Unmanning inspections for enhanced results

Unmanned Aerial Vehicle (UAV)-based inspection systems are revolutionising maintenance practices for turbine blades on wind farms. These drones, armed with high-resolution cameras, perform detailed inspections of wind turbines, capturing essential data to evaluate their condition. By operating beyond visual line of sight, UAVs can efficiently inspect numerous turbines, minimising human exposure to dangerous environments. PES was enthusiastic to explore this innovative technology and its potential with Graham Walker, Architect at Marshall Futureworx.

PES: Thank you for joining us today, Graham. We're particularly interested in discussing Lilypad during this interview. Could you start by giving our readers a brief introduction to it?

Graham Walker: Sure. Lilypad is an ecosystem of resident UAVs providing safe and scalable remote inspection services for wind farm assets, particularly turbine blades.

Each Lilypad inspection UAV is remotely piloted and monitored beyond visual line of sight (BVLOS). Once tasked, the UAV is launched and flown to the required turbine, where it completes a fully automated inspection.

It then returns to an enclosure to upload inspection data and swap battery, ready for the next task.

From an operator perspective, Lilypad provides inspections in a way that is far more flexible, available and responsive. Crucially, it enables earlier identification of faults, giving operators the opportunity to intervene before they become more severe.

PES: How did you design Lilypad to capture the current trends and needs in offshore wind?

GW: As wind power continues to underpin net zero strategies all over the world, the rapid growth in installed capacity is creating burgeoning demand for new and scalable technologies to support operations and maintenance activities.

We are seeing the number and size of wind farms rapidly growing, but traditional methods of inspections don't scale well and the costs are becoming increasingly burdensome for operators. Additionally, the location of these assets and the harsh and unpredictable conditions they face make ad-hoc inspections challenging in terms of scheduling, resources and of course the working conditions for offshore personnel.

That's why scalability is a fundamental characteristic of Lilypad. On an operational level, the ecosystem's equipment is positioned around the wind farm to optimise its coverage. That means the number of UAVS and enclosures that are required for asset inspections will depend on the size and layout of the wind farm.

PES: I imagine using resident offshore UAVs gives you a range of options regarding how they are operated. Does Lilypad generally follow an inspection model, or are its inspections ad-hoc?

GW: Lilypad can actually do both, and that's a key benefit for an operator.

We foresee tasking the Lilypad ecosystem with a programme of routine, scheduled inspections to provide operators with the high quality data they need, when they need it.

At the same time, the resident nature of Lilypad means that inspections can be reactive to events like lightning strikes or hailstorms, which can damage turbines or affect their performance. Lilypad inspections can also be carried out pre-emptively throughout the season to give operators the opportunity to catch defects early before they become too severe.

Additionally, inspection missions aren't dependent on sea state: as long as there is good daylight, wind conditions are suitable, and the turbines are not generating, Lilypad can be tasked to perform an inspection.

All of this means that operators don't face either/or dilemmas: they can meet their business-as-usual inspection needs at the same time as predictively inspecting infrastructure or responding to potential emerging issues.

PES: You mentioned predictive maintenance. How would an operator using Lilypad benefit from this?

GW: Predictive maintenance is one of the best ways to maximise the total lifecycle value of an asset. Keeping a turbine blade in peak condition will optimise revenue generation, extend its productive lifespan, reduce potential downtime, and reduce repair and replacement costs by catching issues early.

Since Lilypad enables more flexible and frequent inspections, operators can easily flag and track minor and emerging issues over time, using the system's high quality data to inform decision-making around the best way to schedule work. This means they can address a problem before it starts to affect asset performance, or before it may require more serious work to rectify.

PES: How exactly do the offshore Lilypad UAVs communicate with onshore ground stations, and how do you ensure quality of data gathering?

GW: Each Lilypad inspection UAV carries a high resolution camera payload which collects image data during an inspection. Once docked in the enclosure, this data is transferred to our fixed enclosure which performs initial processing on the images. We use a blend of deep learning and state of the art image compression techniques to remove non-valuable data, ensuring only image data that is relevant to the customer's asset is transmitted out of the wind farm. This use of edge computing for image processing significantly reduces upload times.

PES: What other benefits to operators have we not touched on yet?

GW: As any operator will know, safety is paramount amongst those working on offshore wind farms, and with Lilypad being a robotically operated system that is controlled beyond visual line of sight from an onshore ground control station, we are able to complete visual inspection missions without having to send people onto the wind farm, keeping people out of harm's way.

There are indirect safety benefits too. By gathering better quality inspection data remotely to inform decision-making, people can be deployed to the wind farm more precisely to only when and where it is necessary reducing the number and duration of deployments offshore.

Additionally, if Lilypad can help spot an issue earlier, the nature of any required remedial work will often be safer than if the issue were spotted much later when it becomes more severe.

PES: How do you plan to ensure Lilypad can keep up with future technological developments in offshore wind?

GW: Lilypad has been developed in quite a modular way which means we can continue to introduce the latest technologies to keep pace with the demand in offshore wind.

Sensors, communications and UAV energy storage are all examples where Lilypad's capability can be improved by integrating technologies as they become available in the future. Visible spectrum and thermographic cameras are constantly improving and Lilypad's modular payload architecture will allow us to introduce new inspection payloads onto the UAV, enhancing the quality of the data we gather.

The communications architecture means that we can rapidly integrate advances in communications technologies. I'm excited to explore the opportunities that UAV operations over 5G networks can offer. With greater bandwidth and reduced latency, we could provide operators with better data, faster than currently possible.

Battery technology constantly improves, and that will enable us to fly longer missions,

Graham Walker

increasing the time that our UAVs can spend on station. That will enable us to carry out more detailed inspections and inspections of larger structures – which is especially important for complex structures like substations.

PES: What future applications do you have in mind for Lilypad, either in or beyond offshore wind?

GW: Offshore wind isn't the only potential application for Lilypad, but it is an absolutely ideal first application: it allows the system to play to its strengths, and the scale of the opportunity is enormous.

Beyond turbine blade inspections, there are several easy-to-achieve adjacent applications in offshore wind. The modular nature of the system means that payloads, taskings and inspection paths can be easily adapted or expanded to adjacent applications, including inspections of transition pieces, towers, nacelles, and offshore substations.

Lilypad can also operate both offshore and onshore, and we plan to explore adjacencies in other sectors, both within energy and potentially beyond.

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