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Editorial

Sensors and Embedded Systems in Agriculture and Food Analysis

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The continuous advance in sensors and sensing systems has a strong impact in agriculture and food production.

Food is routinely screened to assess quality (such as physical appearance and organoleptic properties) and safety (absence of health threatening pathogens and chemical compounds). These tests are usually carried out in laboratory by skilled personnel, thus resulting in delayed response and high costs for the analysis. On the other hand, the availability of transduction techniques (such as electrical impedance spectroscopy, visible and near-infrared optical spectroscopy, fluorescence spectroscopy, and image processing) allows the design of low-cost embedded sensor systems for quick in-the-field analysis with benefits in terms of lower cost, shorter time response, and, in the end, more frequent screening and improved product quality.

Similarly, the introduction of sensor technologies in agriculture has led to the transition from standard farms, where activities are almost entirely carried out by humans, to "smart farms," where activities are automatized, critical parameters are timely monitored by networks of distributed sensors and cameras, information is shared using high-speed wireless communication technologies, and energy is scavenged from natural sources (solar, thermal, etc.). Moreover, the ever-increasing diffusion of modern mobile phones, merging strong computation capability with fast wireless communication, promotes even more the transition to the new "smart farms" in the paradigm of Internet of Things (IoT).

This special issue presents six papers that have been published after two rounds of rigorous peer review.

In the paper "Urban Lawn Monitoring in Smart City Environments," J. Marín et al. propose an Arduino-based system with a camera mounted on a drone that enables to monitor the state of the grass in urban lawns and consequently to optimize the irrigation regime. In the proposed strategy, the drone periodically flies over a garden and takes pictures of the grass. The pictures are then processed with an algorithm that classifies the grass into three categories, accordingly to its quality (thus to the need of irrigation). The authors apply their drone-based strategy to monitor gardens with different sizes to validate its cost and applicability, as well as to compare its pros and cons over alternative monitoring systems (mounted on mall autonomous vehicles). The experimental results demonstrate that for large gardens (bigger than $1000\,m^2$), the proposed strategy achieves a significantly lower monitoring time.

In the paper "The State-of-the-Art of Knowledge-Intensive Agriculture: A Review on Applied Sensing Systems and Data Analytics," B. Basnet and J. Bang reviewed existing sensors and data analytics techniques used in different areas of agriculture. The authors classified agriculture into five categories and reviewed the state-of-the-art technology in practice and ongoing research in each of these areas. The authors also discussed current and future challenges and provided their views on how such issues can be addressed.

In the paper "On-the-Go Grapevine Yield Estimation Using Image Analysis and Boolean Model," B. Millan et al. proposed a methodology for image-based automated estimation of vineyard yields. The paper suggests use of a Boolean model to tackle the problem of occlusions in the images and evaluates the model's performance on three different datasets. The number of berries in a cluster was estimated with a root mean square error (RMSE) of 20 and a coefficient of determination (R^2) of 0.80. The mass of berries on the images of the vines was estimated with 310 grams of mean error and $R^2 = 0.81$ (manually taken images) and 610 grams of mean error per segment (three vines) and $R^2 = 0.78$ from images taken by an automatic camera.

In the paper "The Development of an Intelligent Monitoring System for Agricultural Inputs Basing on DBN-SOFTMAX," L. Yang et al. proposed a system based on deep belief network (DBN) using a SOFTMAX classifier for the traceability of chemical fertilizers and pesticides in agricultural products. The system features sensor nodes performing measurement of pH, electrical conductivity and moisture, and a LoRa wireless communication module that transfers the measured data to a cloud server for further processing. Tests have been carried out on six agricultural inputs (three chemical fertilizers and three pesticides), and the results have shown how the proposed system provides an accuracy of 98.5%.

In the paper "Applicability of a 3D Laser Scanner for Characterizing the Spray Distribution Pattern of an Air-Assisted Sprayer," F. J. García-Ramos et al. presented an original work conducted by using a three-dimensional (3D) laser technology for the assessment of the performance of air-assisted spraying in fruit orchards. The authors developed a static test using an air-assisted sprayer equipped with two axial fans (front and back) with opposing directions of rotation. Two critical criteria were considered: the deposition of the product as a function of distance and the product distribution in the vicinity of the machine. The main results evidenced that measurements carried out by using the laser sensor allowed the quantification of the maximum distance of deposition of the product and the quantification of the amount of products applied in different areas in the vicinity of the sprayer.

In the paper "Monitoring and Control Systems in Agriculture Using Intelligent Sensor Techniques: A Review of the Aeroponic System," I. A. Lakhiar et al. presented a review on the use of wireless sensor network (WSN) in aeroponic cultivation. The authors discussed the advantages of aeroponics, a cultivation system where plant roots are hanged in the darkness in a growth chamber and provided with a nutrient mist in replacement of the soil, in terms of better control and possibility to investigate the effects of different nutrients on plant growth. A discussion on the problems faced by the application of aeroponics in terms of attention required by the grower to timely detect failures in the atomization nozzles and monitor critical parameters has been also presented. The authors discussed how the use of WSNs in aeroponics can effectively solve these drawbacks, thus helping the diffusion of the technique to farmers and scientists.

Conflicts of Interest

The guest editorial team as a whole declares that no conflict of interest or private agreement with companies exists.

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