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DEVELOPMENT OF A TRAINING PROGRAM FOR ENHANCING THE USE OF ICT TOOLS IN THE IMPLEMENTATION OF PRECISION AGRICULTURE

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Introduction to Automation and Robotics in Agriculture

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Contents

1 Objectives

The objectives of this lesson are:

- Give an overview of automation and robotics use in agriculture
- identifying the needs and how existing systems may respond
- Understand different levels of automation with more or less autonomy

2 Tutor instructions

This is a 1h of lesson in presence. This presentation will lead the attendant to get an overview of Automated Systems (AS) and robots used agricultural context.

2.1. Identification of some needs and existing systems

(Slide 4 and 5 from document *LectureintroAS.pptx*) [1]

2.1.1 Improve labor conditions while reducing repetitive and laborious tasks

This list is not exhaustive and can be completed through a short brain storming with participants. Examples of flagship systems used in agriculture (Knotter CLAAS (1921), draft control (Fergusson, 1936) on 3 point lift (Fergusson 1916),… slip control with radar (Bosch EHR, 1978)…) is completed in folloings slides with some emblematic examples of robots (Milkbot, etc.)

Slides 6 to 9, are used by pairs. The first slide describes commercial systems as the second gives more details on the functionalities and process of the automated system. The purpose of these examples is not to deeply analyse AS but to identify key elements of the structure of AS (sensors, actuators, agronomical issues). These examples can also be commented by participants. When available, videos can be used to complete the presentation of systems.

Slides 10-11 from document *LectureintroAS.pptx :* This example is given as an example of the high level of complexity of some tasks : the driver uses his two hands with joysticks and his two feet with pedals. AS systems were developped to automatically memorize some actions and provide standard wood products (ex. calibration of the trunk length)

2.1.2 Replacing the operator in difficult/constraining conditions

Guiding and autoguiding are now functionalities that become a standard in many farms.

Since tractor guiding uses a GPS, other machines may require more adapted systems that can be optical (Garford https://garford.com/products/robocrop-guided-hoes), New Holland (3D image guiding on grape havesters) or mechanical (Autotrac Row Sense John Deere) on combines and forage harvesters.

2.1.3 Improving productivity while increasing the quality of work and safety

Slides 14-15 from document *LectureintroAS.pptx*

AS also emerged in agriculture for productivity and safety reasons. Two examples are given here with autonomous systems : a weed robot and a cleaning robot. Livestock farming proposes adapted conditions to robots for cleaning, feeding and milking.
MIROBOT : http://demo.miro-en.ngpa.com/scrapers/p16356
Weedbots are developing as an alternative to intensive herbicide applications: https://www.naio-technologies.com/en/

More information on robots will be provided on Part 4

2.1.4 improve the quality of work while ensuring a flowrate control

Slides 14-15 from document *LectureintroAS.pptx*

Manage variability is a basic concept of precision agriculture. The fist functionality is that the flow distribution has to adapt to the travel speed or spraying width (DPA function).
The second functionality concerns the use of prescription maps and controlled trapdoors on a fertilizer spreader in order to limit the excess of Nitrogen amounts with beneficial environmental impacts and to optimize the crop yield.

Slide 16 – 17 from document *LectureintroAS.pptx*
First, boom section control on a sprayer limits the risk of overdosing
Second, sensitive areas can be upload on the control system of the sprayer so that antidrift nozzles can be automatically used when needed.
https://amazone.net/en/plan-learn/learn/perfection-for-precision-plant-protection-amaselect/precision-to-perfection-340292

2.1.5 Ensure traceability of field operations while recording operation data

Slide 18 from document *LectureintroAS.pptx* introduces the benefit of AS systems in terms of traceability.
Two examples are give, Ec-tronic from Berthoud sprayers (www.berthoud.com) and PICORE from SIKA on second assembly for bush and tree crop sprayers (viticulture, orchard) https://sika-picore.net

2.2 Introduction to robotics

Slide 22 from document *LectureintroAS.pptx*
The term comes from a Slavic root, *robot-*, with meanings associated with labor. The word 'robot' was first used to denote a fictional humanoid in a 1920 Czech-language play *R.U.R. (Rossumovi Univerzální Roboti - Rossum's Universal Robots)* by Karel Čapek, though it was Karel's brother Josef Čapek who was the word's true inventor.

Functionalities listed here are not exhaustive and can be discussed with participants.

Slide 23 from document *LectureintroAS.pptx*
The evolution of agricultural practices were historically dependent on the availability of bigger/faster equipments as a necessity to gain productivity. The development of Agbots generates new ideas and perspectives including in the economical model of farming.

“A technological revolution in farming led by advances in robotics and sensing technologies looks set to disrupt modern practice”. (King, 2017)

This probably explains why Ag robots first developed in livestock farming (ex. milkrobot).

2.2.1 Introduction to robots in crop production

Slide 24 from document *LectureintroAS.pptx*
Weed management found a favorable terrain for robots since this is a laborious but a precision task. The low productivity is not really problematic. In parallel to domestic mowing bots, there are also mowing robots for agriculture (https://precisionmakers.com)

Ecorobotix (www.ecorobotics.com) has developed a range of weedbots.

Slide 25 from document *LectureintroAS.pptx*
Fruit harvesting saw the development of different robots since the 80’s with the standardization of orchards (fruit wall training for pome fruits and some stone fruits). Fruit harvesting is still a challenge for robots because of the complex environment.
Zhao et al., 2016 reviews key techniques of vision based control for harvesting robots.

Slide 26 from document *LectureintroAS.pptx*
This slide introduces ergonomical advantages with robots that can carry heavy loads and can follow the operator. Example of the French BAUDET ROB (Baudet stands for “donkey”). This system is interesting in every

agricultural operation where operator may carry heavy loads (harvest, tools, etc.)

2.2.2 Introduction to robots in animal production

Slide 27 from document *LectureintroAS.pptx*
Shows three emblematic situations where robots found advantages in livestock farming : feedbot, cleanbot and milkbot. The development of such technologies also involves sociological and ethical questions (ex Driessen et al., 2015 Cows desiring to be milked?).
However, the development of milk robots generally involves positive agreement from farmers (John et al., 2016).

3 Related links:

Ivan Margolius,'The Robot of Prague', Newsletter, The Friends of Czech Heritage no. 17, Autumn 2017, pp. 3 - 6. https://czechfriends.net/images/RobotsMargoliusJul2017.pdf Archived 2017-09-11 at the Wayback Machine

Karel Capek – Who did actually invent the word "robot" and what does it mean? at capek.misto.cz[dead link] – archive

Kurfess, Thomas R. (1 January 2005). Robotics and Automation Handbook. Taylor & Francis. ISBN 9780849318047. Archived from the original on 4 December 2016. Retrieved 5 July 2016 – via Google Books.

King, A. Technology: The Future of Agriculture. *Nature* **544,** S21–S23 (2017). https://doi.org/10.1038/544S21a

Zhao, Y., Gong, L., Huang, Y., Liu, C., 2016 A review of key techniques of vision-based control for harvesting robot. Computers and Electronics in Agriculture, 127, 311-323. DOI 10.1016/j.compag.2016.06.022

Driessen, C., Heutinck, L., 2015. Cows desiring to be milked? Milking robots and the co-evolution of ethics and technology on Dutch dairy farms. Agric Hum Values (2015) 32:3–20. DOI 10.1007/s10460-014-9515-5

John, A.J., Clark, C.E.F., Freeman, M.J., Kerrisk, K.L., Garcia, S.C., Halachmi, I., 2016, Review: Milking robot utilization, a successful precision livestock farming evolution, Animal (2016), 10:9, pp 1484–1492 © The Animal Consortium 2016 doi:10.1017/S1751731116000495