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Agricultural Robotics: A Promising Challenge

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The word robot originates in the twentieth century with the fictional writer Karel Capek,[1] but the idea of a mechanism that can perform tasks automatically is much older, such as an automatic toy dog of Egyptians over 4000 years old,[2] or gold mythological servants who aided the Greek God Hephesto (Vulcan for the Romans) in his works of blacksmith by the years 2000 BC[3] and Da Vinci that designed and built a horse and a "robotic" knight in 1500 AD.[4]

Although the idea is old, its realization occurred only in the 40's of last century, when Wiener was interested in studying the application of control theory in biological systems. Then came the cybernetics that studies the living beings from the neuron and their synapses to the subjective behavior of animals (including humans) with a view to applying this knowledge in robots, because this area of knowledge is concerned with the processes of communication, control and action of artificial systems based on living systems.[5]

These advances in knowledge between the communication/control/action interfaces enabled Gray Walter to develop his "turtles" in 1940, small machines that could be trained or "domesticated," from which Devol devised the first industrial robot to manipulate objects in 1954 and also from his ideas emerged the first commercial industrial robot, called Unimate, in 1961, that manipulated structural elements of car chassis in the production line of General Motors.[6]

In technical terms, a robot is a system developed and designed based on a dynamic interaction between several areas of knowledge in a transdisciplinary process, where theoretical and practical knowledge of kinematics, dynamics, design of mechanisms, sensing, movement planning, control theory, programming, systems architecture and methods in Artificial Intelligence (A.I.) reasoning interact to allow the machine to perform specific tasks defined by its design. Thus, when faced with unforeseen "obstacles", it must have the "mental" capacity to diagnose the obstacle, evaluate the hypotheses to overcome it and choose the one that is most likely to succeed, finalizing the process with the implementation of a change "Behavioral".[7]

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From the first viable industrial robot (1961) to the present day, robotic technology has advanced exponentially, such that today we can define a robot as any automatic machine that has the capacity for decision, and for that it must have electronic "brains" that think through logical expressed in A.I. algorithms that are the vanguard of the current robotics. In general, the A. I. follow Bayesian logic, which in robotics we like to call First Order Predicative Logic (FOPL), because it represents uncertainties about propositions, especially when one does not have complete information about the plausibility of the proposition and, is therefore, it is ideal for agricultural applications.[8] Already the conventional logic is based on a very strong dichotomy, between true or false, zero or one, high or low. This type of logic is very limited for tasks and actions that a robot has to fulfill, and in the agriculture is not different.

In agriculture, robots are pushing hard in all sectors and it is envisioned that they will be essential for humanity that has come up against bleak predictions about the Earth's ability to support a human population that is continually growing while resources are limited. At the beginning of the 21st century when thinking about food for humanity with a horizon of more than 9.5 billion members in 2050,[9] a conceptual tripod always comes to mind: 1- Healthier foods; 2- Sustainability in the agricultural production and 3-Advanced technology.

It can be noticed that the current crop species used for human consumption are in their limit of production, both in genetic and technological terms, not considering problems with the physical area for production or questions regarding the volume and quality of water. Thus, an alternative to trying to mitigate this food shortage scenario is the use of increasingly advanced technologies, such as robotics that are part of the brand new Agriculture 4.0 or Smart Farms.

This new agriculture has many examples of operational applications of robotics that are an overwhelming trend. These advances in Agriculture 4.0, explaining that intelligent machines and crop sensors on farms have obtained large amounts of agricultural data and that the amount, quality, and scope has grown tremendously, enabling data availability to improve agricultural processes.[10]

In this agricultural context, innovations are developing in an accelerated way.[11] There are robots of application of plant health products, for sowing, for diagnosis of soil, plants, water, computer vision systems, harvesting robots, remote control systems, transplantation systems, weed control, disease and pests monitoring, robots for pruning, etc.[12] There are robots that even irrigate individual pots in the agricultural greenhouses, which use moisture sensors, position, and computer vision to evaluate how much water each plant needs and then apply the required water to each plant, this system saves water and substantially improves irrigation efficiency.[13]

Agriculture is experiencing a digital revolution in the field, such as Internet of Things (IOT) Technologies. There are now completely autonomous mechanized systems and with a direct connection to the managers who control all the processes at a distance in the headquarters of the farms. There are also variable rate application technologies fully interfaced with productivity maps and global location system.[14]

Robotic systems generate increased production and efficiency in processes that greatly increase the yield of crops. This benefit comes tied to another one, which is perhaps more important: a decrease in the cost of production. Robotic systems that exist and will exist, they will be cheaper, faster, and safer than the current conventional systems of agricultural production. However, some non-trivial technical challenges stand in the way of the large-scale use of robotics in the field.

The main obstacle is the development of systems adapted to the agricultural conditions, because there are many elements of automatic and robotics (used in industry and smart cities) that are very good, but when they are part of the agricultural world with the great susceptibility of the agricultural products in spoiling of the most varied forms, problems occur.

There is the urgent necessity of developments in robotics technologies for agricultural reality. Many processors used actually in the industry would not stand the environment of a greenhouse, because the condition of moisture, temperature and corrosive factors would destroy them in short time. The issue of connectivity is another serious problem, how will these robotic systems communicate wirelessly in the long distances of croplands?

These realities are hard challenges; of course, we could use systems that are more advanced. Such as processors used in the oil/aeronautics industry or military wireless systems, but this is directly linked to increased cost in agriculture and it is of prime importance to reduce the cost of agricultural production.

Despite these challenges, robotics in agriculture is an inevitable trend and will be increasingly advanced and used. It is the future, and the robotics in the future can be "glimpsed" like a wave to surf, a wave that we do not know for sure where it goes, we only have a "hunch", at first it will take us to the beach, but we are not certain, the only certainty we have is that this wave is irresistible and inexorable, and we will be taken and the future will come, those who surf will be able to think about the next step, the next wave.

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