Although service personnel are cheaper than astronauts, robots that do inspections in space inspired the PV-Servitor idea. Photo: dpa

High-tech module care

The Regensburg University of Applied Sciences in southern Germany is developing a service robot that cleans and maintains the surface of solar arrays.

Marco Reichel came up with the idea during a visit to US aerospace centre NASA. Reichel, the founder and Managing Director of Manu Systems AG of Regensburg, Germany, observed a NASA robot – nothing terribly exciting for him, since his company is a supplier of mobile robot systems which help people to clean house, for instance. But this time, the specialized task performed by the robot piqued his interest: it was designed to inspect a solar sail in space.

Reichel drew a parallel to terrestrial photovoltaics. "I thought, there's got to be a cleaning and inspection service robot for solar arrays on earth too," he explains. So he took up the search for cooperation partners in research and industry, acquired funding through the EU, and started the "PV-Servitor" project in September 2009. The ambitious name says it all. "We do not want to just research a cleaning robot," Reichel says. "By the end of the two-year research phase, we want an autonomous service robot that can automatically clean solar power plants and check for dirt and damage. Precise scientific measurements of yield increases due to cleaning are especially important to me." Funding for the research project is € 1.5 million.

Is cleaning really necessary?

For power generation technologies with moving parts the need for regular maintenance is obvious, but for photovoltaics, the necessity of this insight is only slowly taking hold. Installers, particularly in the private sector, usually portray photovoltaic systems as practically maintenance-free. The conventional wisdom is that a module tilt of at least 15 degrees ensures adequate self-cleaning from rain. But in the view of German project planning company Phoenix Solar, there are limits to self-cleaning. According to company spokesperson Isabell Strüwing, "Areas with local soiling due to industrial or agricultural activities, or arid desert-like locations with high aerosol levels, have to be checked individually to see if module cleaning makes sense." And there are a great many places that meet those criteria. What first comes to mind are very dry locations with high temperatures, which are also often near the coast where the

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air has high aerosol content. Such locations can be found in Southern Europe, the United States, and the Middle East – in short, areas in which solar power generation will be increasingly important over the next few years. But these are not at all the areas that Reichel has his eye on. "Our project concentrates on green-land and brown-land scenarios in Europe."

There is plenty of support from the scientific community. Heinrich Häberlin of the Bern University of Applied Sciences in Burgdorf, Switzerland, is convinced that regular cleaning and maintenance pays off. His academic paper on increased efficiency through module cleaning serves as the basis for the PV-Servitor project. Since 1994, Häberlin has been researching solar module performance with a test system in Burgdorf. The subject of his research is fitted with solar modules that were typical off-the-shelf models in the early 90s. Since their installation, the modules have been cleaned four times – in 1998, 2002, and 2006 – with a powerful cleaning agent. After cleaning, efficiency increases of 7 to 9 % were recorded. Regardless of whether the modules were four or already 17 years old, cleaning increased their performance.

Lack of maintenance may result in performance losses

Apart from soiling, other changes can occur over time, both on and inside of solar modules which can degrade performance. Heinrich Häberlin's research group has conducted long-term delamination tests within the framework of the PV-Servitor project. The test results show that delamination is not just an aesthetic problem, it can also have a serious impact on module performance. "The Servitor will therefore detect and correct problems such as delamination and dips in performance due to dirt, plant growth (e.g. moss) and snow, in order to optimize performance," says Reichel. The stated goal is to reduce power production costs in PV systems on the order of 5 %.

Big names amongst the project partners indicate that service and maintenance are becoming increasingly important. On the list are companies like Juwi, Solon, and Conergy. "Together with our industry partners, we have defined what such a service unit for solar systems will have to be capable of," Reichel says. "Our goal is not to come up with a scientific device like the Mars Rover which, while it may be able to do everything, is prohibitively expensive. Rather, we want a device that can do the necessary tasks for a manageable price," explains Gareth Monkman, who heads up the team of scientists charged with developing the robot. In order to accomplish this in a practical way, the developers decided for a modular robot design which can be adapted to local conditions.

Flexible design

An initial prototype series of the robot has been in existence since late 2009, and others are currently under development. The researchers are not ready to share pictures – the patent is still pending. They describe the initial prototype as a 1.6 metre long, approximately 1 metre wide robot that moves along the surface of the modules like a miniature tracked vehicle. The robot was consciously designed to be very flat, making it resistant to high winds. The Servitor uses rotating brushes just like other cleaning robots which are already available. The cleaning concept originates from the Danish Technological Institute (DTI). "In locations with excessive dirt, a water-cleaning system will be used; in deserts with little available water, dry cleaning may also be possible," says Monkman.

Inspection via machine vision

Reichel describes the inspection system, for which Austrian firm Profactor is responsible, as a worldwide first. "The Servitor will be equipped with an algorithm-based machine vision programme." Until now, the Servitor has relied on sensors to help it steer itself. It detects the end of a row of modules and reverses direction on its own. If necessary, it can also traverse a gap up to 20 cm wide to the next module pedestal. The machine vision programme determines whether the robot can deal with a detected obstacle on its own. If a dead bird is on the module, for instance, the robot simply pushes it off of the array. If it snows, the device sets itself up at an angle and cleans the snow off of the modules. If, however, the Servitor detects a shattered module, it has to request help from a human maintenance team. The robot detects the degree of soiling and adjusts the brush pressure. Above all, the system will also be able to inspect solar cells underneath the glass. "Until now, such systems have existed only for the solar module production process," says Reichel.

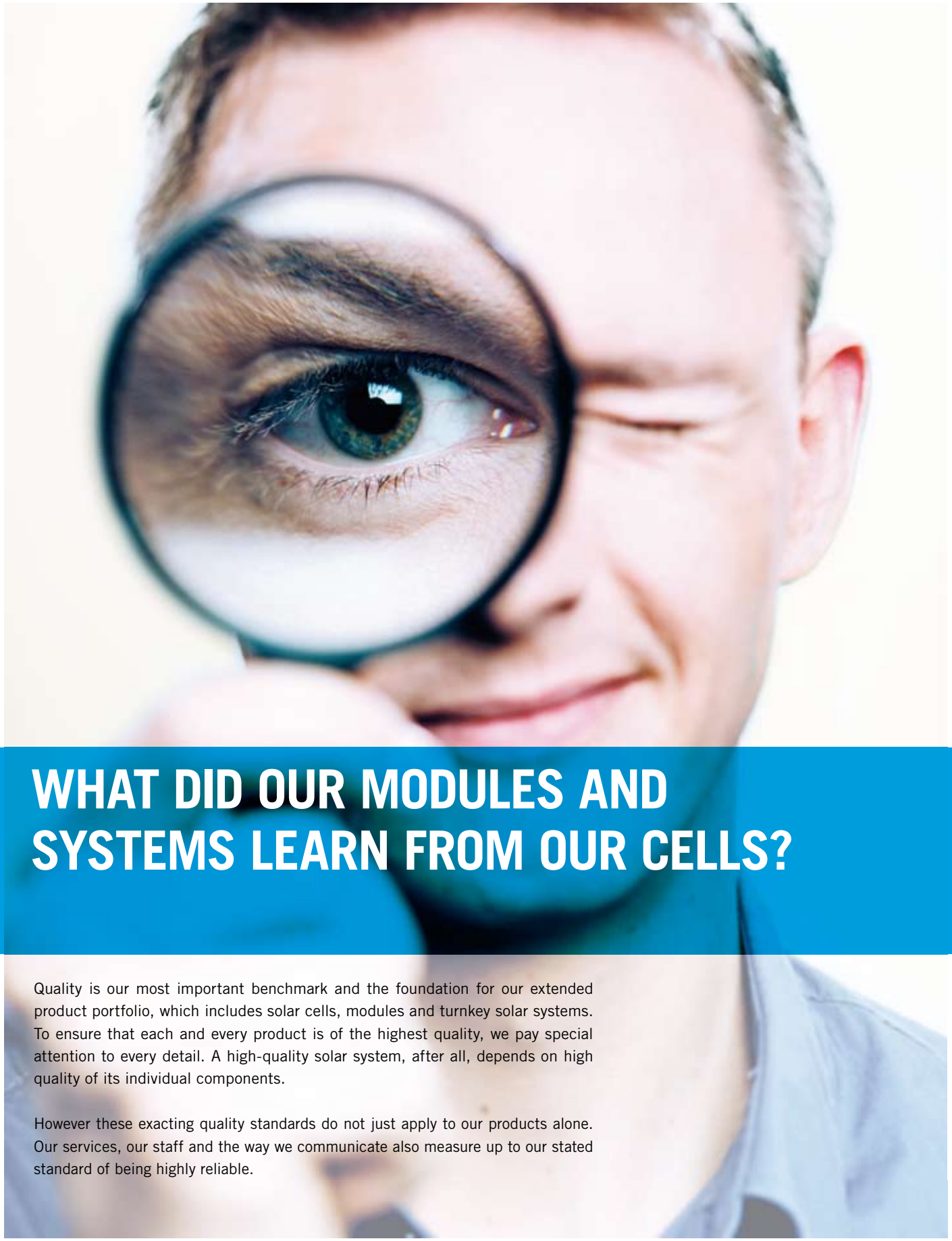
The payoff

"System operators will see a performance benefit of some five per cent over systems which are not cleaned. That means that, at a yield increase of eight per cent, the projected cost of the robot will comprise three per cent," says Reichel. The actual price of the robot is something that Monkman and Reichel prefer not to discuss at this stage. The device will be tested in March on the research solar array in Burgdorf. The test will be performed using a robot with a fully functional inspection system.

But the team members well understand that once the research phase is concluded the real work begins. In the development phase, the current research prototypes will have to yield an industry-ready prototype before the team can even think about series production. If their deployment pays off, it is conceivable that PV-Servitor robots could initially be making their rounds on European solar arrays.

Daniela Becker

Further information:
www.pv-servitor.eu/



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