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ADOPTION OF ARTIFICIAL INTELLIGENCE IN AGRICULTURE

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ABSTRACT

Agriculture is facing major challenges. Increasing the total production by 70% in order to suit the world's demand in the next 50 years is an objective endangered by limited resources, climatic changes and other short term and regional threats. Despite its relatively short life, Artificial Intelligence is seen more and more as a solution to these challenges. The idea that these problems will be surpassed using the technology goes forward, some opinions advocating that humanity will merge with A.I. in the next 50 years, reaching a new phase of evolution. On the other hand, millions of people have no access yet to basic resources, like food, water and shelter. This study is about adoption and the development of artificial intelligent agents in agriculture, focusing on expert systems, sensors for collecting and transmitting data and robots developed for agriculture, in an attempt to reveal their potential impact in this field.

Key words : *Artificial intelligence, agriculture, adoption, robots***.**

Intensification in agriculture sets a high pressure on energy, mainly represented by fossil fuel, the supply of which is predicted to be insufficient to meet the demand over the next 15-20 years without radical measures and investments in all over the world. The gap between available water supply and water demand is increasing in many parts of the world. By 2025 over three billion people are likely to experience water stress (UNDP, 2006). High rate of consumption in the available resources has also a negative impact on the environment, mainly represented by CO2 emissions and deforestation, both causing global warming. Large areas will need to adapt to new environmental conditions, a process unfeasible in all situations due to scarcity of resources, resulting in further food insecurity, especially for developing countries (Mark W., 2008).More than that, short term but difficult to predict events, like financial crises, human or animal epidemics and price volatility of agricultural inputs and food, amplify the uncertainty about farming activity and raise serious concerns to consumers and authorities (Brian Coffey, 2005).

Along with traditional methods of political and economic measures, Artificial Intelligence (A.I.) plays a growing role in the eyes of scientists and governments, in an attempt to face these challenges (U. Cortés, 2000). Despite the relatively short history of this field, complex platforms and devices for solving some specific problems have already been developed (National Research Council USA, 1997) and intensive research projects are ongoing.

The idea that these challenges will be surpassed using the technology goes forward, some opinions advocating that intelligent agents will substitute human labour and humanity will merge with A.I. in the next 50 years, reaching a new phase of evolution (Mihail C., 2003; James Hughes, 2004).This paper tries to outline the A.I. adoption trends in agriculture, starting from the existing state of affairs and going to the intrigue zone of these futuristic ideas. It would be possible in these new circumstances that the artificial intelligence could be the answer for a few million years old fundamental issue, like scarcity of food?

Other papers (Gelb E.M., 1997; Ning Wang, 2006) treat to some extent the topic, without necessarily trying to answer the above question, but the subject claims permanent attention and reassessment of opinions, because of the rapid evolution of this field.

The term Artificial Intelligence was introduced in 1956, as "the science and engineering of making intelligent machines" (Andresen, S.L, 2002). Building intelligent agents (machines) able to find solutions for complex problems and to achieve goals like humans, proved to be a difficult task, despite the initial enthusiasm. This involves reproducing complex behaviours like perception of the environment, reasoning and planning, learning, using natural language (writing and speaking), motion and manipulation, only to name a few (Matthew Stone, 2006). If considering the "general intelligence" concept, which tries to copy or replace somewhat the human mind entirely the progress is not so spectacular, in some particular narrow areas have been created intelligent agents (Pamela McCorduck, 2004) which perform better than a well qualified person and brought positive economic and environmental results (Ahmed Rafea, 2001).

Some of these applications were developed for agriculture or were adjusted and adopted in farming from other industries.

Expert systems and software

The expert systems are able to demarcate management zones taking in consideration soil proprieties, meteorological data and other relevant factors, they are able to suggest suitable crop rotations, optimal density of crops in the planting stage, water needs and irrigation schedule, fertilizer rates and the proper time for application. Expert systems are also capable of diagnosing pests and diseases for crops and suggesting preventive or curative measures. They can indicate the proper time for harvesting and to specify how to use efficiently farm machinery and personnel (Kiong Siew Wai, 2005).

The scientific literature and exploratory trials conducted on available software illustrates that expert systems cover almost all relevant areas of interest in farming activity but their number and complexity varies from country to country. A total number of 1315 software has been reported in eight European countries since 1996 (Gelb E.M., 1997).

More advanced technologies like human-computer interaction via brain signals are in the early stage of development in health and entertainment industries mainly. Non invasive applications, which allow operators to interact with the software focusing or thinking to some symbols or objects, were released in the last five years on the market. The accuracy and efficiency of these systems doesn't allow them yet to be incorporated into a viable expert system for agriculture, but projects to develop these technologies are part of the current research strategy (Mihail C. Roco, 2003).

Qualitative aspects, like technology advancements, decreasing the adoption costs, early education for using the computer, new administrative and legislative requirements, are strong arguments suggesting that adoption of expert systems and specialised software will follow the same trend, becoming usual tools for quasi most farmers, before 2040.

Sensors for collecting and transmitting data

Improving the interaction human computer doesn't guarantee the validity of the solution generated by the expert systems. Human operators can accidentally alter the data fed into expert systems, applying improper techniques to collect them, due to the subjective appreciations or making errors in the inputting process. Delivering data continuously or frequently is not a feasible option for a human operator. Special sensors designed to collect and transmit data to the expert systems are more precise and cut down the necessary effort and time for these operations. A range of special sensors are commonly used today in agriculture especially embedded in complex agricultural machines or placed in farm buildings or in their proximity.

Widespread sensors are used to measure and transmit data regarding air temperature, air humidity, atmospheric pressure, soil temperature, soil moisture, soil pH, solar radiation, wind speed, wind direction, rainfall and leaf wetness (Ning Wang, 2006).

The use of electronic identification tags for some farm animals is mandatory in Europe and is widespread also in some other parts of the world. Prototype collars able to restrict animal access to a predefined area using the computer were tested. There are also in use sensors for collecting biologic data from animals (heart rate, temperature, movements) and precisely locate every animal, via satellites. However, the use of sensors outdoors still has important limitations, mainly because of their low energy autonomy, short distance data transmission capacity and lack of integration.

Robotic and automation

Making right decisions in agricultural activities is less than half the way needed to achieve desired results. The intelligent agents (robots and automatic devices) implementing measures into practice are seen more often as a feasible solution for the future, for increasing technical and economic efficiency and reducing the environmental negative impact of farming (Thomas Bak, 2004).

Manipulator robots have been used with great success in factories in the last 50 years, replacing human workforce in repetitive and tiresome tasks. There were nearly a million robots in operation worldwide. Half of the robot population is located in

Asia, one third in Europe, and 16% in North America. Australasia and Africa each account for 1% (IFR, 2007).

In some green houses, the temperature, humidity, light control, fertilization and phytosanitary treatments are automatically completed. For some crops there are commercially available fully autonomous robots dealing with the whole cultivation process, from planting to packaging in a greenhouse (Daniel de Nokker, 2004).

CONCLUSIONS

This paper demonstrates that there is an unquestionable growing tendency in the adoption of artificial intelligence in agriculture. Computerized expert systems cover a broad area of farming but their number and complexity vary considerably with location. Underdevelopment of the IT infrastructure in many countries is the first obstruction in using them, only around 30% of the world population currently having access to these new technologies.

Great progress was made lately in designing accessible applications, shortening the time and effort of operators, but the expert systems are highly dependent by integrity of data supplied by humans and are not yet designed to cover entirely the farm management process. Expansion of the IT infrastructure, technological advancement and positive attitude about the adoption process, support the idea of further increases, with around 75% of worldwide farmers using them by 2030.A broad range of special sensors for agriculture are commonly used today, embedded in complex agricultural machines or placed in farm buildings or in their proximity. They can provide data continuously or frequently, in real time manner, avoiding human errors and improving the decision making process. However, low energy autonomy, short distance data transmission capacity and lack of integration in complex decision systems are important limitations to use them with maximum effect in farming.

The use of robots and autonomous devices in farming is still in infancy. Only in greenhouses and dairy farms the activity of robots can be counted as relevant, but for other activities the robots have just become commercially available or are in a prototype phase, their visibility and outcome in world agriculture being almost negligible. The new technologies in robotic and automation field still require time and investments in order to make them exceed the performance of technology in use today.

REFERENCES

1. Ahmed, R.(2001). The Evaluation and Impact of NEPER Wheat Expert System, Central Laboratory for Expert Systems, Giza Egypt, p. 2-5
2. Andresen, S.L (2002). John McCarthy: father of AI, IEEE Intelligent Systems Magazine, Volume: 17, p. 84, 85
3. Brian,C., James, M., Sean, F., Ted, S., and Luc, V. (2005). The Economic Impact of BSE on the U.S. Beef Industry: Product Value Losses, Regulatory Costs and Consumer Reactions, Kansans State University, p. 33-37, 45,51
4. Daniel, D.N. (2004). Hortiplan Mobile Gully System. Fruit and Veg. Tech., 4(5): Zwijndrecht, Belgium.
5. Darren, W. (2008). Brain control headset for gamers, BBC News website, San Francisco.
6. European Robotics Research Network (2008). World Robotics 2007, p. 380
7. Food and Agriculture Organization (2002). World Agriculture: Towards 2015/2030. An FAO perspective, Summary Report, Rome, p. 153
8. Food and Agriculture Organization (2007). The State of Food and Agriculture 2 0 0 7. World and regional review, A longer-term perspective , Rome, p. 18
9. Gelb E.M., Bonati G., Carel J.L., Claustriaux J.J., Jurgens P., Lehnert, S., Pasher, P., Kamp J.A.L.M, Mourao A.M.7, Wahl V., Nicol J., Nunez Butragueno J.A., Costa, F., Spoiden, G., Raschas,M. (1997). ICT Adoption in Agriculture - an Agricultural Software-Review Perspective, Copenhagen.
10. Gelb, E., Maru, A., Brodgen J., Dodsworth, E., Samii, R., Pesce, V. (2008). Adoption of ICT Enabled Information Systems for Agricultural Development and Rural Viability, Atsugi Japan, p. 4-5.
11. James, H. (2004). Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future, Cambridge, Massachusetts
12. Kfm, J.S., Werner, Z. (2008). Crude Oil – The Supply Outlook, 2008/02/11 LBST, Ottobrunn Germany, p. 6-9
13. Kiong, S.W., Abd. L., Rahman, A., Mohd, F.Z., and Azwan, A. A. (2005). Expert System in Real World Applications, p. 1- 4
14. Mark, W. R., Mandy, E., Gary, Y., Ian, B., Saleemul, H., and Rowena, V.S. (2008). Climate Change and Agriculture Threats and Opportunities, Eschborn, p. 16-19
15. Matthew, S., Haym, H., (2006). Artificial Intelligence: The Next Twenty-Five Years, AI Magazine Volume 26, Number 4, p. 8, 9
16. Mihail, C. R. and William, S.B., National Science Foundation (2003) Converging Technologies for Improving Human Performance, Dordrecht, p 4-10
17. National Research Council (1997). Precision Agriculture in the 21st Century: Geospatial and Information

Technologies in Crop Management, Academy Press, Washington DC, USA, p. 65-89

18. Ning, W., Naiqian, Z. and Maohua, W. (2006). Wireless sensors in agriculture and food industry. Recent development and future perspective, Computers and Electronics in Agriculture, Volume 50,Issue 1
19. Padraig, W.(2007). Analysis of Adoption and Use of ICTs among Irish Farm Families, Journal of Extension Systems, Volume 23(1), p.14-28.
20. Pamela, M. (2004). Machines Who Think: A Personal Inquiry into the History and Prospects of Artificial Intelligence, p. 10-11
21. Prasad, G.N.R., Vinaya Babu A. (2006). A Study on Various Expert Systems in Agriculture, Georgian Electronic Scientific Journal: Computer Science and Telecommunications No.4 (11), p. 1-5
22. Thomas, B.(2004). The Agrobotics Project (presentation), Agrobotics Workshop, Horsens, Denmark
23. United Nations Development Programme (2006). Human Development Report. Beyond scarcity: Power, poverty and the global water crisis, New York, Summary, p.28