Tarucca

Accelerating Sustainability

“It’s not only about the sensors in blades; it’s what you do with what they tell you”

AI software and system company that develops structural health monitoring solutions for blades

Hans van Beek – CEO Tarucca

AIRTuB Sensors for Damage Inspection of Wind Turbine Blades

12 April 2022

The future we imagine

Imagine a world where the blades tell you what their structural health and condition is, and when they need further inspection and maintenance, without requiring wind turbine stoppage, reducing the need for human intervention, enabling optimized electricity production, costs, and blade lifespan planning.

There's a long history of sensors in blades for monitoring

Electronic and Optical Accelerometers + Strain Gauges

Ice detection and load monitoring systems

Suppliers offer upgrades to condition monitoring

Fiber Optic Sensing Cables

Shape monitoring and vibration measurement

Primarily focused on OEMs
How easy to retrofit?

Brüel & Kjær an HBK company

4X streaming like wind

OPTICS11

FIBERSAIL Shaping the structures of tomorrow

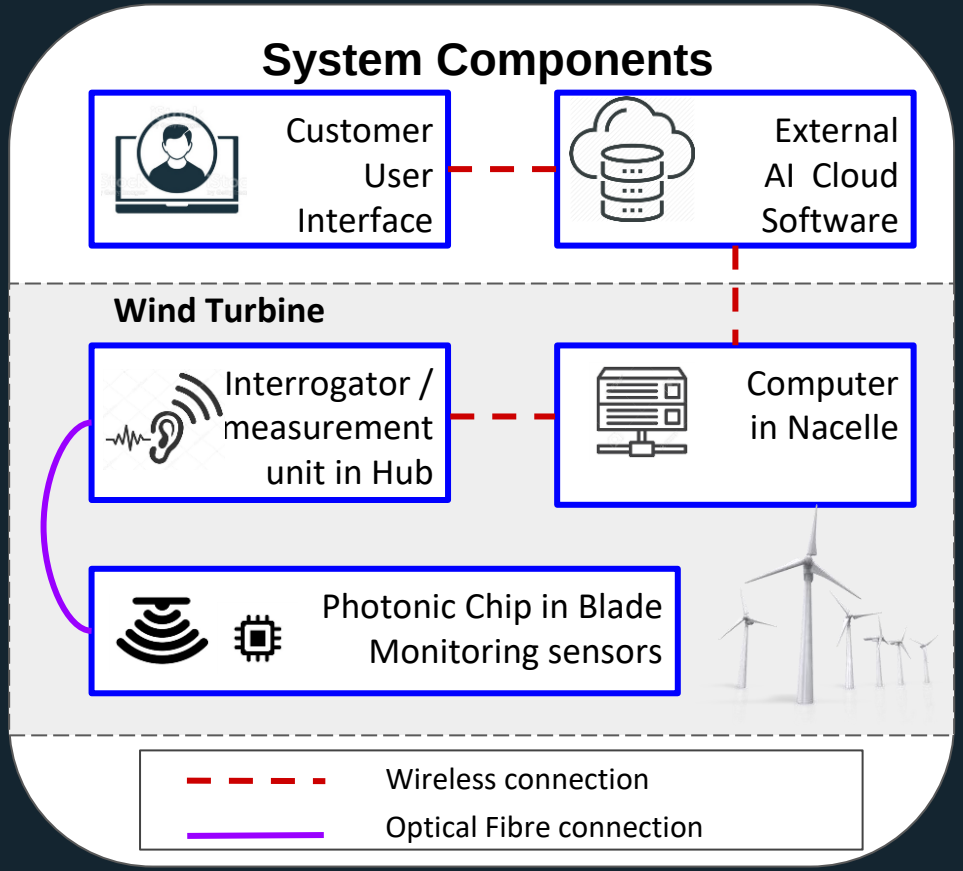
Weidmüller

Also acoustic approaches are now researched and offered

But is there a problem with monitoring reliability?

- Few CMS upgrades
- Few OEM offerings

Standard Condition Monitoring System Architecture



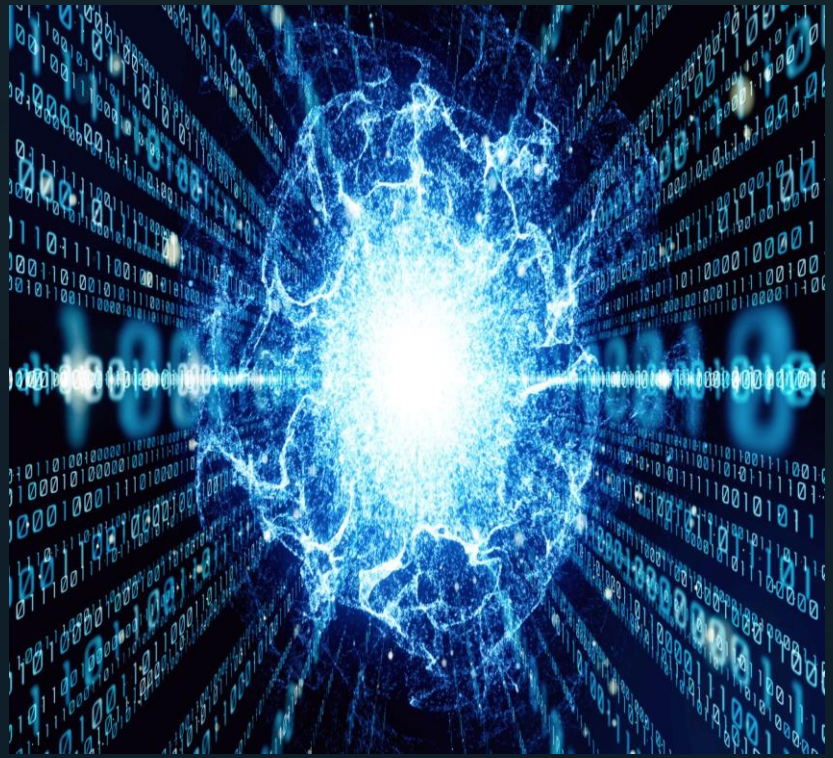
Current Systems

- Evolved from ice detection systems
- Just two one-axis accelerometers per blade (cost optimized?)
- Some with electrical sensors; some with optical sensors.
- Some with additional strain gauges
- Detecting if 1 of the 3 blades shows anomalies compared to other 2.

New photonic chip based sensors perfect for blades

- Non-electric
- Lightning-strike safe
- Magnetic field insensitive
- 10x – 100x more accurate than old optical technology
- Becoming available off-the-shelf
- Price levels sensors and interrogators rapidly coming down
- Allowing more than 2 accelerometers per blade

The evolution in AI driven blade damage detection



1. 2014: Actuator and 20 accelerometers to detect trailing edge damage of 20 cm length.
2. 2016: Actuator and 12 accelerometers to detect a 15 cm crack.
3. 2019: Enhancement of damage diagnosis with adaptive feature selection algorithms.
4. 2021: The influence of environmental variabilities on the damage indicators is used to interpret the difference between false and true positives.
5. 2021: Damage detectability is improved further by adding a new novelty index for damage detection.

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But three challenges that needed to be solved

No artificial vibration actuation

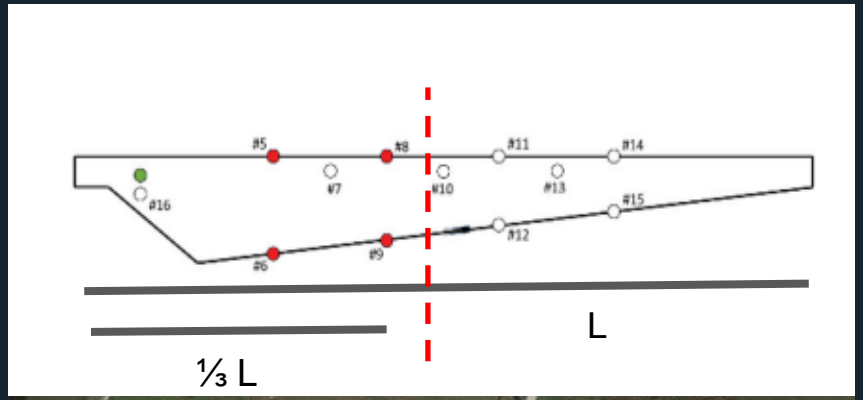
Only data from sensors that could be retrofitted

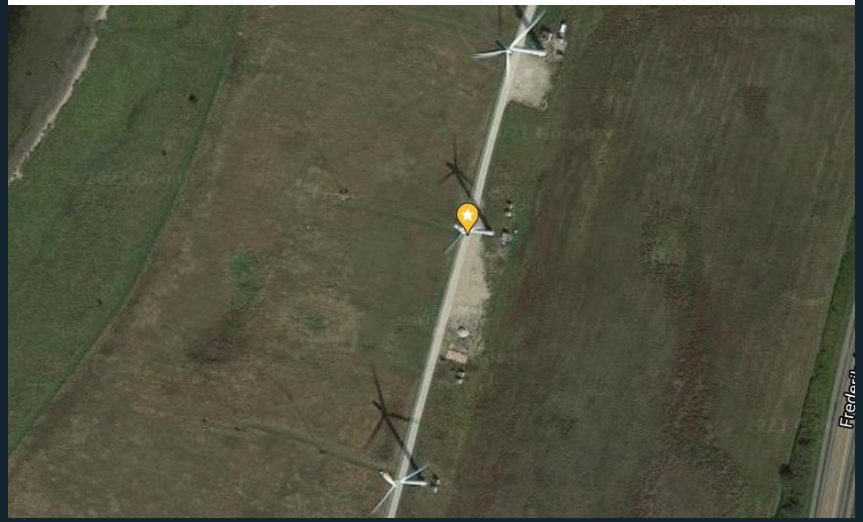
Reliably detecting damage sizes

Confirmed Proof of Concept

Tarucca SW project finalized in February 2022 confirmed:

- The feasibility of detecting different trailing edge crack sizes (15, 30, 45 cm) using 2 vibration sensors
- The feasibility of detecting these damages with sensors at locations in the blade where they can be easily retrofitted
- The feasibility of detecting these damages while the turbine is rotating, and the blade is actuated through the wind only.
- The feasibility of detecting these damages using data captured from an operating wind turbine.





Next Research installations

- Retrofit photonic sensor system in operating wind turbine
  - Installation takes 1 day
  - Usual blade maintenance /inspection crew can be used
  - 4 or 5 round small “27x7mm; 5 gram” sensors per blade plus 1 in hub
  - Sensors connected via fiberoptic cable to interrogator unit in hub
  - Wireless data connection from interrogator to outside world
- Ideal first wind turbine for installation
  - Blade repair is expected in near future
  - Preferably different blades have different type of damage
  - Preferably turbine with longer, older blades
- First deployment steps
  - Install system
  - Start measurements for 1 – 2 months
  - Scheduled blade repair takes place
  - Continue measurements for 2 -3 months
- Prepare in Q2 and install in Q3.

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* Let’s work together making the world more sustainable.