Cyber-physical systems for smart factories

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Abstract. We report on the *CPS for smart factories* activity at EIT Digital, funded by the EU (H2020).[1] The main objective is to implement semantic controllers for the application domains and let the industry partners provide feedback about the cost reduction potential. In this networking session, we describe the technical infrastructure including deep learning and knowledge portal submodules, followed by anomaly detection modules and intelligent user interfaces in the IoT (Internet of Things) paradigm.

1 R&D activities and goals

The tight cooperation of automation and IT vendors should enable sustainable business models supporting the European manufacturing sector to manage its increasingly complex, inter-organizational production networks and align them efficiently with global supply chains. The individual components will be ready as products or as input for product development. Innovation is supported by evaluated business models and concrete examples for customer business cases.

This should be realized by integrating a platform which uniquely combines cross-enterprise event management (anomaly treatment via deep learning, knowledge management via a semantic portal, intelligent user interfaces) with digital product memory technology and smart object virtualization.

In this networking session, we report on our three milestones:

1. CPS Knowledge engineering: understanding the formal requirements of application cases and their formalization;
2. Implementation of software modules and tuning formal models and rules to test scenarios of anomaly detection in physical environments. This includes functional programming with deep learning capacity, and ontology creation/manipulation/extension via a semantic portal infrastructure and intelligent user interfaces;
3. Transfer of modules in industrial settings, first evaluations, and business modelling.

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[1] See http://dfki.de/smartfactories.

2   Technical Infrastructure

The over-arching challenge to address is to combine cyber-physical system (CPS) safety and performance. CPS is to be understood as a network of interacting elements with physical input and output, forming a system of collaborating computational elements controlling physical entities such as Industry 4.0 factories. Technical advancements include, most notably:

1. GPU-based deep learning machine learning infrastructure for anomaly treatment and data mining;
2. smart factories knowledge portal infrastructure for an anomaly instance base (knowledge management);
3. model based prediction with anomaly detection followed by workflow management, including real time verification and, possibly, machine learning fostering earlier anomaly detection;
4. intelligent user interfaces for expert knowledge acquisition, human behavior input and human-robot interaction by using, e.g., vision sensors.

These components are built into an architecture and are to be extended with the characterization of a human collaborator who is also *in the loop* and may also exhibit anomalous behavior. Cyber-physical systems are implemented in human environments. We are looking for partners from the semantic web domain to connect the aforementioned technical advancements with new advancements in semantic technologies, most notably for the characterization of a human collaborator, and use cases based on semantic technologies.