The Big Data era in IoT-enabled smart farming: Re-defining systems, tools, and techniques

Editorial for the Special Issue on

"The Big Data Era in IoT-enabled Smart Farming: Re-defining Systems, Tools, and Techniques"

The continuous generation of data from multiple sources has created numerous opportunities in different domains including agriculture. However, the state of the art in Smart Farming (SF) should be redefined and revisited, since new technologies and tools are coming in the agriculture domain bringing novel and innovative paths for improving the resilience and the efficiency of agriculture. SF has started to be materialized and not being simply a vague futuristic concept, as different fields, such as image processing and machine learning, have found a prosperous area of application.

New and various technologies have invaded the agricultural sector as they can offer new and unprecedented opportunities. SF uses a combination of technological advances, such as sensors, Unmanned Aerial Vehicles (UAVs), variable-rate application machinery, satellite navigation and positioning technology, and the Internet of Things (IoT). All aforementioned technologies produce a massive amount of data capable of changing the current status of the agriculture sector, but a series of effective actions have to be developed and established for their efficient exploitation.

The Big Data era has arrived for the agriculture sector reflecting its changes to a numerous of research fields. The incorporation and the usage of Geographic Information System (GIS) in the agriculture sector takes place for at least a decade as well as the adoption of sensors for monitoring reasons. Furthermore, driven by advanced GIS technologies, emerging image processing techniques adopt neural networks and deep learning approaches for providing new areas of application in the field of computer vision. Tasks such as crop identification and weed discrimination have become easier than ever thanks to the state-of-the-art classification algorithms.

The farm industry and SF expand from the strict limits of the farm location and affect a series of related fields, such as supply chain management, food availability, biodiversity, farmers' decision making and insurance, environmental studies, and various Earth sciences. All of aforementioned fields have significant benefits, when they follow a data-driven approach under the condition that the systems, tools, and techniques used have been designed to handle the volume and foremost the variety of the data.

This Special Issue (SI) of Computer Networks devoted to "The Big Data Era in IoT-enabled Smart Farming: Re-defining Systems, Tools, and Techniques" presents a collection of articles that investigate and address these aforementioned challenges, while offering new insights and introducing schemes, frameworks, and solutions for some of the above challenges. The platform entitled "CYBELE", aspiring to safeguard that stakeholders involved in the agro-food value chain have integrated, unmediated access to a vast amount of very large scale datasets of diverse types and coming from a variety of sources, is introduced in the first paper of this SI. The platform provides secure and unmediated access to large-scale High Performance Computing (HPC) infrastructures, supporting advanced data discovery, processing, combination, and visualization services.

The unprecedented capability of data collection and management offered by Internet of Things (IoT) is discussed within the following paper entitled "Survey, Comparison and Research Challenges of IoT

Application Protocols for Smart Farming", where an up-to-date survey of research efforts on the IoT application layer protocols, focusing on their basic characteristics, their performance as well as their recent use in agricultural applications is presented. This survey paper provides a comparison among them, especially in terms of well-accepted key performance indicators and comments on their suitability in the framework of smart farming.

A Convolutional Neural Networks (CNN) architecture named Modular-CNN is proposed in the fourth paper, entitled "A Modular CNN-based Building Detector for Remote Sensing Images", to improve the performance of building detectors that employ Histogram of Oriented Gradients (HOG) and Local Binary Patterns (LBP) in a remote sensing dataset in the context of the smart farming. The authors introduce two improvements to increase the classification accuracy of Modular-CNN, where the first improvement combines the power of raw and normalized features, while the second one concerns the Euler transformation of feature vectors.

A deep learning framework for multi-class fruit detection is proposed in the fifth paper, entitled "Faster R-CNN for Multi-class Fruit Detection using a Robotic Vision System", by using an improved Region-based CNN (R-CNN). This work creates a multi-labeled and knowledge-based library of 4,000 images, while a faster and more accurate detection process is ensured.

A three-step methodological approach is introduced in the next paper, entitled "Keeping Data at the Edge of Smart Irrigation Networks: A Case Study in Strawberry Greenhouses", which covers the design, an implementation, and the validation of the solution for smart strawberry irrigation in greenhouses, while keeping the corresponding data at the edge of the network. In particular, the authors (a) developed a small-scale smart irrigation prototype solution, which was tested and evaluated for different kinds of plants, (b) introduced a reference network architecture, specifically targeting smart irrigation and edge data distribution for strawberry greenhouses, and (c) adopted the proposed reference architecture in an actual strawberry greenhouse environment. Their design outperforms the conventional approach, both in terms of soil moisture variation and in terms of water consumption.

Lastly, the paper entitled "Distributed Aerial Processing for IoT-Based Edge UAV Swarms in Smart Farming" addresses challenges of a decentralized and heterogeneous UAV swarm deployment, where UAVs are equipped with either multimedia sensors or scalar sensors. A Nash bargaining-based weighted intra-Edge processing offload scheme is introduced to mitigate the problem of heavy processing in some of the swarm members, while real-life hardware tuned the simulation of a large UAV swarm, showing that by increasing the number of UAVs in the swarm, the proposed scheme achieves better scalability and reduced processing delays for intensive processing tasks.

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