"Challenges and trends in smart instrumentation and measurement"

Journée conjointe Chapitre IEEE I&M Section France et GDR SOC2-Frontière et interfaces cyberphysiques

Jeudi 10 Octobre 2019, Campus Artem, Nancy.

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Context

In the era of the Internet of Things (IoT) where a myriad of smart connected sensing systems are deployed and used in different application fields such as health, energy, transport, etc., a huge amount of data of different type is permanently generated and collected over time. These acquired and collected data need to be processed in order to extract useful information, or temporally stored before their transmission for further processing. The processing, storage and transmission constraints being more and more restrictive strain the design of such systems at all levels, mostly resulting in costly solutions in terms of used resources, processing latency and power consumption. An alternative to the conventional design techniques that has become obvious over the past decades are the solutions requiring artificial intelligence (AI) tools and techniques. The use of supervised and/or unsupervised learning techniques in sensing systems may bring significant improvements with regards to the conventional ones. However, despite the increasing use of AI tools and techniques mostly in software implementations, the most challenging from embedded system's perspective is to bring these AI techniques in smart sensing systems as hardware circuits thus providing them with better processing precision, performances and low power consumption.

The aim of this workshop is to present the state of the art techniques and advances in the field of smart instrumentation and measurement systems. The presentations of renowned international experts in the field covering the current societal challenges in the fields of transport, energy and health are programmed.

Program

Time	Speaker	Title
09h00		*Welcome*
10h00	D. Dallet, IMS, Bordeaux INP	*Presentation of I&M Chapter and future events*
10h15	P. DesgreysTelecom-ParisTech	*Presentation of GDR SoC2*
10h30	S. Saponara, IEEE DL, Università di Pisa, Italy	*Instrumentation and Measurement and Autonomous Driving*
11h30	A. Amira, De Monfort University , Leicester, UK	*Empowering digital health with AI and IoT technologies*
12h15	—	*Lunch*
14h00	O. Chuquimia, LIP6, Université de Sorbone	*Smart vision chip for colon exploration*
14h45	N. Ramzan, University of the West of Scotland, UK	*Advanced AI/ML for Emotion Recognition*
15h30	—	*Break*
15h45	Duc Vu, Institut Jean Lamour, Université de Lorraine	*Convolutional Neural Networks for series arc-fault detection*
16h30	S. Jovanovic, Institut Jean Lamour, Université de Lorraine	*Self-Organizing Maps for Data reduction*
17h15	Closing discussion	

Summary of the presentations

Instrumentation and Measurement and Autonomous Driving

Sergio Saponara from University of Pisa, held an IEEE IMS DL about ACES (autonomous, connected, electrified and shared) vehicles and related instruments and measurement/perception tools. The IEEE DL presented the opportunities and challenges of the ACES trends, with a focus on high performance machine-perception sensors (like Radar, Lidar, Camera), navigation and positioning technologies (Inertial Measurement Units, Global Position/Navigation Satellite Systems). The challenge of the High Performance Computing, needed on-board the vehicles to process in real-time such large amount of data, using either deterministic signal and data processing techniques or new machine learning and AI tools, have been also discussed. To this aim, the opportunities offered by the European Processor Initiative H2020 project have been also presented.

Empowering digital health with AI and IoT technologies

In his talk, Prof. Abbes Amira from the Artificial Intelligence Research Institute, at De Montfort University, Leicester, UK, presented an overview about two of his main funded projects: Embedded multi-core systems for multi-critical applications in the Internet of Things Era (EMBIOT) and Computer Enabled Radiological Resource for Blood flow Rates in Aneurysms using Lattice-Boltzmann (CER2EBRAL). In EMBIOT, Prof. Amira describes how Artificial intelligent coupled with IoT can empower applications in connected health such as remote monitoring of elderly people at homes, smart ambulance services and robotic surgery. Novel and efficient IoT architectures are presented for fall detection, ECG monitoring and recognition. Moreover, he has presented the work carried out by his research team in CEREBRAL, where AI has been used for aneurysm segmentation together with Lattice Botlzman technique used for blood flow measurement. Prof. Amira ended his talk with other illustrations on how AI has been used for digital health applications.

Smart vision chip for colon exploration

To reduce the incidence of colorectal cancer (CRC), we propose a new paradigm of Wireless Capsule Endoscopy (WCE) that permit the in-situ recognition of polyps: an intelligent Wireless Capsule Endoscopy (iWCE). This iWCE embed image processing to extract features in the images and fuzzy-forests to classify images. We present the image processing part, more specifically the Hough Transform that enable to detect circles in High Definition (HD, 1920x1080) images. A circle here is a probable marker of colorectal cancer: a polyp. The Hough Transform is a widely used shape-based algorithm for object detection and localization. This technique can be generalized to circles. To embed the Hough Transform inside our iWCE, considering real-time execution and a limited area, several optimizations are necessary. Our work presents an efficient real-time architecture that can be integrated into an 8x8mm2 electronic system. This architecture has been validated in a FPGA Xilinx Spartan 7 XC7S15-CPGA196 packaged in an area of 8x8mm2. It can process large resolutions images (1920x1080) in real time (<40ms) and it can run at 135.46MHz.

Advanced AI/ML for Emotion Recognition

Prof Naeem Ramzan, Director of the Affective and Human Computing for Smart Environments (http://ahcse.uws.ac.uk/), at the University of the West of Scotland, UK. Prof Ramzan's talk looked at both historical and contemporary video processing, communication and machine learning techniques in different case studies especially focus on emotion recognition. He referred to his own work in helping to develop the video standards and finally consider how video processing and analysis along with physiological signals are used to recognise the human emotion by exploiting

machine learning techniques. In addition, talk covered the different machine learning techniques used in image retrieval and other applications in the context of BigData and Digital Health/eHealth.

Convolutional Neural Networks for series arc-fault detection

An arc fault is an electric arc that appears accidentally in series or parallel with appliances. If an arc fault is maintained for a long duration, the energy produced by arc may lead to the ignition of a fire accident. Arc fault detection devices have been required in several electrical installations for about 20 years. To achieve better detection performance, we proposed a method that finds optimal arc fault features and creates a detection algorithm based on plural arc fault features. We also investigated the possibility of using deep learning for the detection task. Among different techniques, convolutional neural networks and recurrent neural networks have been used.

Self-Organizing Maps for Data reduction

In the era of the Internet of Things (IoT) and Big Data (BD) , a huge amount of data of different type is permanently generated and collected by sensing systems over time. Depending on the nature of the application, these collected data should be processed often in real time with hard timing constraints in order to extract useful information needed for prediction purposes or control decisions. The collected data streams often include redundant information making the overall computing workloads more challenging. A common solution is to reduce the dimensionality (clustering, vector quantization, compression, etc) of the collected data before their further processing. Among techniques commonly used for the data dimensionality reduction and clustering we find Self-organizing Feature maps (SOMs). Their inherent property of topology preservation and unsupervised learning of processed data put them in the front of candidates for data reduction. However, the high computational cost of SOMs limits their use to offline approaches and makes the online real-time high-performance SOM processing more challenging. In the presented work, main attention is drawn on the challenges and trends in hardware implementations of SOMs.

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