SATAE - Sensors and Actuators for Agricultural Decision Making and Knowledge in Engineering

Special Track along with ALLSENSORS, April 24 - 28, 2023-Venice, Italy
https://www.iaria.org/conferences2023/filesALLSENSORS23/SATAE.pdf

Paulo E. Cruvinel
Brazilian Agricultural Research Corporation
(Embrapa Instrumentation)
São Carlos, SP, Brazil
e-mail: paulo.cruvinel@embrapa.br

***Abstract*—Sensors and actuators interoperability, embedded computing, enterprise integration, and business convergence by competence sharing are some of the main problems faced in the agricultural industry today. The majority of these topics still find unexplored solutions, which can be an opportunity for research, development and innovation. This white paper is related to the special track in sensors and actuators for agriculture and address solutions and challenges in needs engineering for food and energy production.**

Keywords-sensors; computational inteligence; decision-making models; agricultural production; sutainability.

I. INTRODUCTION

The evolution of agricultural technology began very long time ago. From a simple hand tools providing relief at the beginning gradually gain value aggregation by the use of knowledge, which have been available to food producers today [1].

The use of knowledge and engineering have become important for modern agriculture than ever before. Nowadays that the agricultural industry is facing huge challenges, from decreasing the productive costs of supplies, customization for the productive scale area, a shortage of labor, as well as changes in consumer preferences for transparency and sustainability.

In the last 20 years, agriculture technology has seen a huge growth in recognized scientific knowledge, technology innovations, and investments not only for the indoor vertical farming, but also regarding to automation and robotics, livestock technology, modern greenhouse practices, precision agriculture, artificial intelligence, and blockchain.

In fact, to allow the use of agricultural machinery and any support decision making systems in agriculture many different types of sensors should be used. Therefore, they play an important role and are essential to allow an interface between men and the soil-plant-environment systems [2].

Likewise, sensors allow not only the evaluation of the physical-chemical parameters but also the crop field monitoring for production and sustainability, i.e., helping in risk decreasing and the rational use of agricultural inputs.

Nowadays the use of precision agriculture, a farm management strategy that utilizes a large number of sensors and information technology to optimize agriculture's productivity with sustainability, could help addressing the world population demand for food.

Furthermore, regarding to sensors and actuators for agricultural decision making is also relevant to take into account a multidisciplinary context, which demands practically all kind of sensors and related signal processing concepts, actuators and its control process, modeling, simulation, emulation and enactment, signal and image processing, interoperability, internet of things (IoT), computational technologies, machine learning, deep learning, and Big data analysis, among others aspects.

This report is related to the special track carried out with the Eighth International Conference on Advances in Sensors, Actuators, Metering and Sensing organized by the International Academy, Research and Industry Association (IARIA). After this introduction, in section II it is presented a summary of the international contributions for the theme, followed by section III with the conclusions and future opportunities.

II. SUMMARY OF CONTRIBUTIONS

Wherever The agenda prepared for the track session is considering the presentation and discussion of four scientific papers.

The first presentation will explain the characterization of an Internet of Things (IoT) stereo image sensor system for weed control [3]. The authors have carried out the development and characterization of an embedded stereo system using camera sensors and IoT principles, for future application in the area of digital image processing. In fact, a discussion about concepts and validation of lenses by using Modular Transfer Function (MTF), calibration of intrinsic parameters of sensors and 3D system and memory have been considered. In addition, authors also evaluate energy consumption, and the implementation of an equipment, which aim to control invasive plants in agricultural crops.

The second presentation will discuss a model based on intelligent sensor, useful to control sprinklers in spray actions [4]. In such a context, it is important to observe that pesticides application in crops should be achieve considering quality and effectiveness in terms of pest control for food production. The paper presents an intelligent control system

based on smart sensors for automatization of a spray nozzle that enables error corrections as a function of the boom trajectory. Such a strategy allows to increase quality and efficiency of when using agricultural sprayers.

The third presentation will demonstrate the opportunity by using affordable sensors in agriculture as well as results in such a content related with researcher works developed at Embrapa for tropical agriculture [5]. Although pointed out sensor's conception, the paper also presents examples of affordable sensors that can be easily integrated into existing farming systems. Also, a discussion related to inexpensive sensors development using low-cost materials and simple manufacturing methods is presented. Additionally, briefly discussions regarding of the following's sensors for different farm scale are presented, i.e., for soil moisture based on microwave technique, soil electrical conductivity based on electrodes techniques, sensors for evaluation of water and plant relationships, and an embedded pH smart-sensor for spray solution evaluating, which is useful for crop yield improvements and to reduce the water consumption.

The fourth presentation will illustrate a new design for one thermo-formed piezoelectret accelerometer, that are used to measure acceleration in various applications, including agriculture [6]. In such a paper the authors shown the use of new piezoelectret materials, which offer advantages over the traditional ones. Accelerometer sensors have the ability to alter obtained physical acceleration from motion or gravity into a voltage output. Accelerometers are widely used to measure inert acceleration due to gravity, the low-frequency module of the acceleration and the dynamic acceleration due, for instance, to agricultural machinery or robot movement.

III. CONCLUSIONS

This white paper summarizes the context and gives a preview on the presentations that will be carried out during the special track regarding sensors and their application in agriculture. Despite challenges related to the development and use of sensors in agriculture, nowadays one may observe the rising acceptance of them as fundamental part of the available new technology amongst farmers. Also, the scalability and practicality of using these devices and related signal processing architectures and software's will continue to increase, as will their importance to the agricultural industry. The use of sensors is essential to understand the complex soil-plant-environment behavior and to increase food security with sustainability. Nevertheless, not only the small-farmer but also the large-scale agriculture is still challenge innovation in sensors and actuators for agricultural decision making to continue feeding people in the world, new and customized sensors will have to be utilized and continually developed.

ACKNOWLEDGMENT

It is recognized the support received from both the Brazilian Agricultural Research Corporation (Embrapa) and the International Academy, Research and Industry Association (IARIA).

REFERENCES

[1] M. F. Neves et al, Food and agribusiness in 2030: a roadmap, 1st ed., The Netherlands: Wageningen Academic Publishers, 2020, pp. 1-123.

[2] P. E. Cruvinel and S. Mascarenhas, Advanced studies in agricultural instrumentation, Brazil: Rima Publishers, 2002, pp. 1-216.

[3] B. M. Moreno and P. E. Cruvinel, "Characterization of an IoT stereo image sensor system for weed control", The Eighth International Conference on Advances in Sensors, Actuators, Metering and Sensing, ALLSENSORS 2023, Venice, Italy, April 24-28, 2023.

[4] D. R. Schutz et al, "A model based intelligent sensor to control sprinklers in spray actions", The Eighth International Conference on Advances in Sensors, Actuators, Metering and Sensing, ALLSENSORS 2023, Venice, Italy, April 24-28, 2023.

[5] P. S. P. Herrmann Junior et al, "Developing affordable sensors in agriculture based on results obtained at Embrapa Instrumentation", The Eighth International Conference on Advances in Sensors, Actuators, Metering and Sensing, ALLSENSORS 2023, Venice, Italy, April 24-28, 2023.

[6] I. N. Soares et al, "New design for thermo-formed piezoelectret accelerometer", The Eighth International Conference on Advances in Sensors, Actuators, Metering and Sensing, ALLSENSORS 2023, Venice, Italy, April 24-28, 2023.