

ROBOTIC HARVESTING

Getting a grip. A soft gripper for delicate mushrooms?

Several new technologies have been, or are being developed and tested to automate the harvesting of mushrooms. But a fully integrated robotic harvester, where mushrooms are harvested effectively by a robotic ‘gripper’, has not yet been fully commercialized. Research by a new European project consortium focusses on developing an intelligent and sustainable ‘soft’ gripper.

Anyone who has been in the mushroom sector for some time will know that the idea of a robotic harvester for mushroom crops is high on the wish list, particularly in view of the high labour cost associated with hand-harvested mushrooms. In recent years the sector has also been challenged with an extreme shortage of skilled labour for this very critical role on the farm. Many attempts have been made over the years to automate the harvesting of mushrooms and there have been several interesting and exciting technologies developed that improve harvesting efficiency. These include semi-automated growing systems that facilitate two-handed picking and conveyor systems that transport,

trim and pack harvested mushrooms, but the ‘holy grail’ of a fully integrated robotic harvester, where mushrooms are harvested effectively by a robotic ‘gripper’, has not yet been fully commercialized.

Robotic harvesting systems in development

The sweeping technological advances being made in the robotics world should give some confidence that the robotic harvesting of mushrooms will become a reality. There are positive reports of fully automatic robotic harvesting systems coming from two Canadian companies, Mycionics and TechBrew Robotics, as well as from Penn State University in the USA.

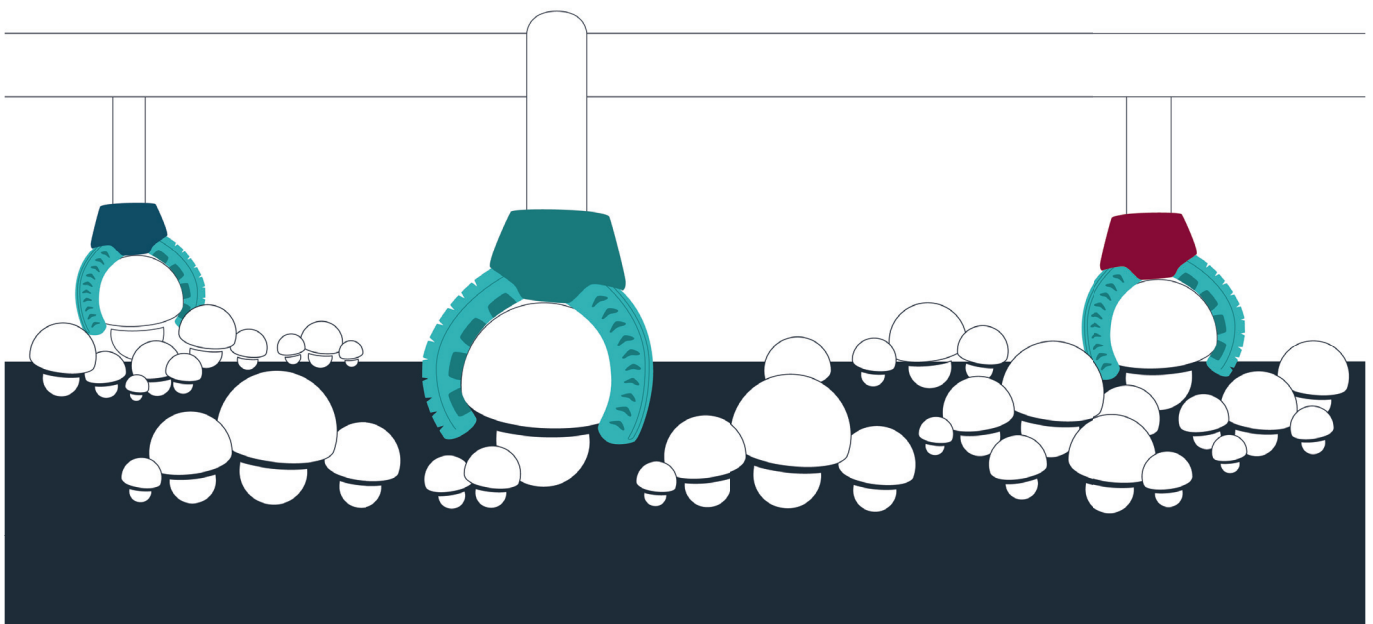




Photo: Advise



SoftGrip project coordinator Matteo Cianchetti of the BioRobotics Institute at Scuola Superiore Sant'Anna, Italy.

Crowded mushroom bed.

The systems developed by Mycionics and TechBrew Robotics are certainly exciting in that it they have developed fully integrated robotic harvesting systems that are being evaluated on mushroom farms in Canada. Mycionics uses a 3-D vision system that maps and identifies the mushrooms to be picked and then directs a 'three-fingered gripper' to harvest the mushroom and transport it to a packer, where it is trimmed and deposited in a tray for weighing. TechBrew Robotics also has a fully autonomous, vision guided mushroom harvesting system that uses a 'suction-cup gripper', and which also trims the mushrooms and places them in punnets for cold storage and transport. Both are at advanced stages of development and we are now waiting to hear how these robotic systems are performing at farm scale and if they could be rolled out commercially. The Penn State system is still in development. It too is based on a suction-cup gripper, and a

new four-year research grant will progress the work to develop a fully integrated prototype system that can be evaluated at a commercial scale.

Replacing humans?

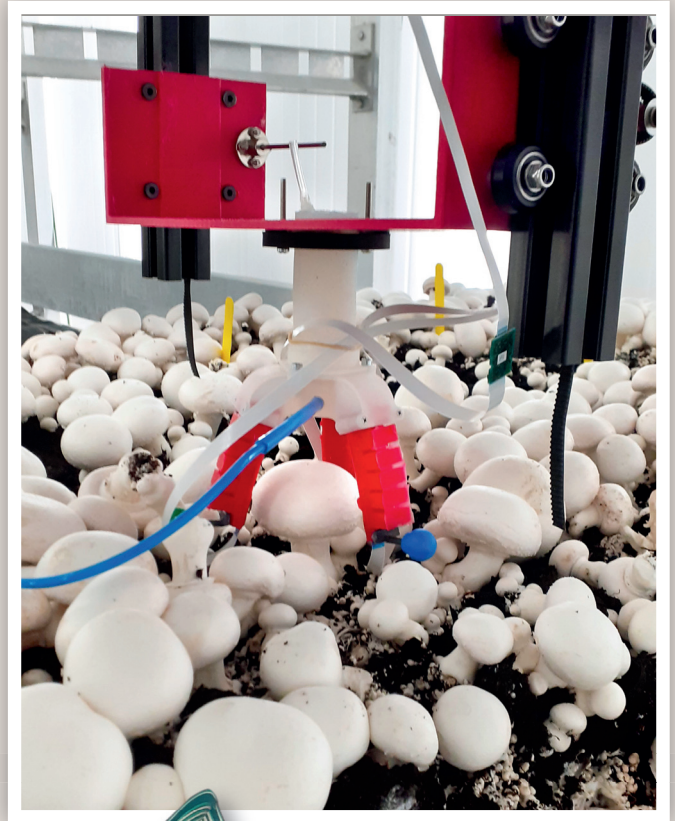
However, despite all this progress, I think many growers still have concerns, especially when we look at the density of mushrooms on the beds at the beginning of first and second flushes. I wonder if any robot could be as versatile and dexterous as a human harvester when dealing with the first day or two of a flush? It may be that robots will have to work alongside humans, who will do the tricky task of picking over and separating out the mushrooms early in the flush, and leaving a nice even spread of mushrooms for robotic harvesting later in the flush? Or perhaps the management of crops may need to change so as to reduce the density of mushrooms in general? Whatever the out→

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Soft gripper prototype.



Prototype soft gripper in action.

come, we still have a way to go yet, before hand-harvesters are replaced, especially when supplying to markets that demand exceptionally high quality products.

SoftGrip – EU-funded research project

Into the arena now is a new project consortium, SoftGrip (www.softgrip-project.eu), which is an EU-funded three-year research project that started in January 2021. The project aims to develop a state of the art 'soft' robotic gripper for the automated harvesting of delicate produce, such as mushrooms. Soft robotics uses technologies that focus on imitating living organisms in terms of flexibility and dexterity, such as the human hand. The consortium includes experts in vision systems, robotics, artificial intelligence, engineering and material science, and they are from research institutes across Europe including the BioRobotics Institute at Scuola Superiore Sant'Anna (SSSA, Italy), the Institute of Communications and Computer Systems associated with the National Technical University of Athens (ICCS-NTUA, Greece), the University of Essex (UK), TWI Hellas



A glove with force-sensors attached that is collecting data while mushrooms are being harvested.

(Greece), Mitsui Chemicals (Germany), and – the Horticulture Development Department in my own organisation, Teagasc, (Ireland), where all the robotics and engineering experts come together to confront the realities of a crop of mushrooms.

Intelligent and sustainable gripping

Speaking recently in the agROBOfood newsletter (<https://agrobfood.eu/newsletter22-interview/>) SoftGrip project coordinator, Matteo Cianchetti of SSSA, Italy, says: “In essence, the SoftGrip consortium are working on teaching soft robotic grippers the ways of skillful harvesters through expert demonstrations of the picking process. The overall goal is to equip the soft robotic grippers with algorithmic intelligence that will coordinate and control the physical movements of the grippers. Then, they will be able to effectively observe in detail the grasping surface in front of them, control their grasp, and monitor their motions and applied forces to perfectly imitate a real-life harvester.” A prototype has now been developed and will be put to the test at a workshop planned for July 2022 at the Teagasc mushroom facilities. Matteo continues to say that “Additionally, apart from the robotic nature of the grippers, the project is looking into novel functionalized

structures and materials that are soft and self-repairable. At the same time, they should be capable of actuating movement in a controlled manner, extracting insights from sensor data and controlling how the pressure distributes when coming in contact with a mushroom. This way, the soft robotic grippers will be programmed to adjust their grasp to the size of different mushroom caps and know the precise twisting and pulling moves that can successfully outroot them. Last but not least, the ‘intelligent’ materials to be developed for the surface of the gripper will be food-safe and recyclable, making SoftGrip a consumer-friendly and sustainable innovation.”

Interaction

The team had hoped to meet with other robotics engineers and growers from the mushroom industry during the Dutch Mushroom Days 2022, which unfortunately has been cancelled, however we are keen to interact with others in the sector to help make the Soft gripper a contender in the pursuit of an effective functionalized robotic harvesting system. 🍄

Please check out the website <https://www.soft-grip-project.eu/#> or contact the co-coordinator Matteo Cianchetti at: matteo.cianchetti@santannapisa.it or Helen Grogan at: helen.grogan@teagasc.ie.

‘In essence, the consortium is teaching soft robotic grippers the ways of skillful harvesters’



Some of the SoftGrip team at a data-collecting workshop held at Teagasc, Dublin, in February 2022 (author Helen Grogan middle right).