The IEEE Instrumentation and Measurement Society Technical Committee TC-22: Intelligent Measurement Systems

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This article provides an overview of the IEEE Instrumentation and Measurement Society Technical Committee TC-22 on Intelligent Measurement Systems[1]. The scope of the TC is related to fostering development and use of artificial intelligence, computational intelligence, and soft computing in measurement systems and related applications [1], [2], [3]. In particular, the goals of the TC-22 are the following.

- Develop, promote, and support artificial intelligence and soft computing in instrumentation and measurement systems.
- Develop, promote, and support the integration of artificial intelligence and soft-computing technologies in advanced instrumentation and measurement procedures and systems.
- Develop, promote, and support standards in the field of artificial intelligence and soft-computing technologies for intelligent instrumentation and measurement applications.
- Disseminate information and knowledge about artificial intelligence and soft-computing technologies for instrumentation and measurement applications and attract a wider audience to their benefits.
- Maintain liaisons with other committees, groups, societies, and organizations working on artificial intelligence and soft-computing technologies and in the applications fields.

Moreover, the TC-22 performs joint activities with other societies and councils that have a similar scope, including organization and sponsorship of conferences and workshops, organization of special sessions, and organization of special issues in journals in the field of intelligent measurement systems. Societies and councils include the IEEE Computational Intelligence Society, IEEE Systems Council, and IEEE Biometrics Council.

I. TC-22 Activities

The members and chairs of the TC-22 are involved in several activities related to developing, promoting, and supporting the research related to intelligent measurement systems as well as the other goals of the committee, including organization of conferences, research activities, dissemination, teaching of degree courses, and collaboration with other universities and research centers.

A. Organization of Conferences

The activities include the presentation of several papers, the organization of special sessions, and chairing activities for several conferences, such as the 2020 IEEE International Conference on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA 2020), the 2019 IEEE International Instrumentation and Measurement Tehnology Conference (I2MTC 2019), and the 2019 IEEE International Conference on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA 2019).

1) 2020 IEEE Int. Conf. on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA 2020): the members of the TC-22 participated in the organizing committee and presented the paper "On approximating the non-negative rank: Applications to unsupervised image reduction".

2) 2019 IEEE Int. Instrumentation and Measurement Technology Conf. (I2MTC 2019): the members of the TC-22 participated in the organizing committee, organized the special session "Instrumentation and measurement for ambient intelligence applications[2]", and presented the paper "IoT-based architectures for sensing and local data processing in Ambient Intelligence: research and industrial trends".

3) 2019 IEEE Int. Conf. on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA 2019): the members of the TC-22 participated in the organizing committee and presented the paper "Touchless palmprint and finger texture recognition: A Deep Learning fusion approach".

B. Research Activities

The research activities related to the scope of the TC-22 are carried out within national and international projects as well as within several collaborations with universities and research centers.

1) National and International Projects: The research activities of the TC-22 are performed within several national and international projects, including "3SUN – Real-world assessment of 3^{rd}-generation Solar cells: a UNified scientific

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[1]https://ieee-ims.org/technical-committee/tc-22-intelligent-measurement-systems

[2]https://i2mtc2019.ieee-ims.org/pages/special-sessions-listing

approach", "Prediction of the electric power production", "I-PAN – Innovative Poplar Low Density Structural Panel", and "ASEM – Adaptive Systems for Environmental Monitoring".

a) 3SUN – Real-world assessment of 3^{rd}-generation Solar cells: a UNified scientific approach: the project focuses on the development of integrated experimental and modelling tools to assess the role of environmental stress factors (ESFs) on new materials for renewable energy production, taking 3rd-generation Dye-Sensitized Solar Cells (DSSCs) as a case-study.

b) Prediction of the Electric Power Production: the project focused on the study and realization of innovative artificial intelligence and signal processing techniques for predicting electric power production in power plants based on renewable energy.

c) I-PAN – Innovative Poplar Low Density Structural Panel: the project focused on the design of a lightweight wood panel, by studying a novel manufacturing process with a limited environmental impact, requiring less energy during the drying and pressing process, a minor amount of pollutants, and reducing the overall production costs[3]. Fig. 1 shows some of the members of the TC during laboratory activities for the I-PAN project.

d) ASEM – Adaptive Systems for Environmental Monitoring: the project focused on the study, design and test of a system based on image processing and artificial intelligence for the detection of wildfire smokes[4]. The main goals of the project were to achieve a robust and accurate detection system capable to adapt to different environmental situations, with the use of low-quality frame sequences and limited hardware power. Since the availability of wildfire smoke footages is limited, the project included also the design and development of a virtual environment for the generation of synthetic smoke clouds based on real frame sequences, in order to give the possibility to create a greater number of test and train sequences for the proposed system.

2) Collaborations with Universities and Research Centers: Several collaborations that include the members of the TC-22 are active with different universities and research centers, including STMicroelectronics (Italy), Yildiz Technical University (Turkey), and the University of Toronto (Canada).

a) STMicroelectronics, Italy: the collaboration includes joint research activities focused on the study and realization of innovative pattern recognition approaches based on signal and image processing and on artificial intelligence techniques, with a specific focus on autonomous driving applications [8].

b) Yildiz Technical University, Turkey: the collaboration focuses on the analysis of recent cybersecurity methods, with a specific attention to artificial intelligence techniques using Deep Learning for intrusion detection in network communication scenarios [4].

c) University of Toronto, ON, Canada: the collaboration is active in the form of several research visits. Within the collaboration, the research activities focused on the study and realization of innovative pattern recognition methods and algorithms based on image processing and artificial intelligence techniques, with a specific focus on biometric and biomedical applications [10], [7].

C. Dissemination

The results of the research activities performed by the TC have been published in several journal articles [4], [5], [6] and conference papers [7], [8], [9]. In the following, we give a short description of the main result achievements.

1) A Comprehensive Survey of Databases and Deep Learning Methods for Cybersecurity and Intrusion Detection Systems: the article has been published in the *IEEE Systems Journal* in 2020 and describes a comprehensive overview of methods based on machine learning for intrusion detection, in particular regarding methods based on Deep Learning [4].

2) A Decision Support System for Wind Power Production: the article has been published in the *IEEE Transactions on Systems, Man, and Cybernetics: Systems* in January 2020 and proposes a novel method based on artificial intelligence for the long-term prediction of electrical power, generated by renewable sources [5].

3) 3-D Granulometry Using Image Processing: the article has been published in the *IEEE Transactions on Industrial Informatics* in March 2019 and proposes an innovative three-dimensional vision system to compute the granulometry of thin falling particles in real time [6].

4) Acute Lymphoblastic Leukemia Detection Based on Adaptive Unsharpening and Deep Learning: the article has been accepted for publication at the *2021 IEEE Int. Conf. on Acoustics, Speech, and Signal Processing (ICASSP 2021)* and describes an approach based on machine learning and deep learning for adaptively unsharpening blood sample images, with the purpose of increasing the classification accuracy of tumoral cells [7][5].

5) Driver Attention Assistance by Pedestrian/Cyclist Distance Estimation from a Single RGB Image: A CNN-based Semantic Segmentation Approach: the article has been accepted for publication at the 22^{nd} *IEEE Int. Conf. on Industrial Technology (ICIT 2021)* and introduces the first method in the literature for estimating the distances of pedestrians from the vehicle in automotive applications, using only an RGB image and deep learning [8][6].

6) IoT-based Architectures for Sensing and Local Data Processing in Ambient Intelligence: Research and Industrial Trends: the article has been published in the *2019 IEEE Int. Instrumentation and Measurement Technology Conf. (I2MTC 2019)* and reviews recent methods based on Internet of Things for Ambient Intelligence applications, with a specific focus on approaches that prefer local data processing over cloud-based computing [9].

D. Teaching

The members of the TC are also active in teaching degree courses, related to the scope of the committee, at the Università degli Studi di Milano, such as the Ph.D. course

[3]https://iebil.di.unimi.it/projects/ipan
[4]https://homes.di.unimi.it/genovese/wild/wildfire.htm
[5]https://iebil.di.unimi.it/cnnALL/index.htm
[6]https://iebil.di.unimi.it/DistPedCNN/index.htm

Fig. 1. Members of the TC during laboratory research activities for the I-PAN (Innovative Poplar Low Density Structural Panel) project.

"Deep Learning for signal and image processing" and the M.Sc. course "Intelligent systems for industry, supply chain, and environment".

1) Deep Learning for Signal and Image Processing: the course presents recent artificial intelligence and machine learning techniques for multi-dimensional signal processing and pattern recognition, with a specific focus on Deep Learning (DL) approaches, which – with respect to traditional pattern recognition algorithms – have the advantage of automatically extracting distinctive data representations from multidimensional signals, thus reducing the need of domain expertise in a specific field. In particular, the course describes the main DL approaches for signal and image processing, such as Convolutional Neural Networks, Autoencoders, and Generative Adversarial Networks. Then, the course presents application examples for heterogenous scenarios, including scenarios related to intelligent measurements systems, such as industrial monitoring and ambient intelligence[7].

2) Intelligent Systems for Industry, Supply Chain, and Environment: the course introduces the methodologies and techniques for intelligent systems for monitoring and control of industrial, environmental and supply chain applications, typically based on artificial intelligence techniques[8].

II. Future Activities

The TC will organize, together with other IEEE members, the next edition of the International Conference on Computational Intelligence and Virtual Environments for Measurement Systems and Applications (CIVEMSA 2021)[9]. As the previous years, the conference will be an interesting venue for researchers and interested scholars to publish works and exchange ideas related, among others, to the key activities of the TC. Topics in the scope of the CIVEMSA conference include:

- Intelligent measurement systems;
- Multi-sensor data fusion & intelligent sensor fusion;
- Intelligent monitoring & control systems;
- Neural & fuzzy signal/image processing for industrial, environmental & domotics applications;
- Machine & deep learning for intelligent systems;
- Computational intelligence technologies for robotics & vision;
- Computational intelligence technologies for medical & bioengineering applications;
- Hardware implementation of neural & fuzzy systems for measurements.

Lastly, the TC will be constantly active in the organization of internships and theses supervision on intelligent measurement systems, on the organization and promotion of conferences and workshops, on the organization and chairing of special sessions, and on the presentation and dissemination of papers and tutorials.

III. Conclusion

The TC-22 is constantly planning new activities in research and education and encourages young researchers, university professors, and industry experts to submit their request for participating in the TC. For information about the TC-22, its scope and goals, and how to apply to become a member, please visit the website of the TC (https://ieee-ims.org/technical-committee/tc-22-intelligent-measurement-systems) or contact Dr. Angelo Genovese (angelo.genovese@unimi.it) for details. Thank you in advance for your interest.

[7]http://dottorato.di.unimi.it/index.php/teaching/2019-2021/101-deep-learning-for-signal-and-image-processing-november-december-2021

[8]https://www.unimi.it/en/education/degree-programme-courses/2021/intelligent-systems-industry-supply-chain-and-environment

[9]https://civemsa2021.ieee-ims.org/

ACKNOWLEDGMENT

The authors would like to thank the Administrative Committee and the Technical & Standards Committee of the Instrumentation and Measurement Society for their continuous support in the activities of the TC. The authors would also like to thank all members of the TC-22 for their support and participation: Prof. Mario Diván, Dr. Zsolt János Viharos, and specifically Prof. Vincenzo Piuri and Prof. Fabio Scotti.

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