FLYING FOR SCIENCE

Is it a plane?

Wageningen researchers are increasingly using their own drones to take measurements of crops, vegetation or soil from the air. The use of this fleet is subject to stringent conditions.

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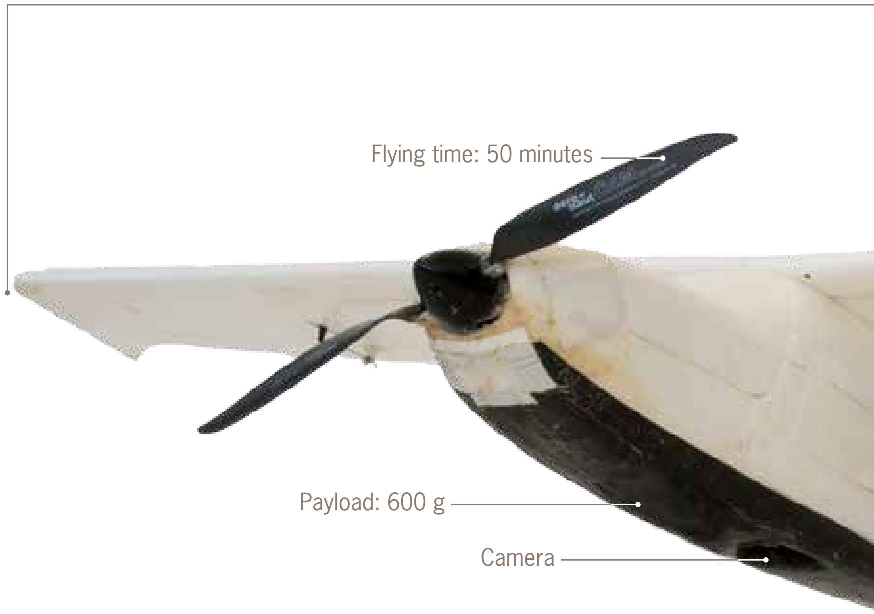
Pilot Niels Anders stands on the beach at Ter Heijde and watches the MAVinci Sirius zoom by at 70 kilometres an hour (with the wind behind it) at a height of 100 metres. The Soil Physics and Land Management postdoc has a device around his neck that enables him to take over control from the automatic pilot should the little plane run into problems. But no intervention is needed. The drone flies backwards and forwards just as planned, along the route pre-programmed with GPS, to map the beach and dunes.
In the space of half an hour, the camera in the plane's belly takes about 1200 over-

Altura PRO AT8 Octocopter

lapping colour photos. Afterwards, the computer will put them together to create an accurate picture of the height differences in the dune landscape. 'We will be able to see the tyre tracks here on the beach in the images,' says Anders. The photos form the basis for doctoral research on the influence of the Sand Motor, a large man-made area of sand along the coast off Ter Heijde, on the adjoining dunes and vegetation.

THE VIEW FROM ABOVE

Wageningen researchers are increasingly using drones to examine their areas of interest from above. But they prefer to refer to their toys using an abbreviation such as UAV (Unmanned Aerial Vehicle) rather than 'drone', because of its military connotations. Wageningen UR has three UAVs: two octocopters (a kind of flying saucer with eight rotors) and the MAVinci, a high-tech instrument disguised as a child's toy. It consists of separate foam parts screwed together to make a mini aeroplane with flashing lights under the wings and with the battery casing held together by an elastic band. 'You can get them in carbon too. Ours might not look great, but it works fine,' says Anders. 'The MAVinci enables us to map the soil much better than in the past,' explains Saskia Keesstra, assistant professor of Soil Physics and Land Management at Wageningen University. She is using MAVinci images of the soil surface for her study of water erosion in Spain. They show how rough or steep the land is, but more importantly they reveal the changes over time, for example after a big downpour. Where does the water fail to drain away, how much soil gets washed away, where do new gullies develop?
Until recently, Keesstra was dependent on satellite images or aerial photos to get the view from above. 'Not only can we >



MAVinci Sirius

see far more detail now, what is more important is that you can fly whenever you want.' Aerial photos are only taken once a year at best. Hiring a plane is far too expensive and a satellite passes over only once a fortnight. Then you're praying it's not cloudy.' Keesstra thinks the MAVinci is a fantastic alternative: 'We can take photos of an area covering more than 100 hectares per flight, whenever it suits us.'

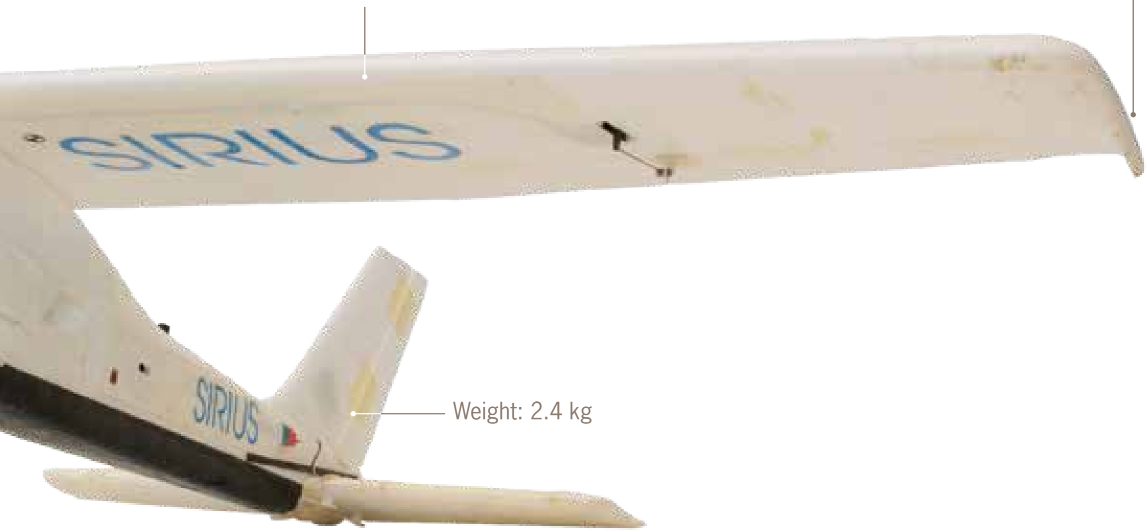
POWERHOUSES

Lammert Kooistra from the Laboratory of Geo-Information Science and Remote Sensing and Sander Mucher from Alterra Wageningen UR have different requirements. Their octocopters can only stay up in the air for about eight minutes, but these powerhouses are able to carry remote sensing's showpiece instrument into the air, a hyperspectral camera weighing two kilos. It carries out measurements at about 100 different wavelengths from ultraviolet to infrared. This gives scientists all kinds of information: the state of the grass on a heath for example, or the condition of a tropical forest, the amount of biomass in a field or an arable farm, the volume of nitrogen in plants, the number of layers of leaves or, on a more experimental note, virus infections or drought stress. 'The technology to create a fingerprint of a crop in this way and interpret it is already there,' says Kooistra. 'The challenge now is how to turn those images into information that tells farmers what setting to use for their fertilizer spreader or where to spray. Anyone can buy an octocopter and attach a camera to it. That will give you images, but not of a high, standardized quality. It's only useful if you can make comparisons over space and time. That is our niche: processing the images to give information that genuinely helps the user. That involves an awful lot of software and loads of new algorithms for image analysis.'

COMPETITION

Before the UAV can get a foothold, it first needs to contend with an established rival – satellite images. 'Satellite imaging still forms the basic infrastructure for getting a picture of the Earth, says Mucher. 'The images with a resolution of 20 by 20 metres are virtually free these days. We see the UAV as a complimentary method, with flexibility and high resolution as its big advantages.'

Corné Kempenaar, an Agrosystems researcher at Plant Research International (PRI) and lecturer in Precision Farming at Vilentum University of Applied Sciences in Dronten, thinks that the use of UAVs in arable farming depends crucially on a smart, cost-effective application for the images. 'Processing them is a skill in itself. You can't just say there is a spot with not enough biomass so you should apply more fertilizer. Perhaps the soil is slightly dryer there. It's a great tool for research but it is still too premature for farmers to use it.'
He does not rule out the possibility of farmers with large farms or contract work companies using UAVs to collect crop data or detect weeds and diseases, but there is competition from the multispectral cameras that farmers install on the tractor's spray arm, for instance. 'They only scan part of the field, but even that gives valuable information,' says Kempenaar. 'The drones have to find a niche between the cameras on the ground and the satellite high up in the air. Plus the information that they deliver must come at an attractive price.'
He suspects the potential savings on fertilizer or pesticides are modest, a few dozen euros per hectare per treatment.



Erik Pekkeriet, greenhouse horticulture project manager at PRI, is less cautious. 'There is a lot of potential for the use of UAVs in greenhouses,' he notes. While contact with satellites for navigation is not possible inside, that problem can be solved by installing beacons that let a UAV in the air get its bearings. 'You can manoeuvre incredibly accurately in a greenhouse.

And there is no wind that you need to adjust for in the images,' says Pekkeriet. Another advantage is that the rules are not so strict: you do not have to request a flight in advance, nor do you need a pilot's licence. Which means less hassle and is cheaper.

Pekkeriet sees the UAV as the ideal aid for market gardeners who want to get information quickly, for example about the state of their crop. He has worked with someone who had a big plant nursery and wanted to monitor the progress of the germination. 'Nurserymen agree plant sales in advance. They will then sow 15 to 20 percent extra to make sure they can deliver the agreed quantity. That could be reduced to perhaps five percent, a substantial saving, if you know in good time whether you need to sow extra seeds.'

But getting to the right section is a real challenge in modern greenhouses, and counting by hand would be impossible, says Pekkeriet. 'A UAV gives you the information you need in no time. You send it off with the instruction: check section 12. It flies over there, scans the section and transmits the data directly to the nurseryman's computer. That may seem like pie in the sky now but I wouldn't be surprised if it was really happening a few years from now.'

The MAVinci has completed its route on the beach at Ter Heijde. It continues to circle above us until Anders takes over the controls and guides the plane back to land gently on the sand. He downloads the data from the camera and the flight details from the black box, the final step in a series of mandatory actions and protocols.

PILOT'S LICENCE

The use of drones is subject to stringent rules. Both the MAVinci pilots got their licence at the end of June. They are now allowed to fly up to an altitude of 120 metres anywhere in the Netherlands as long as the owner of the land, the government and the provincial authority give prior permission. There must always be an observer with the pilot during a flight to keep an eye on the vehicle. This means a drone can fly up to 500 metres from the point at which it was launched. 'Apart from that, we basically need to keep to the same rules as for civil aviation,' explains Anders. 'I realize the authorities need to be careful, but it all means hours of work for a half-hour flight.' ■

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