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Future for robotics in agriculture

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Introduction

Agriculture today is a major industry world-wide. Food is produced with high yields, but also high inputs. The adverse effects of widespread herbicide use, over fertilization and genetically modified foods have aspired protests and inspire ecological alternatives. Precision Agriculture uses the measured field variability as a feedback to smart application of fertilizer, herbicides, pest treatment and irrigation. Pollution, pests and weeds can be reduced, water and fertilizer can be saved - and yields can increase. The idea of applying robotics technology in agriculture is very new. In agriculture, the opportunities for robot-enhanced productivity are immense - and the robots are appearing on farms in various guises and in increasing numbers. We can expect the robots performing agricultural operations autonomously such as ploughing, seed sowing, mud closing and water spraying. Watching the farms day & night for an effective report, allowing farmers to reduce the environmental impact, increase precision and efficiency, and manage individual plants in novel ways.

The applications of instrumental robotics are spreading every day to cover further domains, as the opportunity of replacing human operators provides effective solutions with return on investment. This is very important when the duties, that need be performed, are potentially harmful for the safety or the health of the workers, or when more conservative issues are granted by robotics. Heavy chemicals or drugs dispensers, manure or fertilizers spreaders, etc. are activities more and more concerned by the deployment of unmanned options.

Robotics at different stages of agriculture

Preparation of Seed bed

Ploughing is one of the most important primary cultivation processes and has been carried out since the start of civilization. It is effectively the inversion or mixing of topsoil to prepare a suitable seed bed. It also has the ability to bury surface crop residues and control weeds. A small robot utilising current technology does not have the energy density to sustain ploughing over a large area due to the high levels of energy needed to cut and invert the dense soil. Secondly, the draft force required to plough also needs relatively high weight to give traction. Perhaps we would leave it at that, but by considering what the plant, or in this case the seed actually needs, we can approach the problem in a different way. The seed requires contact with the soil moisture to allow uptake of water and nutrients, it requires stability to hold the growing plant and a structure that allows the roots to develop and the shoots to grow.

Seed mapping

Seed mapping is the concept of passively recording the geospatial position of each seed as it goes into the ground. It is relatively simple in practice as an GPS is fitted to the seeder and infrared sensors mounted below the seed chute. As the seed drops, it cuts the infrared beam and triggers a data logger that records the position and orientation of the seeder. A simple kinematic model can then calculate the actual seed position. The seed coordinates can then be used to target subsequent plant based operations. As the seed drops, it cuts the infrared beam and triggers a data logger that records the indicated position and orientation of the seeder. Some mechanisms do ensure that each seed has zero ground velocity which is important to stop the seed bouncing after impact with the soil.

Reseeding

Reseeding is the concept of being able to identify where a seed was not planted, or that a crop plant has not emerged and a machine can automatically place another seed in the same position. This concept could be extended to transplanting a seedling instead of a seed if the surrounding plants are too far advanced. A reseeder would have the ability to insert individual seeds/plants without disturbing the surrounding crop. Conventional seeders could not then be used as they create continuous slots in the soil.

Scouting of crop

Data collection would be less expensive and timelier if an automated system could remain within the crop canopy for continual monitoring that can be used for assessing crop status. This could be achieved by either embedding cheap wireless sensors at strategic positions within the crop, or placing more expensive sensors onto a moving platform. With the advent of biosensors, a whole new set of opportunities will become available to monitor growing crops for pest and disease attack. As the robotic/autonomous vehicle could patrol the fields continually looking for weeds and other threats, real-time alerts could be sent to the manager whenever certain conditions were encountered.

Robotic irrigation

A robotic irrigator in the form of a mechatronic sprinkler (to simulate a travelling rain gun) was developed to apply variable rates of water and chemigation to predefined areas. The trajectory and sector angles of the jet were controlled by stepper motors and could be adjusted according the current weather and the desired pattern by a small computer. When the airborne water was blown down wind, the jet angles could be adjusted to compensate by measuring the instantaneous wind speed and direction. This system could not only apply the required water in the right place but could irrigate into field corners.

Micro spraying

Micro spraying takes the concept of a spray boom down to the centimeter level. It applies highly targeted chemicals and can treat small areas by selectively switching the jets on and off. It is part of a larger system that can recognize individual weed plants and locate their leaves for treatment. Within the close-to-crop area, great care must be taken not to damage the crop nor disturb the soil. One method of killing weeds close to the crop plants is to use a micro spray that delivers very small amounts directly on to the weed leaf. Machine vision can be used to identify the position of an individual weed plant and a set of nozzles mounted close together can squirt an herbicide on to the weed.

Future of robotics

Most new machines brought to the market are bigger than the previous model. When discussing this issue with equipment manufacturers, this trend is likely to continue into the future. By taking a systems approach to designing robotic systems, consideration can be given to a system in terms of its action, interactions and implications. The result should be a new mechanisation system that collectively deals with the crop's agronomic needs in a better way than is done now. Robots meet stringent hygiene and safety regulations, work tirelessly 24 hours a day, and relieve human workers of physically arduous tasks. Robots contribute to the freshness, variety and quality of food.

Conclusion

The current article presented the necessity, advantages, and applications of using robots in agriculture. In addition, at this stage of development, the initial investments and annual costs for expensive GPS systems are still relatively high but it seems possible to design economic viable robotic systems.

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