Self-service autonomous drones as the next step in blade inspections

Where once rope access and ground-based cameras had to be enough to inspect the condition of wind turbines, technology has evolved to provide a safer and more accurate process. Machine learning and AI have opened up new possibilities in self-service drone inspections. Time then to gain some insight into the benefits of this shift, from Kostas Karachalios, CEO at Perceptual Robotics.

PES: Kostas, it's great to welcome you to PES Wind. Tell us a little about the company and your services, for background for those readers who may not be aware.

Kostas Karachalios: Perceptual Robotics was founded in Bristol in 2016 with the dual aim of supporting the renewables industry and working with robotics. With this focus, we created Dhalion, a pioneering system, which harnesses drones and artificial intelligence to inspect wind turbines.

The basic principle of Dhalion is the complete automation of the wind turbine inspection process. With the use of a tablet device, the operator, who requires minimal training, commands the drone to take-off and autonomously collect high-quality data of the whole turbine, including the tower, in less than 20 minutes.

After landing, a cloud-based artificial intelligence system automatically processes the images to detect any damage. Our clients from around the world are then able to view their inspection results within just a couple of hours rather than waiting the traditional time of around two weeks.

PES: So your main focus is on automated wind turbine inspections, is that right?

KK: The beauty of our Dhalion system is its adaptability. We specialise in self-service inspections of wind turbines, both onshore and offshore, through our patented flight

technology. Our drones can be used by existing field teams, with no prior drone experience. The inspections have the highest quality, without the need to hire an expert pilot, coordinate with a subcontractor or have us be on site, all of which are significant costs with third party inspections.

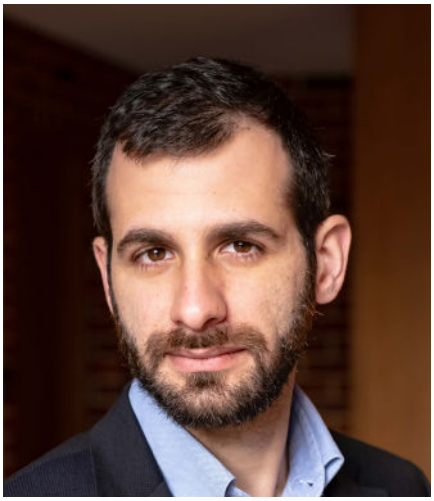
At the same time, our parallel focus is our AI machine learning, which is capable of detecting more damage than other technologies and ensures our clients receive all the relevant information they require.

PES: How has drone technology developed in the last few years and what benefits does this offer the wind industry?

KK: The benefits of drones and the associated technologies for the wind industry cannot be underestimated. When we think of how turbines were initially inspected, and still are in many places, with rope access and ground based cameras, it involved risks, a great deal of time and with only the human eye, results were less accurate.

As technology evolved, manual inspections utilising drones and then automated drones followed. Perceptual Robotics has brought a new evolution to the sector, with self-service autonomous drones that allow any team member at a wind farm, regardless of previous drone experience, to carry out inspections. This has followed the development of driverless car technology and machine learning.

This new adaptation reduces costs, improves the logistics of carrying out inspections and, most importantly, the improvement in machine learning finds damage that would otherwise be missed. Finding more damage has a substantial positive impact on downtime, production and repair costs of turbines. Our unique technology increases safety and productivity while providing unique information on how to keep the assets working to maximum capacity in the long term. Having that key information is invaluable.



Kostas Karachalios

PES: Reliability is a key factor. How do customers know that your systems can be relied on to give them the data they need?

KK: Perceptual Robotics prides itself on a system that is effortlessly quick yet consistently reliable. In 2022, we celebrated results from ground-breaking studies we undertook with the University of Bristol and DNV.

Over a three-year period, our Innovate UK Research and Development projects focused on onshore and offshore wind turbine inspections before being extended for another year to consider validation of results and extreme offshore environments. We focused on demonstrating the capabilities of the inspection system and analysing the way the performance is measured to ensure it is as accurate as possible and in line with customers' expectations.

Our findings clearly stated that robots and artificial intelligence are 14% more accurate in detecting faults in wind turbines compared with human experts carrying out the same inspections. This is key evidence that our technology brings a unique offering to the industry.

The real validation comes from our customers who use Dhalion on thousands of turbines across the globe. By structuring the data with our machine learning annotations and web portal we can not only provide the data they need but go one step further and provide them with future insights and damage evolution of their assets. This allows our clients to detect patterns and identify preventive measures in advance. We help them move from reactive maintenance to preventive maintenance and save them time and costs by optimising detections and the subsequent management.

PES: How do you overcome the challenges of offshore automation to ensure this reliability?

KK: In offshore automation, there are several challenges in terms of automation: one is the lack of a fixed point to take off and land. We solved this issue by mirroring the SpaceX capabilities for reusable rockets in order to land on moving crewed and uncrewed vessels. Over many years, we have proved this cutting-edge take off and landing system provides the same level of reliability offshore as it does in an onshore environment.

The final vision of the solution we created is an autonomous vessel capable of leaving a port, inspecting a full farm and then travelling back to the port. We have demonstrated this vessel's technical capabilities successfully and both participated in, and led, innovation projects with key organisations such as Innovation UK and ORE Catapult.

PES: Are these challenges changing as the wind sector moves further offshore and grows bigger?

KK: With the kind of solutions we have designed, we are already addressing all those challenges as we focused from the very beginning on designing solutions for the long term. The main challenge for bigger turbines is the current autonomy of drones with good optical payloads, but this is evolving at a phenomenal rate with solutions already forthcoming. The same issues happen the further offshore the turbines are; communications are crucial to deploy autonomous systems but most of the big wind farms already have 4G networks and where they don't, we can deploy alternative systems.

PES: Is it possible to operate in high wind and adverse weather conditions?

KK: Yes, our drones self-monitor themselves and are capable of making their own decisions, such as landing, if the conditions become too adverse or challenging. This is key in terms of automation as it not only ensures safety but prevents costly replacements. To date, no drone of Perceptual Robotics has ever crashed, with safety and distance criteria ruling our whole operation. However, when it comes to high wind it is always better to have the turbine operating, so it's better to inspect at lower wind speed to ensure the end customer doesn't lose valuable production hours.

By utilising robotics and AI, the onshore and offshore wind industries can take advantage of rapid and easily-deployable technology and ensure wind turbines are kept at their optimal level, whatever the weather. As a result of this, wind farm operators will see a decrease in downtime and an increase in output. We now have such high, and necessary, targets to reach net zero by 2050, that increasing the output of wind turbines by ensuring they are running as often and as effectively as possible is now as important as creating more wind farms.

PES: How can AI be used to reduce cost and minimise error?

KK: Through our Innovate UK Research and Development project, we were able to showcase that incorporating fully-automated surface defect detection into our Dhalion system enhances the speed of wind turbine inspections, significantly minimising costs, increasing quality and reducing missed damages.

The machine learning algorithms are designed to achieve the highest recall so no damage is missed. The amount of detail that we can detect is incredible; we can even count the legs of a fly on a blade.

As we have seen with our clients, missed damage evolves and becomes a significant cost that could have been prevented if detected earlier. This high-quality data collection and analysis from Perceptual Robotics quickly provides blade engineers with all of the information they need to carry out preventive maintenance, dramatically reducing turbine downtime, increasing safety and cutting costs.

PES: Your data processing pipeline processes thousands of images per hour, is that correct?

KK: Yes, our system is totally scalable and can process as many images as needed in a matter of minutes by incorporating additional cloud resources. This way, we can deal with fleets which have thousands of assets.

PES: What do you think is next for such technology for the wind industry in general and Perceptual Robotics in particular?

KK: We feel we are just getting started. We have recently signed incredibly exciting contracts to work in new regions across the globe, allowing wind farm operators to use our technology no matter where they are. The demand for renewable energy and its corresponding technological solutions is only getting bigger and we are ready to adapt and further improve our technology so it becomes cheaper, lighter and even more automated and reliable.

If you are attending WindEurope in April, please join us at Stand S5 in Hall C4 where we will be exhibiting. We would love to chat with you.

www.perceptual-robotics.com