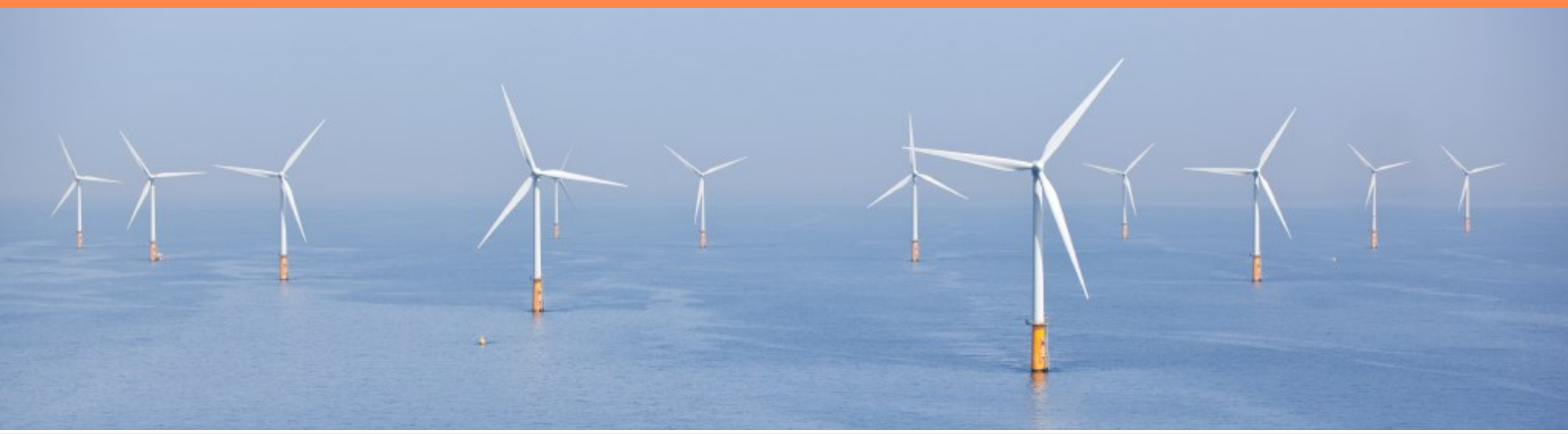


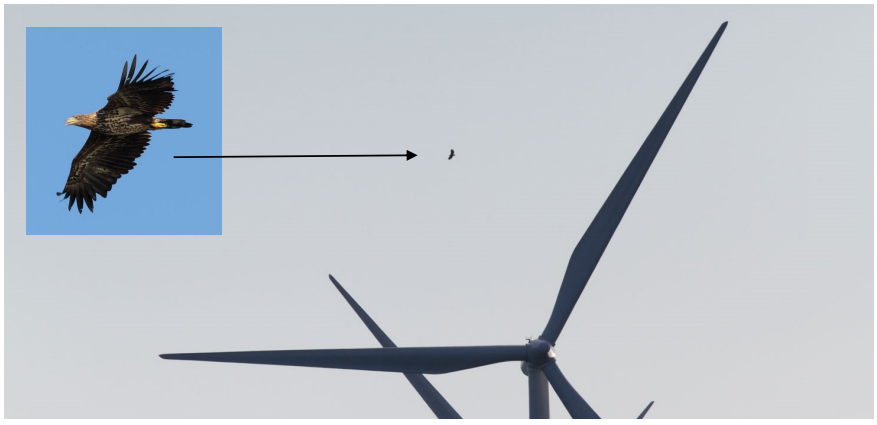
AUTOMATED MONITORING OF BIRD MOVEMENTS IN WIND FARMS

MUSE (MUlti-SEnsor) integrated radar and digital camera monitoring of bird behaviour and collision in entire wind farms

Compliance with regulatory requirements increasingly demands clear evidence on how birds behave within and around wind farms. To meet this demand, DHI has developed an automated multi-sensor monitoring system MUSE based on integrated radar and digital camera designed to provide robust data on real life bird behaviour at and within a wind farm.

BIRD COLLISION IMPACT

Wherever wind turbines are erected birds will inevitably collide. At land-based wind farms this can be measured directly post-construction by corpse collection. Offshore, the collision numbers can be estimated through modelling on the basis of data on known avoidance behaviour for the relevant species at the macro and micro scale, and size of the proportion of a given population that actually pass the proposed wind farm.



Raptors constitute the group of birds for which collisions with wind farms may possess the highest risk — here a white-tailed eagle passes above the rotors of the Rödsand 2 wind farm, southern Denmark. © Thomas W. Johansen

However, the mortality rate at different wind farms is far from uniform. At the species level, a given number of collisions at a wind farm may have very different direct effects on the population due to the species-specific differences in sensitivities to the added mortality. Large long-lived species like raptors, storks and cranes show higher sensitivity than smaller and more reproductive bird species like passerines, and often occur on lists of protected species.

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CLIENT

- Wind turbine operators
- Environmental consultants

CHALLENGE

- High transportation costs involved in human-based monitoring
- Requirement for data collection 24-7
- Requirement for data on species-specific responses to wind farm
- Requirement to monitor movements and flight heights of birds in entire wind farm
- Limited access of observers to offshore turbines and platforms (small weather window)
- Requirement for integration with SCADA control system

SOLUTION

Integrated radar and digital camera monitoring 24-7 of bird movements and behaviour .

VALUE

- Accurate and efficient assessment of baseline flight heights and movement patterns
- Accurate and efficient assessment of avoidance behaviour and collisions of birds

HELPING YOU MITIGATE THE IMPACTS OF WIND FARMS ON BIRD MIGRATION

Since 2007, we have developed and applied a range of radar applications to Environmental Impact Assessments (EIAs) and monitoring related to wind turbine and other infrastructure projects. One of the major challenges in measuring movements and behavioural reactions of birds within and around wind farms is to collect accurate information 24-7 at the species level in an efficient way. DHI have developed techniques to circumvent these challenges. We can now integrate automated tracking with identification of flying birds based on a combination of radar and digital camera recordings.

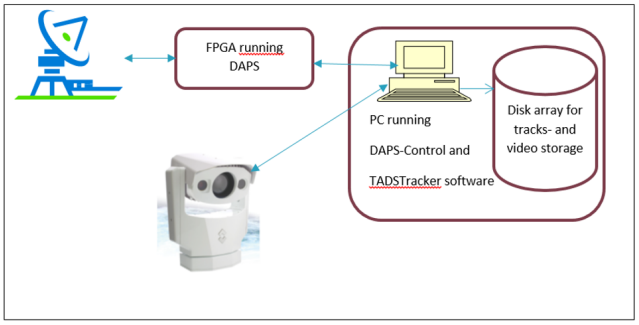
MUSE radar-camera unit on turbine platform (Thanet Offshore Wind Farm, ORJIP project). © Bo Præstegaard Jensen

The system makes it possible to monitor several turbines from one unit and generate documentation for flight paths both as visual and infrared video and GIS tracks. The system is based on digital communication between a fan-beam radar and a digital camera in which the camera gets original direction and distance coordinates from the radar, and subsequently estimates the flight height by triangulation and records the event by video tracking.

The integrated radar and camera unit is remotely controlled, and is subdivided into a FPGA based Data Acquisition and Pre-processing System (DAPS) and a software package DAPSControl, for controlling the DAPS. The DAPS samples at 100 Mhz and performs real time median filtering of data from the radar. The data connections between the systems are TCPIP. This design facilitates modular utilization of one or more computers. The computer system is capable of processing more than 500 blips per radar antenna rotation.

The classification of bird objects by the radar is facilitated by the high temporal resolution of the signal acquisition which makes it possible to filter radar echoes against the known signature of a bird signal on the fly.

Once the camera receives the position of the flying bird from the radar it will estimate the flight height and record the bird movement by pattern recognition and zoom on the bird while recording the event on video. All video footage has unique track ids matching the track ids of the radar. Thus, all behavioural responses by the bird can be documented as georeferenced tracks. The system is capable of running with both solid state and magnetron-based radars, as well as with a range of digital pan-tilt cameras with both visual and infrared channels, which will enable 24-7 operation and coverage of even large wind farms.



Overview of MUSE radar-camera tracking unit

The number of turbines (rotors) which can be monitored will depend on the target species and distance between turbines. As a rule of thumb, the radar can detect a standard seabird at 4 km range, and a digital camera with high-resolution motion control can follow a seabird at approximately 1 km distance.

Year	*Client*	*Terms of reference*
2013-2016	Carbon Trust, United Kingdom. ORJIP Bird avoidance behaviour and collision impact monitoring at offshore wind farms	Measurements of the level of bird behaviour at one or more offshore wind farms and provision of robust evidence on the rates of avoidance and collision for a number of key seabird species identified as being at risk from collision with offshore wind turbine
2016-2017	Market Development Fund, Denmark	Development of multi-sensor system capable of measuring micro, meso and macro avoidance behaviour and collision events at the species category level.
2017-2021	Deepwater Wind, Block Island Bird and Bat Monitoring, US	Measurements of bird and bat flight behaviour and collision at the Block Island Offshore Wind Farm

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