Editorial

Ishwar Singh and Zhen Gao*

W Booth School of Engineering Practice and Technology,
McMaster University,
1280 Main Street West – ETB 206,
Hamilton, ON L8S 0A3, Canada
Email: isingh@mcmaster.ca
Email: ijimr.editor@gmail.com
*Corresponding author

Biographical notes: Ishwar Singh is an Adjunct Professor in the School of Engineering Practice and Technology at McMaster University since 2011. Prior to that he was the founding Associate Director of the four-year BTech programs, a joint venture between McMaster University and Mohawk College, and Chair of the process automation program within this stream. He coordinated the curriculum design, development and implementation of the process automation, automotive and vehicle technology program, and biotechnology programs in addition to his contribution for the establishment of the energy engineering technology degree completion BTech program.

Zhen Gao is an Assistant Professor at McMaster University. He has published over 80 papers, one book, and four book chapters in areas of robotics and control. He served as the Program Committee Member for many conferences such as World Congress on Intelligent Control and Automation, International Conference on Information and Automation, IEEE Conference on Robotics and Biomimetics, and International Conference on Intelligent Robotics and Applications. He was invited to talk about 'Frontier and Interdisciplinary Research with Machine Learning' in Global Machine Intelligence Summit. His current research interests include advanced robotics and automation, artificial intelligence and pattern recognition.

1 Embrace the age of intelligent machines and robotics

Human beings have experienced three major revolutions, namely the agricultural revolution, industrial revolution and digital revolution. The digital revolution includes the massive applications of computing technology, robotics, networking, Industry 4.0 and artificial intelligences. The digital revolution already happened since the mid 20th century and it has not been finished yet. Obviously, compared with the first two major revolutions, this one has the greatest impact to any individual, any organisation, to our race, and to our planet as well. We are fortunate that we are living in such a great time facing the co-existence of challenging and opportunity.

Apparently, the rapid development trend of robotics and machine intelligence will not be irreversible. Generally speaking, there are four kinds of intelligence being researched so far. They are:

1 Motion intelligence, e.g., Big Dog and Atlas by Boston Dynamics.

2 Computing intelligence, e.g., Alpha Go and Alpha Zero by Google's Deep Mind.

3 Perception intelligence, e.g., driverless vehicles and various pattern recognitions by vision, sound, and other sensory modules.

4 Consciousness intelligence.

The age of artificial general intelligence (AGI) majorly depends on the research progress of consciousness intelligence, which is very difficult to breakthrough. When teaching lectures for graduate students, the question that would always be asked was "Can humans really transfer our intelligence to machines, and even make machines really smarter than humans." If the issue of consciousness intelligence cannot be conquered, it could not be believed that AGI will become true.

Recent development of machine intelligence mainly relies on the availability of evolved models and high-quality data which are used to train those models. Since open source policy has become more and more popular, robotics and AI community keeps growing. Nowadays, not only have we algorithms and models open sourced, but also lots of hardware and devices are also designed with open-source concept. For example, Raspberry Pi and Arduino boards are becoming extremely popular these days, which makes the implementation of robotic and intelligent machine projects very convenient, which also makes fast prototyping with low cost feasible.

International Journal of Intelligent Machines and Robotics (IJIMR) will be leader of the global community of AI and robotics. We are striving to deliver high-quality papers in areas of:

1 Industrial automation and process control.

2 System control and data acquisition.

3 Industrial robots, service robots.

4 Intelligent robots, autonomous robots, collaborative robots.

5 Robotics and computer integrated manufacturing.

6 Cloud machines, cloud robots.

7 Smart systems, HCI, brain computer interface.

8 Artificial intelligence, big data and analytics.

9 Industry 4.0.

10 Internet of things (IoT), industrial IoT.

11 Machine learning.

12 Machine vision and image processing.

13 Human-machine interaction.

14 Machine emotion and consciousness.

15 Robotics and automation education.

In the first issue of *IJIMR*, T. Yuvaraja and K. Ramya introduce a hybrid learning algorithm for training in an MIMO nonlinear automated control system based on neural network which can be applied for micro-grid with renewable energy sources. You may check this work in 'Lenient computation in controlling the nonlinear system based on adaptive error optimisation in microgrid'. Tushar Jain et al. develop an active vision recognition method for checking the accuracy and robustness of industrial tool to optimise the industrial manufacturing automation. Their work is titled 'Robust active vision industrial CAD parts recognition system'. In the paper 'Towards a secure and automated platform for fingerprint-based electronic voting machine', Ifthekhar Ahammad et al. propose a fingerprint-based automatic voting machine to provide high performance, flexibility, security and lower price. In the paper 'Optimal conceptual design and vision based control of a fruit harvesting robot', K. Saran Kumar et al. design a vision enhanced five-DOF serial robot for harvesting fruits. Carlos Santos et al. conducted an experiment for an aperiodic remote-controlled plant based on the comparison of classic periodic control solution with their self-triggered approach in the paper 'Digital implementation of a self-triggered control approach for a mechatronic platform: experimental results'. Last but not least, in the paper 'Dynamic simulation of serial robots under force control', Arun Dayal Udai and Subir Kumar Saha propose a recursive forward dynamic algorithm for force control of industrial robots.

We look forward to receiving your submission in *IJIMR*.

2 Industry 4.0 education and challenges for academic institutions

Industry 4.0 is a vision commonly used to describe the concept of 'smart factory' of the future. In smart factories the manufacturing processes will be fully automated and cyber physical systems will be able to communicate with one another and corporate networks to achieve a common goal. The four main characteristics of Industry 4.0 that need to be considered in designing and developing such factories are: vertical networking of production systems; horizontal integration of global value chain networks; end to-end engineering of overall value chain; and the impact of disruptive technologies such as AI, advanced and micro sensors, collaborative and speciality robotics, cloud systems, augmented reality, 3D printing, increased performance with reduced cost, software based networking and virtualisation, size and power consumption devices and automation components of microprocessors and microcontrollers. These technologies have led to the advancements in the following major areas: the IoT and cyber physical systems, big data and analytics and communications infrastructure.

In a recent publication Boston Consulting Group has listed ten use cases that show the effects of Industry 4.0 on the workforce and they are: big data driven quality control, robot-assisted production, self-driving logistic vehicles, production line simulation, smart supply networks, predictive maintenance, machines as a service, self-organising production, additive manufacturing of complex parts, augmented work, maintenance and service. In the same publication the authors asks what should education systems do to prepare the graduates for the new jobs that require broader skill sets including IT skills and require job specific capabilities for the new roles for the Industry 4.0 jobs. For the industry persons offer new formats for continuing education that focuses on capabilities instead of qualifications. It is also acknowledged that universities can't ignore the role of research in advancing the cause of Industry 4.0 implementation and knowledge.

In addition in the world of learning there are nine trends that cannot be ignored along with the specific technological skills for Industry 4.0 education and they are: more opportunities to learn at diverse times and places; personalised learning based on student's capabilities; more learning choices devices, tools, and resources available; project based learning; experiential and collaborative learning; data interpretation; exams are going to be different and may be based on capabilities rather material crammed a day before the exam; students will be able to design their own curricula and corresponding degrees; and mentoring will become more common.

If we were to design a program/courses that can incorporate Industry 4.0 learning foundational technologies (Industry 4.0 Literacy), we could base it on the ubiquitous Raspberry Pi. Here is what we can teach with it: C and C++ programming, Java, Micro Python, Node.js, operating system concepts and programming, database concepts (SQL and NO SQL), web server, cloud computing, building a Hadoop cluster, interactive data analytics and data mining, networking concepts, hardware interfacing, wireless communications-BlueTooth, Zigbee, WiFI, LORA, and GPS, real-time image processing, basic neural network application, IoT and M2M communications and AI and machine learning. For the last few years the students in the BTech program at McMaster University have used Raspberry Pi as a tool for developing their capstone projects in many of the above areas of study. In addition they have been using designing and modelling projects using different cad software packages and using 3D printers to build and test their project ideas along with designing their own printed circuit boards.

More recently the newly formed W Booth School of Engineering Practice and Technology (SEPT), an educational unit in the Faculty of Engineering at McMaster University, under the leadership of Dr. Mo Elbestawi, Director of this school, has taken the two significant steps in developing talents for workforce with Industry 4.0 foundational education and skills. First of these steps is the establishment of the cyber physical systems learning centre that is expected to complement the students' qualifications and abilities by providing new technical skills that emphasise the inherent multidisciplinary nature of smart systems and advanced manufacturing. The second, more practical in nature, is the establishment of learning factory for Industry 4.0 education and applied research. The learning factory, to be described in a few publications soon, includes several machine tools and specialised stations with focus on Industry 4.0, IoT and IIoT that are expected to address the educational, research, and training components of the SEPT cyber physical systems learning centre. The learning factory includes an IoT learning station, cyber physical system stations with IIoT implementations, collaborative and mobile-intelligent robots, several additive manufacturing stations, and modern machine tools equipped with sensors and actuators that address the Industry 4.0 manufacturing digitisation aspects. In terms of software, the SEPT learning factory uses edge-to-cloud applications with integrated hardware and software, messaging software platforms, and manufacturing execution systems (MES). The students and industry employees will use the various components of the learning factory based on the purpose of the educational component, training or applied research.