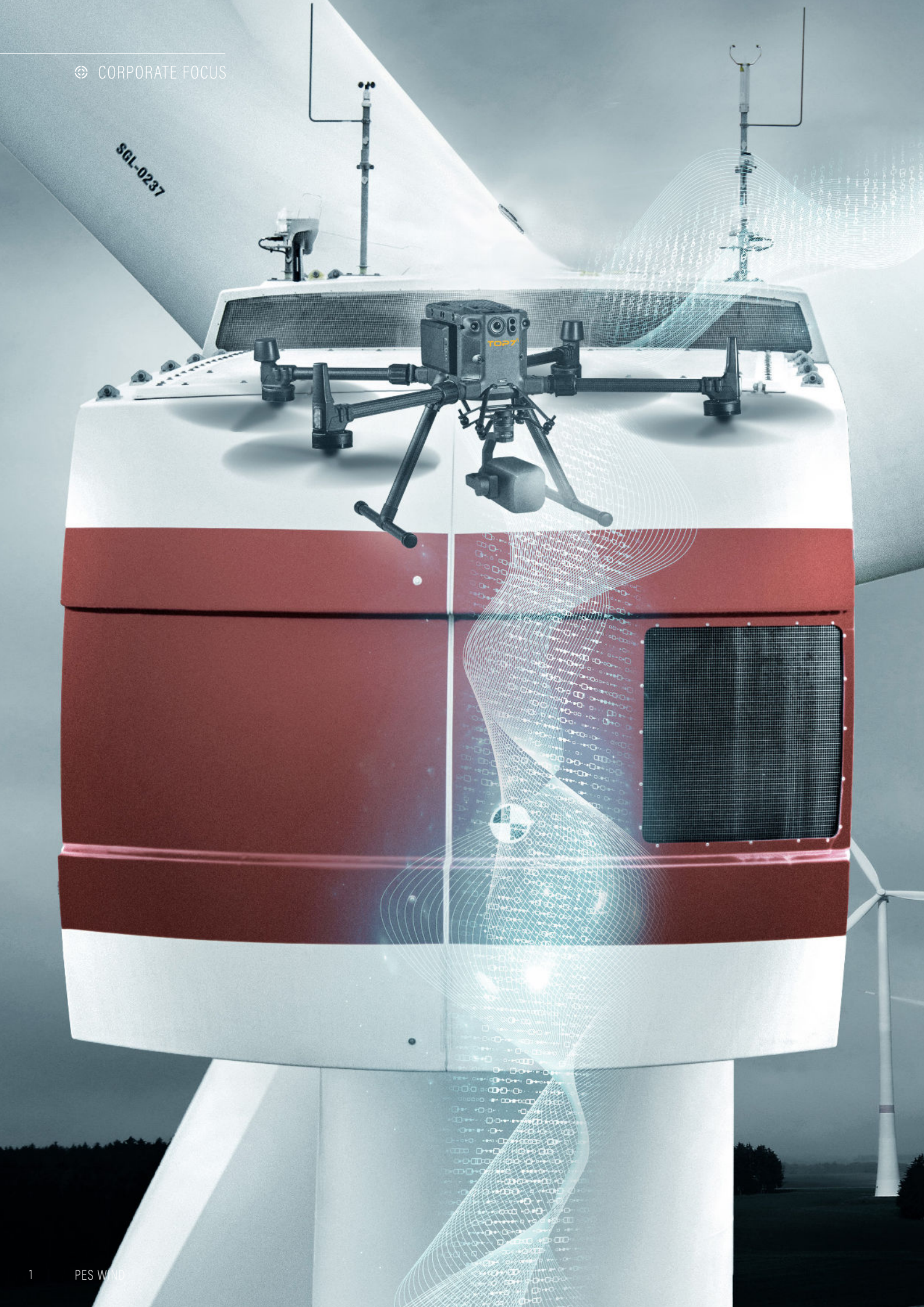
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How LPS measurement became contactless

Innovation in wind energy often stems from obstacles, challenges, or the pursuit of more efficient solutions to streamline routine tasks. When TOPseven unveiled its pioneering development for autonomous visual drone inspection of wind turbines to an Original Equipment Manufacturer (OEM), industry professionals posed an intriguing question that would become the catalyst for a groundbreaking advancement. 'Is it possible to measure the lightning protection system using a drone, more comfortably and precisely?'

This challenge was not only accepted but embraced, giving birth to an ingenious concept: Contactless Lightning Protection System (LPS) measurement. The method involves inducing a signal into the LPS cable of the rotor blade, creating an electrical field akin to an antenna, and measuring this signal using an advanced E-Field-Sensor attached to a drone.

When combined with autonomous flight capabilities, this approach guarantees a highly automated, cost effective, and precise inspection of the LPS, capable of pinpointing interruptions and anomalies with remarkable accuracy.

The mechanics of autonomous inspection

TOPseven's intelligent flight planning begins with meticulous preflight preparation. Leveraging an extensive database encompassing over 700 3D turbine models and employing advanced web3D and georeferencing software, the system calculates optimal flight routes for each inspection. This ensures comprehensive coverage and precise data collection while minimizing flight time and downtime of the turbine.

An additional advantage of autonomous navigation is the reduced need for specialized pilots. In most countries, inspection companies can train their teams with a concise three to six hour course for drone licenses A1 and A3. Drone operators need only to activate a simple command to initiate the autonomous inspection flight, allowing them to work independently and efficiently.

TOPseven's drone based rotor blade inspection, including its innovative lightning protection measurement system, represents the cutting edge of innovation in the wind energy industry.

Cutting edge hardware integration

TOPseven's approach is rooted in the integration of state-of-the-art hardware. The DJI Matrice 300 RTK and DJI Matrice 350 RTK, renowned for their reliability and precision, form the base for the system. These drones are equipped with TOPseven's advanced intelligent software, adhering to their motto of 'making drones smarter'.

The drone setup is further enhanced by a proprietary 61 MP camera, enabling the capture of high resolution, detailed images of all four sides of the rotor blades. This powerful combination facilitates precise visual data collection from wind turbines in real time, ensuring that even the most minute irregularities and damages can be accurately identified and documented.

The power of AI assisted analysis

The visual inspection process benefits from patented AI assisted camera adjustment and exposure control. This innovative approach enables consistent image quality and accurate damage detection across various lighting conditions and environments. By continually training the AI system with manual damage detection, marking, and data categorization, the analysis becomes increasingly reliable and sophisticated over time.

The company's commitment to innovation is evident in its portfolio of more than 50 worldwide patents covering various inventions that enhance the usability and precision of drone inspections. Among these, the most renowned is undoubtedly the patent for contactless LPS measurement, a game changing technology in the field of wind turbine inspection.

The benefits of contactless LPS measurement

While conventional methods like resistance measurement conducted by rope access have their merits, they also face several challenges. As wind turbines grow taller and skilled human resources become scarcer, coupled with the increasing cost of downtime, operators are actively seeking more efficient ways to inspect the LPS. Drone technology, as a tool to support automation and digitization, now offers a reliable solution to these challenges.

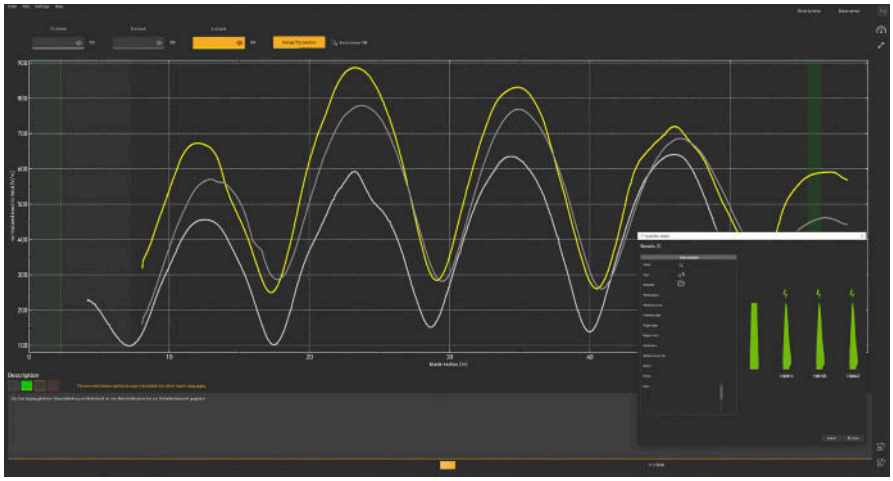
The most significant improvement offered by this drone based LPS measurement is the precise localization of interruptions and anomalies. Their trained customers utilize signal generators that induce a frequency signal into the LPS cable of the rotor blade, which in turn creates an electric field.

The drone, equipped with a specialized E-Field-Sensor, measures this field from the tip to the root of the rotor blade. Any deviations from normal values indicate potential issues in the LPS, which can then be investigated more thoroughly.

This globally unique method enables contactless and thus less risky lightning protection measurements of wind turbines, even under challenging weather conditions. The DJI M300 drone, for instance, can operate stably in wind speeds up to 12 m/s, conditions under which no rope climber would be permitted to ascend the turbine for manual measurement.

The heart of data processing and analysis

At the core of TOPseven's inspection solutions lies their sophisticated software suite. The company has developed comprehensive software modules that enable its customers to manage inspection tasks, perform damage annotation and



categorization, and generate detailed expert reports right after the inspection.

The software modules for flight calculation and data collection in the field exchange information continuously, ensuring a high degree of automation and usability that simplifies the inspection process for operators. As a result, high resolution data, whether in the form of images or LPS measurements, is securely stored in a cloud with servers currently based in Germany, ensuring data privacy and compliance with regional regulations.

Scalability and future applications

The TOPseven ECO system is highly scalable and forms the foundation for future drone based asset inspection solutions. While currently focused on onshore wind turbine inspection, the technology has the potential to revolutionize inspections across various sectors, including photovoltaic parks, offshore wind farms, bridges, and harbor infrastructure.

As the demand for renewable energy continues to grow and infrastructure ages, the need for efficient, accurate, and safe inspection methods will only increase. This drone based inspection technology is well positioned to meet these evolving needs, offering a versatile solution that can be adapted to a wide range of applications beyond the wind energy sector.

Shaping the future of wind turbine inspection

TOPseven's drone based rotor blade inspection, including its innovative lightning protection measurement system, represents the cutting edge of innovation in the wind energy industry. By leveraging advanced drones, precise sensors, and intelligent software, they are establishing new benchmarks in inspection accuracy and efficiency. Their overarching goal is to enhance the safety and cost effectiveness of wind turbine operations while contributing to the longevity and reliability of these vital renewable energy assets.

As we look to the future, it's evident that the role of automated, AI driven inspections will only grow in importance within the wind energy sector and beyond. TOPseven, with its unwavering commitment to innovation and its guiding principle of 'making drones smarter' is not merely participating in this future; it's actively shaping it.

By continuously pushing the boundaries of drone technology capabilities, it is ensuring that the inspections of tomorrow will be faster, safer, more accurate, and more insightful than ever before.

In an era where data is king and operational efficiency is paramount, these technologies are more than just tools, they're the key to unlocking new levels of performance, safety, and sustainability across industries. As it continues to innovate and expand its capabilities, it is poised to remain at the forefront of the drone inspection revolution, driving progress and setting new standards for years to come.

The success of TOPseven's contactless LPS measurement system serves as a testament to the power of embracing challenges and thinking outside the box. By transforming a complex problem into an opportunity for innovation, the company has not only improved the inspection process for wind turbines but has also paved the way for future advancements in the field of drone based inspections.

As the renewable energy sector continues to grow and evolve, solutions like these will play a crucial role in ensuring the efficiency, safety, and longevity of wind energy infrastructure worldwide.

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Charging Case with TOPseven Signal Generators and TOPseven Fieldsensor for LPS measurement

About TOPseven

TOPseven is headquartered in Munich, Germany, with a subsidiary in Emden, located in the north of Germany.

A team of international experts is continuously working on advancing drone technology solutions, bringing diverse perspectives and expertise to the development of cutting edge inspection technologies.

This global outlook, combined with local industry knowledge, enables TOPseven to stay at the forefront of innovation in the rapidly evolving field of drone based inspections for the renewable energy sector.