of control in biology, economy, and technical areas in order to highlight the general system behaviors: preventive control, reactive control, or combined control. In this chapter, fundamentals of genetic algorithms theory are featured: genetic representation, genetic operators, how it works, and why it works. Further, two process control systems based on genetic algorithms are described: a chemical process control involving mass transfer, where the genetic algorithms are used in the system identification for a NARMAX model, an important issue with respect to model-based control and a job shop scheduling process in manufacturing area where the genetic algorithm is the tool to model the optimization process control.

Knowledge-Based Intelligent Process Control

In the last decades, the number of process control applications that use intelligent features has increased. This is mainly due to the complex and critical character of the process to be controlled. The intelligent process control systems work better than conventional control schemes in the domains of fault diagnosis (detection, cause analysis, and repetitive problem recognition); complex control schemes; process and control performance monitoring and statistical process control; real-time quality management; control system validation, startup and normal or emergency shutdown. Conventional control technologies use quantitative processing while knowledge-based integrates both qualitative and quantitative processing (having as target the increase of efficiency). This chapter presents an overview of intelligent process control techniques, from rule-based systems, frame-based systems (object-oriented approach), hybrid systems (fuzzy logic and neural network). The focus is on expert systems and their extension, the knowledge-based systems. Finally, an industrial case study is presented with conclusions to knowledge-based systems limitations and challenges associated to real-time implementation of the system.

Ciphering of Cloud Computing Environment Based New Intelligent Quantum Service

Cloud computing environment is a new approach to the intelligent control of network communication and knowledge-based systems. It drastically guarantees scalability, on-demand, and pay-as-you-go services through virtualization environments. In a cloud environment, resources are provided as services to clients over the internet in the public cloud and over the intranet in the private cloud upon request. Resources' coordination in the cloud enables clients to reach their resources anywhere and anytime. Guaranteeing the security in cloud environment plays an important role, as clients often store important files on remote trust cloud data center. However, clients are wondering about the integrity and the availability of their data in the cloud environment. So, many security issues, which are pertinent to client data garbling and communication intrusion caused by attackers, are attitudinized in the host, network, and data levels. In order to address these issues, this chapter introduces a new intelligent quantum cloud environment (IQCE) that entails both intelligent quantum cryptography-as-a-service (IQCaaS) and quantum advanced encryption standard (QAES). This intelligent environment offers more secured data transmission by providing secret key among cloud's instances and machines. It is implemented using System Center Manager (SCM) 2012-R2, which in turn is installed and configured based on bare-metal Hyper-V hypervisor. In addition, IQCaaS solves the key generation, the key distribution, and the key management problems that emerge through the online negotiation between the communication parties in the cloud environment.

Paraconsistent Logic and Applications

In this work we summarize some of the applications of so-called Paraconsistent logics; mainly one class of them, the paraconsistent annotated logics. Roughly speaking, such systems allow inconsistencies in a nontrivial manner in its interior; so it is suitable to handle themes in which inconsistencies become a central issue, like pattern recognition, non-monotonic reasoning, defesable reasoning, deontic reasoning, multi-agent systems including distributed systems, collective computation, among a variety of themes.

Annotated Logics and Intelligent Control

Annotated logics are a kind of paraconsistent (and generally paracomplete) logic, whose origin is paraconsistent logic programming. Later, these logics have been extensively studied by many researchers and applied to many areas, in particular, artificial intelligence and computer science. Annotated logics are also suited as the foundations for intelligent control in that they can properly deal with both incomplete and inconsistent information. The chapter addresses the aspects of annotated logics as a control language for intelligent systems. After reviewing the motivation and formalization of annotated logics, we give an application to robotics to show how they can be used for intelligent control.

Paraconsistent Annotated Logic Program EVALPSN and Its Application to Intelligent Control

We have already proposed a paraconsistent annotated logic program called EVALPSN. In EVALPSN, an annotation called an extended vector annotation is attached to each literal. In order to deal with before-after relation between two time intervals, we also have introduced a new interpretation for extended vector annotations in EVALPSN, which is named before-after(bf)-EVALPSN.

In this chapter, we introduce paraconsistent annotated logic programs EVALPSN /bf-EVALPSN and their application to intelligent control, especially logical safety verification based control with simple examples. First, the background and overview of EVALPSN are given, and paraconsistent annotated logics $P\tau$ and the basic annotated logic program are recapitulated as the formal background of EVALPSN/bf-EVALPSN with some simple examples. Then EVALPSN is formally defined and its application to traffic signal control is introduced. EVALPSN application to pipeline valve control is also introduced with examples. Bf-EVALPSN is formally defined and its unique and useful reasoning rules are introduced with some examples. Lastly, this chapter is concluded with some remarks.

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