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Research profile:

1. *Intelligent manufacturing systems*
   - Control systems with distributed intelligence; control frameworks. service oriented enterprise architectures
   - Total integration of enterprise processes; control layers ISA95; interconnecting ESB and MSB2.0
   - Control techniques for intelligent, safe and sustainable manufacturing
   - Optimization methods for mixed batch planning and product scheduling with resource allocation
2. *Multi-agent systems for holonic manufacturing control*
   - Holonic control architectures for industrial processes; holarchies; basic and expertise holons; Holonic Manufacturing Execution Systems (HMES)
   - Semi-heterarchical control systems for industrial processes; hierarchical, centralized control for performance optimization; heterarchical, distributed control for agility and robustness at disturbances
   - Product-driven automation
   - Service-oriented agents for manufacturing, automatic control and environment conditioning; SOA – MAS duality
3. *Digital transformation of manufacturing*
   - Cloud architectures, systems and services for manufacturing control (CMfg): PaaS and SaaS
   - Direct Digital Manufacturing – digital part modelling and 3D printing
   - Cyber-physical Manufacturing Systems (MCPS); Industrial Internet of Things (IIoT); pervasive resource instrumenting; communication middleware and protocols between high level ("Web services") and low level ("I/O") layers
   - Resource virtualization in cloud manufacturing; MES virtualization (vMES)
4. *The Intelligent Product (IP) concept; implementing in the production value chain*
   - Product intelligence; classification, characterization, implementing
   - Extended Information Systems (EIS) for IP management
   - Virtualization of intelligent products in CMfg and MCPS platforms

- Traceability of intelligent products; applications

5. *Robot-Vision systems in industrial and service applications*
   - Feature-based description of material flows
   - Robot motion tracking methods and techniques based on visual feedback
   - Image processing algorithms and techniques for part geometry and surface inspection, and product assembling control
   - Human-Robot Interaction (HRI); human detection; visual gesture recognition for dexterous motion learning and skills reproducing
6. *Service systems with informational support*
   - Business process modelling in service systems; implementing in Service Oriented Architectures (SOA)
   - Service innovation criteria and strategies
   - Product-Service Extensions (PSE); service dominant logic; metrics and key performance indicators for service value and perception
   - Methods and techniques for service management

Ph.D. coordinator since 1992
- 44 theses finalized;
- 5 theses undergoing.

Scientific publications: 64 monographs and book chapters 312 articles and conference papers.

Research projects, grants (selection):

- Big Data, Analytics and Cloud for Digital Transformation on Manufacturing (DTM), IBM Faculty Awards National IBM Research Grant, 2016, project coordinator
- Empowering Romanian Research on Intelligent Information Technologies (ERRIC), EU research grant FP7, REGPOT-2010-1, 2011-2013, WP coordinator
- Strategic program fostering service innovation through open, continuous education (INSEED), POSDRU/86/1.2/S/57748 project, MECTI, 2010-2013, project director
- R&D strategic program for growth and innovation in the service sector, foresight grant ANCS, contract no. 207 CP/II/2010, ANCS, 2010-2011, project director
- Autonomous, intelligent robot-vision platform for qualifying, identifying, sorting / processing / packing and quality inspection of products, with holonic, service oriented, feature-based control architecture (SOFHICOR), grant PN II Program 4 Partnership, Contract CNMP, no. 11-042/2007, ANCS, 2007-2010, project director
- Modelling, design, and object-oriented implementation of adaptive control of multi-robot systems for material conditioning, using the holonic manufacturing concept, grant IDEI, CNCSIS, 2006-2008 , project director
- Artificial vision-based device and robotized installation identifying, locating and on line automatic inspecting products for in line quality control, sorting and mounting , grant RELANSIN, Contract MECI, 2004-2006, project director
- Feature-based modelling and control of a robot vision system integrated in flexible manufacturing, Grant MERCATOR of Deutsche Forschungsgemeinschaft (DFG), Germany, 2002-2003, scientific project director
- Reactive control procedure of mobile robots in unstructured working environments, grant of the Romanian Academy, Contract 2001-2003, project director

Chairs, memberships in scientific organizations and committees, editorial boards, scientific awards

- Coordinator of the R&D Laboratories: “Robotics and applied AI” and “Intelligent Manufacturing Systems and Cloud” in the faculty of Automatic Control and Computers, UPB
- Director of the Research Centre in Robotics and CIM (CIMR) within UPB

- Member of the Steering Committee of the international scientific group ”Service Orientation in Holonic and Multi-Agent Manufacturing” since 2011
- Member of the Steering Committee of the international scientific group ”Exploring Service Science” since 2015
- Member of the International Scientific Committee (ISC) of the EU organisation ”Robotics in Alpe-Adria Danube Region” since 1992, President of the RAAD ISC in 2013-2015
- Member of the IFAC Technical Committees ”Manufacturing Plant Control” and ”Robotics” since 1992
- Member of the Board of Directors ISSIP, ww ”International Society of Service Innovation Professionals” since 2013
- Invited professor at the Universities: Cambridge (UK) 2012, 2015, Murcia and Cartagena (Spain) 1996-1999, Valenciennes (France) 1996-2013, Konstanz (Germany) 1999-2003, Vienna, Krems (Austria) 1998-2000, Porto (Portugal) 2013-2015
- Member of the research group IMS2 (Intelligent Manufacturing Systems and Services), in the French R&D organisation GdR-MACS (Groupe de Recherche en Modélisation, Analyse et Conduite des Systèmes Dynamiques), France since 2004
- Member of the editorial board of the journal ”International Journal of Service and Computing Oriented Manufacturing” since 2010
- Award "Tudor Tanasescu" of the Romanian Academy, Section Information Science and Technology in 2003

Ph.D. research subjects proposed

1. *Semi-heterarchical control architecture of holonic manufacturing, with service-oriented agents*

   Subject description: Modern control architectures of industrial, distributed discrete-event processes are realized in dual, semi-heterarchical topology: hierarchical (centralized) – the system scheduler (SS), respectively heterarchical (decentralized) – the delegate MAS system. The Manufacturing Execution System (MES) switches dynamically between the two organizing modes, providing on one hand optimal cost functions at the global horizon of product batches in the absence of disturbances, and on the other hand robustness at breakdowns and agility at variation in received orders, product recipes, etc. The scope of the research is the design and implementing of a control architecture based on multi-agent systems with service orientation.

   Objectives: a) proposing the semi-heterarchical control architecture; b) defining the holarchy for the heterarchical layer and the cooperation mode with the system scheduler; c) developing a solution for resource instrumenting allowing to measure their power consumptions and to evaluate their state and operating performances for sustainable allocation; d) designing the switching mechanism hierarchical – heterarchical with control of the system’s nervousness; modelling the manufacturing processes as services; e) service orientation of the agents implementing the holarchy in MAS framework; negotiation protocols for resource allocation in heterarchical mode.

2. *Service models and Cloud architecture for holonic manufacturing control*

   Subject description: An important driver of the digital transformation of manufacturing concerns the technologies related to the virtualization of shop floor devices that may enable the use of a correct balance between local computing abilities (e.g., close to manufacturing resources and intelligent embedded products) with global computing abilities allocated to a data centre, specifically to the private cloud manufacturing infrastructure. Cloud Manufacturing moves from production-oriented processes to customer- and service-oriented process networks.

   Objectives: a) private cloud models for the virtualization of shop floor devices; b) transferring MES functions in the cloud; c) modelling single manufacturing processes as services; d)

virtualization of mobile and stationary shop floor devices in the cloud; e) communication protocols for the transfer of shop floor data in the cloud; f) integrating smart connected objects in the cloud using the Industrial Internet of Things (IIoT) technology.

3. *Using the concept of intelligent product in traceability and context monitoring applications*

   Subject description: an Intelligent Product (IP) is a product (or part, appliance or order) that has some or all of the following five characteristics: 1) possesses a unique identity; 2) is capable of communicating effectively with its environment; 3) can retain or store data about itself; 4) deploys a language to display its features, production requirements, etc; 5) is capable of participating in- or making decisions relevant to its own destiny. The subject concerns the evolution of product centric control, traceability and usage monitoring towards virtualization.

   Objectives: a) Establishing new data patterns and formats to describe IP functions; b) Virtualizing IP in CMfg systems; c) Designing an Extended Information System (EIS) for IP management; d) Implementing the product-driven automation concept in manufacturing processes; e) Application using product intelligence: e1) IP traceability in supply chains or e2) Monitoring appliance usage and operating conditions for predictive maintenance.

4. *New robot-vision system architectures for special industrial applications*

   Subject description: Rapid Deployment Automation (RDA) is a model of representation of resources, processes and tasks of Robot-Vision Systems allowing for efficient aggregation of control and computing services in special applications characterized by: partially / totally unknown environment, high-speed control tasks, managing moving objects in dynamic scenes, recognizing, locating and grasping special types of objects (e.g., articulated, made from non-rigid materials, etc.) New robot-vision architectures allowing the combination of application and context-dependent processing tasks are required.

   Objectives: a) feature-based description of object classes; b) visual recognition and locating techniques and algorithms for special types of objects; c) visual servoing methods and solutions for context-driven grasping; d) embedding guidance vision and visual inspection functions in FPGA modules, as RDA extensions of robot systems.

5. *Development of an open Service System activity model and implementing in the Cloud*

   Subject description: the subject concerns the development of an activity model for a generic Service System (SSyst), in an approach derived from the service's lifecycle, also considering the interactions between the four stakeholders: Service provider (including his suppliers), Customer, Competitors and Regulatory bodies. An information system in SOA approach has to be created, and integrated in a Cloud business model.

   Objectives: a) establishing the Service System's global model and information architecture; b) developing the Service Contracting (SLA) module for interactive value co-creation; c) developing a KB service set-up and configuring module; d) providing dynamic reconfigurability of the service delivery and monitoring module; e) Service and After-Sales Service (ASS) follow up and monitoring; f) establishing a consistent set of KPIs for service value and perception evaluation.