Vitibot

3D cameras on self-driving robots for vineyards

Eight eyes see more than two

The robot's 3D sensors allow for independent work in the vineyards

Before the exquisite grapes are harvested and used to produce a fine Champagne, the vines need to be cared for over the course of several months. An autonomously driving robot relieves the winemakers of this work. Eight electronic "eyes" in form of 3D cameras ensure an autonomous navigation through the vineyards.

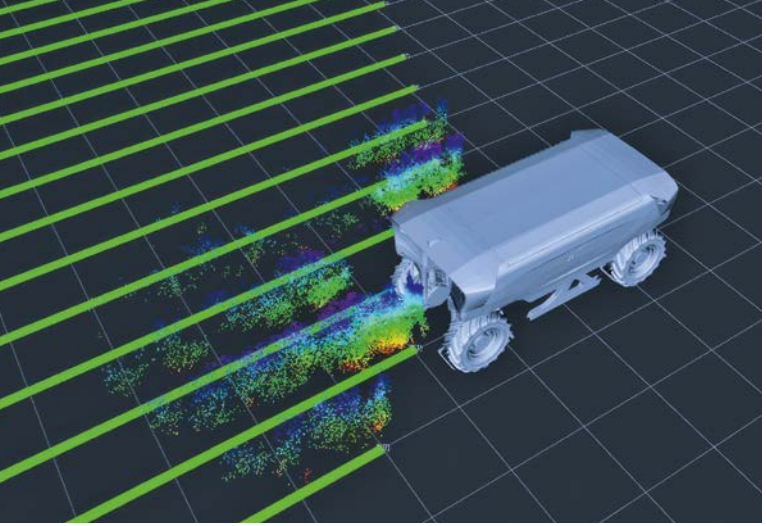
A vineyard somewhere in the Champagne region in France: as if by magic, the four-wheeled robot rolls along the rows of vines systematically, makes a turn at the end of each line and starts working on the next row.

> *In cooperation with ifm we found a solution that meets our needs.*

"Bakus" is the name of this autonomously driving vehicle, developed and manufactured by the relatively young company Vitibot in the French city of Reims. Founder Cédric Bache is not only an engineer, but also the son of a winemaker. Thus he precisely knows the challenges which modern viticulture must face. Enough reason for him to found the company Vitibot in 2016.
The goal: coming up with solutions together with a team of 50 people to automatise most of the work in the vineyards. The result after two years of development is now the autonomously driving robot "Bakus" , ready for series production. It is a moving "Tooling platform".

Jocelyn Vermillet, Senior Manager for mechanics at Vitibot: *"The machine meets the requirements of our customers, the winemakers, who want to automatise all tasks in the vineyard. We produce everything ourselves, from body to chassis, drive, controller on to machining tools. With this stand-alone solution, the winemaker can act a lot more flexibly and can take care of tasks automatically (which used to be carried out by hand and be very time-consuming) during the day as well as by night."*

After two years of development and tests, the first autonomously driving robots are now ready for series production.



The software puts the point cloud images from the eight cameras together into a three dimensional image of the environment. This serves the robot to navigate autonomously through the fields.

Autonomous turning manoeuvre: thanks to several 3D cameras potential obstacles are avoided and the Vitibot can drive through the rows with the vines perfectly centred below the vehicle.

For various types of work, tools can be mounted below the vehicle. Here: hooks for loosening the ground.

Various tools are attached to the vehicle which take care of different tasks on the field like loosening earth, cutting leaves and weeds and spraying the plants.

"Bakus is capable of precisely spraying the plants at the right spot with exactly the right dose. We can thereby cut the amount of pesticides by half. This does not only save money but also preserves the environment," says **Jocelyn Vermillet.**

Powerful performance

The electrically powered robot takes its energy from batteries with a capacity of 80 kWh. This enables 10 hours of autonomous work, before the battery needs to be charged again for two hours. Its all-wheel drive and the four big, individually driven and steered wheels provide for maximum agility even on rough terrain, while at the same time they enable turning manoeuvres where space is restricted. Even steep slopes with a 45 % gradient pose no problem to the Bakus.

Cédric Bache is the founder and Managing Director of Vitibot: *"This machine is special in the way that it's not just electrically powered, but also drives completely autonomously. It is placed by the winemaker at a corner of the vineyard and runs through the entire field on its own. Bakus follows the vine rows and as soon as it reaches the end, it lifts its tools and starts working on the next row."*

Autonomous navigation

What makes Bakus unique is its autonomous navigation and obstacle detection. The vehicle is equipped with eight precise 3D cameras from ifm: two cameras at the front, back and on the sides.

Cédric Bache explains, *"The 3D cameras use time of flight technology and can capture the surroundings in three dimensions. With the software developed by ourselves we can depict the surroundings around the vehicle via the transferred image data. The software offers two functions: on the one hand, it enables an autonomous navigation through the rows of the vines and on the other hand, we can detect obstacles and stop the vehicle in time. In order to navigate our machine safely, we need sensors that can "see" by day and by night. We have experimented with LIDAR-based systems, but they came with a lot of restrictions. Other solutions were too expensive to bring on the market. We have also tested solutions on the basis of standard cameras. However, this also proved to have difficulties: during the day with too much brightness, during the night with too little light.We wanted a solution that would work reliably by day and night. That is why we decided for the 3D cameras from ifm. Their image sensor transmits a clear 3D image of the surroundings no matter what the light conditions are."*

The "eyes" of the robot: PMD cameras from ifm generate a 3D image of their surroundings thanks to time of flight technology.

The 3D camera from ifm

The core element of this system is the 3D camera chip from the automation specialist ifm. It creates a 3D image using PMD technology (= photonic mixer device). The resolution of the PMD image sensor is 176 by 132 pixels.
For each of the 23,232 pixels the camera supplies a precise distance value – up to 25 times per second. Compared to laser scanners, the ifm 3D camera does not need moveable parts. Therefore, it is especially robust, small, light and cost effective.
With the PMD technology used, the image sensor can work without being influenced by ambient light.
Advantage: despite direct sunlight or complete darkness, the camera generates its 3D image.

3D image evaluated by software

Centrepiece of the Bakus is without doubt the evaluation algorithm, which generates a 360° 3D scenery out of the eight 3D camera images.

Damien Legrand, Product Manager 3D Vision at ifm:
"Every camera generates a three dimensional point cloud of the scenery in its vision. Complex algorithms create a virtual image of the scenery out of these point clouds, which depicts the direct surroundings around the vehicle, for instance vines or other objects. This image is then used for the autonomous navigation of the vehicle between the rows of vines and the turning manoeuvre at the end of each row."

Vitibot Managing Director **Cédric Bache** adds, *"It was a real challenge to put the 3D images together. In cooperation with ifm we found a solution that meets our needs."*

Conclusion

Autonomous vehicles in viticulture do not only relieve the winemakers of work, they also ensure highest product quality with minimal use of resources, e.g. when it comes to spraying the plants. Additionally, the winemaker can let the vehicle run independently at night without needing a supervising worker. As a result, the winemaker can make a large financial profit by using a robot like this, as he lowers the operating costs for most of the mechanical work on a vine by three quarters.
ifm is contributing by providing 3D cameras, which are essentially the "sensory organs" of the robot. By the way, the close cooperation with the customer is reflected in the ifm slogan "close to you".

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