# Imaging Makes Agriculture Greener

## Wageningen University

Wageningen University and Research Center of the Netherlands is one of the most important international universities with study programmes and research in the field of healthy food and the living environment. **www.wageningenuniversity.nl**

## Battling weeds: swatting a fly with a bazooka

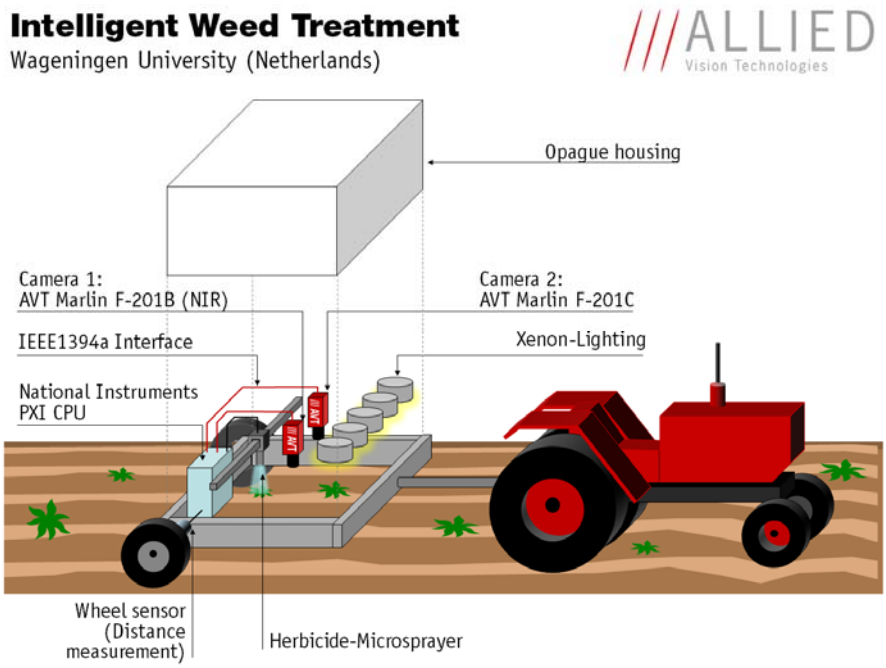
Just as weeds are barely managable in the average garden, they are no less unwieldy on farms. One typical example is the wild potato that grows in sugar beet fields. The plant in question results from leftover potato plants that then grow back wild in years when the crop is rotated to sugar beets. The potato weed releases nematodes and can also spread diseases such as phytophtora infestans across the field. In multi-acre fields, it is impossible to manually dig up each individual wild potato, necessitating chemical means as the only real solution: thus, to eradicate a few scattered weeds, the entire field must be sprayed with pesticides that of course also come into contact with the intentionally cultivated crop.

The Netherlands are known for their advanced and highly productive agricultural sector, occupying one of the top spots in global agronomy. Thus, it is no wonder that Dutch researchers have taken on the problem of weed eradication. This five-year-long project of the Farm Technology group of Wageningen University was part of a dissertation research project and was supported by the STW Technology Foundation in Utrecht.

## The Solution: A Giant Field Scanner

The goal of the project was to recognize and to precisely attack potato weed plants without contaminating the entire field surface and, above all, the sugar beet harvest. It quickly became evident that an imaging system would be necessary to differentiate between plants in the field and accordingly to spray only those to be destroyed.

With the support of Dutch imaging specialist Data Vision, Allied Vision Technologies' sales partner in the Benelux countries, researchers developed a mobile system that can be hauled by a tractor. This giant scanner captures the ground surface and recognizes the wild potato plants, which are then subsequently targeted and treated with a herbicide microsprayer.



## The Requirement: Recognizing and Targeting Weeds

The entire system is mounted on a trailer that can be towed over the field.

During the first stage, the weed must be detected. To this end, two Marlin F-201 digital cameras by Allied Vision Technologies are engaged. Both cameras are equipped with 2 megapixel sensors; one of the cameras is a color version, while the other is an infrared sensitive monochrome variety with a 780 nm IR pass filter. The cameras serve two functions: first, they localize the plants against the earth background; then, they identify the plants either as weed or agricultural crop.

In a captured ground area of 150 x 18 cm, resolution of just over 1 pixel/mm is achieved (1.08 Pixel/mm). For optimal, comparable images, the cameras are installed in a bin that is open from below, allowing five Xenon lamps to provide controlled illumination. Furthermore, a distance measurement device is mounted on one of the trailer wheels, documenting the exact position of the image on the field. To control the image capture and analysis, Dutch developers decided on National Instruments hardware (NI PXI system with Virtex-5 FPGA) and software (NI LabView).

## Marlin: Flexible and Robust Industrial Camera


When considering cameras, the decision went quickly to the Marlin from Allied Vision Technologies. This proven industrial camera was predestined for the task, thanks to its reliable use under difficult conditions. "Beyond that, this AVT camera allows for especially easy configuration to individual needs, such as area of interest, shading correction or trigger calibrations," explained Ard Nieuwenhuizen.

## Intelligent Image Analysis Accommodates Naturally Occurring Aberrations

Image analysis must first and foremost recognize the weeds. Supporting this task, the system is adaptive. "On a mechanically planted field, the path of the furrows is a clearly defined constant: anything growing between the furrows can only be weed," explained Dr. Ard Nieuwenhuizen. Still, weeds can also grow in the furrows themselves between the cultivated plants. Therefore, this system concentrates first on plants beyond the furrow and analyzes their color and infrared properties. Having learned the characteristic features of the wild potato, the software can differentiate between plant types on the furrow as well, even when located between sugar beet plants.

"One additional challenge for an imaging system in agriculture is that the ground properties, such as water or nitrogen content, aren't homogenous in nature, which leads to variations in the color properties of plants," according to Nieuwenhuizen. To circumvent this problem, the system recalibrates anew every ten meters so that only adjacent plants are compared to each other.

Once the undesired growth is identified, it needs only to be treated with the microsprayer. This device, new to the field of agriculture, sprays small quantities of herbicide in 5 microliter drop increments directly onto the leaves of the wild potato. Traveling at 3 kph, the sprayer works with a precision of ±15 mm.

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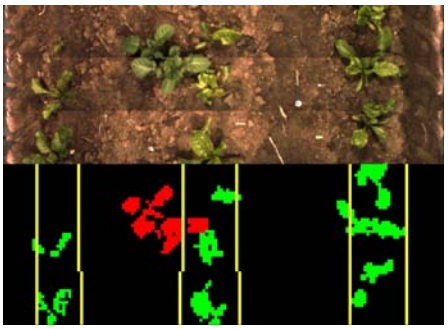

## Use in Practice:
## Efficient weed control increases harvests and protects the environment

Deployment of prototype equipment in practical use proved to be a complete success. For the first time, an automated solution had been developed to do away with weed potatoes. Using such a solution yields economic as well as ecological benefits: thanks to the targeted spraying of only the undesired plants, large quantities of previously applied herbicides are spared and costs are reduced.

Likewise, environmental impact is radically reduced in two ways. First, less poison is used to destroy wild potatoes, and second, early and efficient abatement of the weed as disease agent enables reduced chemical treatment of the sugar beet itself in the course of the plant's growth cycle. Industrial companies have already shown an interest in marketing the system. However, more development is needed before the system can abate not just wild potatoes but other invasive plants as well, making it more attractive for farmers. Moreover, another research team at Wageningen University and Research Center is working on another automatic weed recognition system using AVT cameras that will not spray undesired plants but instead will mechanically remove them, making it also appropriate for organic farming.

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