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Editorial

Industry 4.0: Quo Vadis?

Industry 4.0 or the Fourth Industrial Revolution, is a collective term embracing contemporary automation, data exchange and advanced manufacturing technologies (Kagermann et al., 2011). In this system, machines redefine themselves in how they communicate and perform individual functions where constant connectivity, human assistance and decentralized decision making are absolute necessities (Pacchini et al., 2019).

First Industrial revolution was dedicated to mechanization through water and steam power and electricity played a big role in the Second Industrial revolution. Automation, advanced electronics fueled by artificial intelligence contributed a lot to the Third Industrial revolution. Last few years are witnessing a significant transformation in the way the industries produce products by having a collective term for technologies and concepts of value chain organizations which bring together Cyber–Physical Systems (CPS), the Internet of Services (IoS) and the Internet of Things (IoT). Due to the unlimited possibilities of having billions of people connected by mobile devices, rapid availability of low cost processing power, storage capacities and Internet connectivity the concept of smart factory is becoming a reality (Kadir et al., 2019; Horváth and Szabó, 2019; Javaid and Haleem, 2019). We are also witnessing emerging technology breakthroughs, covering wide-ranging fields such as robotics, CPS, IoT, autonomous vehicles, nanotechnology, smart energy networks, energy storages etc. to name a few. Interestingly, many of these innovations are in their infancy, but they are already approaching an inflection point in their development as they build on and augment each other in a fusion of technologies across the physical, digital and biological worlds.

Industry 4.0 could be considered as a necessity for the future competitiveness of manufacturing companies. Smart manufacturing helps to improve energy efficiency, productivity and the quality of manufacturing while minimizing product life cycles and reduced environmental damage (Rajput and Singh, 2019; Galati and Bigliardi, 2019; Müller et al., 2019). Future is also geared towards environmentally sustainable manufacturing and supply chain management. There are also several administrative/research challenges in the long run. Starting from investment costs, business model adaptation, reliability, integrity, redefinition of workflows, unemployment, data security issues, privacy concerns, lack of regulation/standards, unclear legal issues, retraining the workforce for new jobs, among other challenges. This is an interesting research field and there is an exciting way to go towards cognitive enterprises.

Since 2011, there are several ongoing industrial and academic projects (Frank et al., 2019; Castelo-Branco et al., 2019). From an academic perspective, the sheer number of publications, annual conferences, focused workshops, dedicated special issues etc. verifies this fact. This special issue emphasized on Industry 4.0 and its real-world applications. Some of the topics covered are big data and analytics, autonomous robots, CPS, IoT, cybersecurity, additive manufacturing, assistance systems etc. Full papers were invited and after the deadline 29 papers were received and based on the three rounds of review process, finally 6 papers were accepted and are arranged as follows:

In the paper titled "*Industry 4.0: A bibliometric analysis and detailed overview*" Muhuri et al. (2019) provided a state-of-the-art bibliometric analysis and an extensive survey on recent developments in the field. The authors' summarized the growth structure of Industry 4.0 during the last few years and provided the concise background and various application areas.

Kunst et al. (2019) in the paper titled "*Improving devices communication in Industry 4.0 wireless networks*" illustrated a Quality of Service (QoS) -aware cloud-based solution by adapting a resources sharing architecture to the IoT framework. The developed methodology provided support to big data cloud-based applications, which demand QoS-enabled Internet connectivity for information gathering, exchange, and processing. The focus is on improving device to cloud communication considering the coexistence of different wireless network technologies and by proposing a dynamic scheduling of those technologies for data transmission monitoring QoS while minimizing pricing.

In the paper titled "*Reinforcement learning based compensation methods for robot manipulators*" Pane et al. (2019) introduced two reinforcement learning methods, which compensates for un-modeled aberrations, to the existing nominal input with an objective to enhance the control performance. The proposed methods were evaluated on a six degree-of-freedom industrial robotic manipulator arm to follow different kinds of reference paths.

Para et al. in the paper titled "*Analyze, Sense, Preprocess, Predict, Implement, and Deploy (ASPPID): An incremental methodology based on data analytics for cost-efficiently monitoring the industry 4.0*" introduced a unique methodology for iterative decision workflow that spans from the acquisition of sensing equipment to the quantitative assessment of the contribution of their captured data to enhance the production step. Using a case study in the automotive industry, authors depicted how this could help crucial decisions about which parts of the process need to be sensed, and how to exploit this information towards a verifiable improvement of the production cycle.

In the paper titled "*A novel non-parametric method for time series classification based on k-Nearest Neighbors and Dynamic Time Warping Barycenter Averaging*" Tran et al. (2019) illustrated an interesting methodology for time series classification which is an important research area in data analytics and decision making. Authors experimental results demonstrated significant improvement of the performance of time series classification.

In the final paper "*Ubiquitous smartphone based localization with door crossing detection*", Racko et al. (2018) discussed the importance of locating the user's smart devices such as smartphone or tablet to reduce reaction times for service providers and improve user's orientation in the environment, or delegate work to the nearest available employee

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etc. This work is focused on estimation of crossing between environments and does not require deployment of new infrastructure and can be easily used on smartphones.

This special issue initiative was started more than 3 years ago, and a lot of people have worked hard and collaborated for the successful completion of this project. We wish to thank all authors for their valuable contributions, the reviewers for their constructive comments, which helped improve the quality of this special issue. Taking this opportunity, we would like to thank Ms. Hong Li, Associate Publishing Content Specialist, Elsevier for all the follow up works and Ms. Salma Pattan, Journal Manager, Global Journals Production, Elsevier for the final production related work. Enjoy reading!

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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