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EDITORIAL

AI in Current and Future Agriculture

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Agriculture is without a doubt an ancient human activity, contributing even to the emergence of civilization. In contrast, the technological applications of artificial intelligence (AI) are not even a century old. Perhaps due to such a wide gap, it isn't always obvious that agriculture is a fitting application domain for AI; the development of agriculture is, in fact, intrinsically tied to technological progress, which continually provides new materials, tools and machinery to address a growing set of demands.

Today, agriculture is a high-priority sector with ample opportunities (and pressure) for technological innovations, as our global society faces rapid climate change, an increasing world population and many industrialized countries struggle with a shortage of workers. Unsurprisingly, this has led to a variety of modern agricultural technologies (Ag Tech) worldwide. Agriculture is characterized by many complex and unpredictable factors: outdoor conditions are influenced by the weather, soil, type and number of plants, and even animals as well as pests and diseases. AI is particularly well suited to solve such problems, as it provides methods capable of handling data-intensive and knowledge-intensive applications and designed to be resilient under complications such as limited information, lack of complete control and poor predictability.

Agriculture, on its own, is a vast and complex research and application domain with a large diversity of topics. Although this issue explores some of its subdomains and their associated technologies, it is impossible to offer an exhaustive list of ongoing research and applications and account for the thousands of articles published in recent years. Such figures alone, however, help emphasize the global importance of the topic.

This special issue also contains technical contributions which constitute additions to an already impressive body of work and provide examples of the latest research from different aspects of AI in agriculture, which may help inform our expectations of how future developments could further shape the field.

It is worth noting that AI in agriculture is not merely a thing of the future nor is it restricted to research labs. As exemplified in the AI Transfer articles in this special issue, AI-based Ag Tech already has numerous successful application examples and many companies, both small and large, include elements of AI technology in their current products and new developments.

1 Content

In this special issue we provide a collection of recent developments and applications of AI in current and future agriculture, which also serves as an entry point for further research. We start with an introductory overview and an interview with an expert on the topic, followed by two thorough technical contributions on insect detection with acoustic sensors in greenhouses and leaf segmentation of diseased plants using UAV imagery. Next, a project report describes an end-to-end architecture for selective weeding in arable farming, and a series of solutions for navigation control and path planning for autonomous mobile robots are presented in a dissertation abstract. Finally, two transfer articles discuss applications of learning-based methods in agriculture: in the first, indices from multispectral satellite and weather data are used to train a grassland yield model; in the second, a platform that uses active learning for efficient model creation (based on Zauberzeug's Learning Loop) is described.

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1.1 Introduction

- *AI in Current and Future Agriculture: an Introductory Overview* [6].
  Benjamin Kisliuk, Jan Christoph Krause, Hendrik Meemken, Juan Carlos Saborio Morales, Henning Müller and Joachim Hertzberg.

1.2 Interview

- *Cyrill Stachniss' View on AI in Agriculture* [5].
  Joachim Hertzberg, Benjamin Kisliuk, Jan Christoph Krause and Cyrill Stachniss.

1.3 Technical Contributions

- *Data Augmentation for Mask-Based Leaf Segmentation of UAV-Images as a Basis to Extract Leaf-Based Phenotyping Parameters* [1].
  Abel Barreto, Lasse Reifenrath, Richard Vogg, Fabian Sinz, Anne-Katrin Mahlein.
- *Towards noise robust acoustic insect detection: from the lab to the greenhouse* [2].
  Jelto Branding, Dieter von Hörsten, Jens Karl Wegener, Elias Böckmann, Eberhard Hartung.

1.4 Project Reports

- *Cognitive Weeding: An approach to single-plant specific weed regulation* [7].
  Mark Niemeyer, Marian Renz, Maren Pukrop, David Hagemann, Tim Zurheide, Daniel Di Marco, Markus Höferlin, Philipp Stark, Florian Rahe, Matthias Igelbrink, Mario Jenz, Thomas Jarmer, Dieter Trautz, Stefan Stiene, Joachim Hertzberg.

1.5 Dissertation Abstract

- *Navigation Control & Path Planning for Autonomous Mobile Robots* [8].
  Sebastian Pütz.

1.6 AI-Transfer

- *Grassland Yield Estimation Using Transfer Learning from Remote Sensing Data* [3].
  Elias Eder, Peter Riegler-Nurscher, Johann Prankl, Heinrich Prankl
- *Zauberzeug Learning Loop* [4].
  Philipp Glahe, Rodja Trappe.

2 Service

2.1 Conferences and Workshops

The large international AI and/or Robotics Conferences like IJCAI, AAAI, ICRA, IROS typically include papers and workshops related to AI in Agriculture, Agricultural Robotics, and related topics. There are a few special events addressing specifically agriculture topics in the spectrum of this KI Issue:

- ASABE Annual International Meeting (AIM).
- GIL Tagung (Gesellschaft für Informatik in der Land-, Forst- und Ernährungswirtschaft).
- International Conference on Agricultural Engineering (LAND.TECHNIK/AgEng).
- Scientific Workshop at International Forum of Agricultural Robotics (FIRA).
- ECMR Workshop on Agricultural Robotics and Automation (AgriWS).

2.2 Journals

- Wiley: Journal of the Science of Food and Agriculture.
- Wiley: Journal of Field Robotics.
- Sage: International Journal of Robotics Research (IJRR).
- Elsevier: Computers and Electronics in Agriculture.
- Elsevier: Smart Agricultural Technology.
- Elsevier: Artificial Intelligence in Agriculture.
- Elsevier: Information Processing in Agriculture.
- MDPI: Agriculture.

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