watereye
RESEARCH
& INNOVATION ACTIONS

WATEREYE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 851207

O&M Tools Integrating Accurate Structural Health in Offshore Energy

Welcome


Dr. Ainhoa Cortés
WATEREYE Project Coordinator

Dear reader,

This seventh newsletter is mainly focused on the results obtained in the final validation, conducted at the PLOCAN's Offshore Platform. There, CEIT, Flanders Make and Delft Dynamics tested and validated their developments in a relevant environment. In the following pages you will see a detailed description of the elements that composed the validation and the main results obtained.

There has been time also for producing a review article on corrosion monitoring and prognostics in offshore wind turbine structures, developed by FMAKE, SINTEF Industry and CEIT. If interested, you will find a link to this review article in this newsletter.

In terms of communication activities, video recordings of the final validation were taken to produce a promotional video that will be available soon through our communication channels. Moreover, the validation results of the monitoring system were presented in the Windfarm Operational Analysis Workshop organised in Madrid (Spain), with the attendance of key industry players of the wind sector.

Finally, I encourage you to visit our partners' corner section, this time with TU Delft.

Thank you for your interest in the WATEREYE project, enjoy the reading!

Ainhoa Cortés.

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About WATEREYE

The WATEREYE integral solution will allow Wind Farm Operators to accurately predict the need for future operations & maintenance (O&M) to reduce its costs, which can represent up to 30% of the Levelised Cost of Energy (LCOE) (an estimated LCOE of 70€/MWh in 2030), and to increase the annual energy production from the offshore wind thanks to an accurate structural health monitoring and control of the Offshore Wind Farms.

For this purpose:

1. WATEREYE aims to develop high-accuracy, fast-response, and non-invasive ultrasound smart sensors to detect and estimate corrosion levels by analysing wall thickness, which will be integrated into a high-precision indoor "drone-based mobile platform" inspection system capable of monitoring the entire critical area.
2. Design a robust wireless communication system and a custom protocol that will prevent data losses or corruption even in a harsh environment.
3. Collect, store, and provide efficient access layers for the wind turbine data to ensure optimal understanding of structural health.
4. Develop accurate mathematical corrosion models for offshore wind turbine structures to characterize the corrosion phenomena in the wind turbine tower.
5. Develop condition-based maintenance tools for fault diagnosis; corrosion prognosis algorithms; decision support to define predictive O&M; and fault-tolerant control of offshore wind structures.
6. Develop control algorithms for adaptive O&M strategies of individual wind turbine and the overall plant. The WATEREYE monitoring system will determine the condition of the structures. This information, together with O&M tasks, will minimise the need for human inspection, vessel transfer, and optimising onshore logistics.

Visit us at www.watereye-project.eu to extend this information

Download here our leaflet to get more details about WATEREYE concept and methodology

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Meet the WATEREYE Team

*Click on logos to access the partner's webpage

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Follow us and share it

We would like to encourage you to follow us on our website, Twitter , LinkedIn and YouTube official channel as well as to tag @watereyeproject in your tweets to circulate news, publications or events on our Twitter feed. In the same way, we encourage you to use @WATEREYE PROJECT in your LinkedIn public actions regarded to WATEREYE.

WATEREYE News

Final validation at PLOCAN's offshore platform

After several months of preparation, the validation of the WATEREYE monitoring system in a relevant environment was finally conducted at the PLOCAN's offshore platform, representing a major milestone within the project.

This validation is the result of multiple integration sessions held in Delft (The Netherlands), Trondheim (Norway), San Sebastián (Spain) and Sint-Truiden (Belgium) with the aim to maximize the success of the final validation and minimize possible failures.

The final validation was completed within four days and took place inside the hangar of the offshore platform, using a steel tower as the main element to which the sensors, UWB anchors and steel plate are attached.

The test set-up was composed by four fixed sensor nodes, one mobile sensor node attached to the drone, four UWB anchor nodes for indoor positioning, the drone, the WATEREYE computer (WEC) and the analysis software (Decision Support Tool).

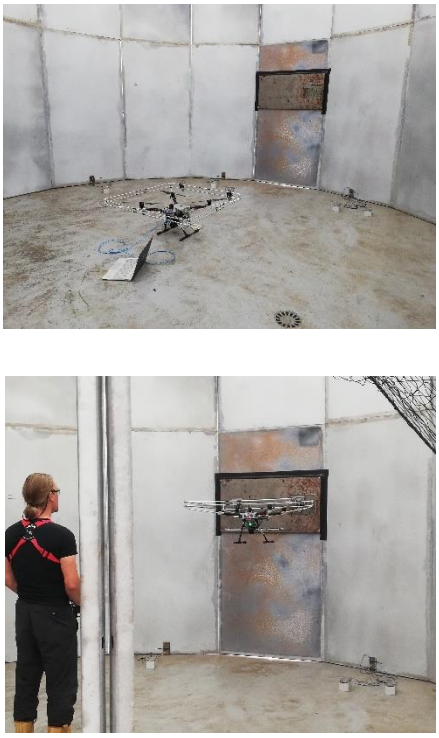

Figure 1. Different moments of the validation

The results obtained were positive, measurements from the fixed and the mobile sensors were received by the database, and could be displayed in the 3D visualisation tool, all with realistic values.

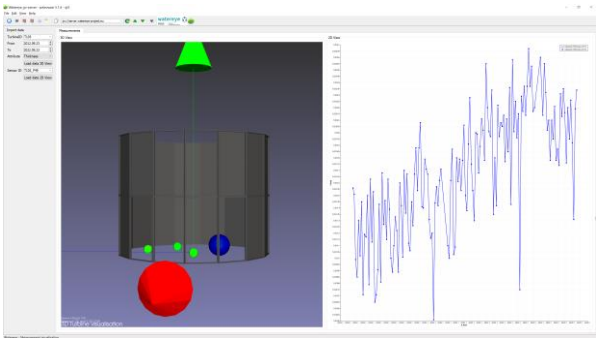

Figure 2. 3D visualisation tool

The data was visible and therefore the correctly working components – and their integration in the full system – was proven.

The quality of the measurements were quite good, standard deviation of around 1 µm for the fixed nodes and around 10 µm for the

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mobile node. Therefore, it can be concluded that the accuracy of the measurements is within the expectations.

More info about the final validation and its results can be found in the public deliverable D5.4 'WATEREYE Monitoring validation in relevant environment' that will be publicly available on the WATEREYE website.

In terms of communication activities, a video of the final validation and interviews were recorded and will be available soon on the WATEREYE YouTube channel.

Review article developed by FMAKE, SINTEF Industry and CEIT

A review article developed by FMAKE, SINTEF Industry and CEIT has been published on Frontiers about corrosion monitoring and prognostics in offshore wind turbine structures. Article available here.

WATEREYE results presented at Windfarm Operational Analysis Workshop

Last 4th October, the WATEREYE validation results of the monitoring system were presented at the Windfarm Operational Analysis organised by Spanish Wind Energy Association (AEE). These results were presented by Ainhoa Cortés from CEIT during the panel discussion on the importance of inspections on wind farms.

Figure 3. Participants of panel discussion on wind farms inspections

Horizon Results Booster seminar

During the last month, several seminars related to the Exploitation and Business plan have been held with the Horizon Results Booster facilitator in order to improve the exploitation strategy of the WATEREYE project results.

In the first one, attended by CEIT, DD, Flanders Make, TUD, SINTEF-E, COBRA and PLOCAN, new tools were used with the aim of identifying the main characteristics of each Key Exploitable Result (KER) and providing information on the selected exploitation route, as well as analysing the risks and the probability of their occurrence and defining different corrective actions.

In the following seminars, the focus was on the development of the business plan by using other tools to define a business strategy, perform a market and competitor analysis and define a clear action plan to be implemented by the project. CEIT (KER 1 leader), COBRA and the Horizon Results Booster facilitator participated in these seminars.

More info about the Horizon Results Booster tool can be found here.

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Events

WATEREYE Final Dissemination Workshop, 20th October, 2022, Gran Canaria, Spain.

The WATEREYE consortium is pleased to invite you to the Final Dissemination Event of the WATEREYE project, which will take place on October 20th, at 9.30 a.m. at PLOCAN facilities, where the main achievements of the project will be presented.

After three years of development, WATEREYE presents a solution proposal for cost reduction of maintenance and operation of offshore wind turbine towers, contributing to the increase in annual energy production.

In this project, the partners have developed a series of products, such as fixed and mobile ultrasonic sensors, a drone platform, prediction and visualization software, among other tools. For more information, please, visit our website: https://watereye-project.eu/

The project is financed with European funds, receiving more than 4.7 million euros distributed among the nine partners of the consortium led by the CEIT Research Center in the Basque Country, including Delft Dynamics and the University of Delft (TUD) from The Netherlands; Semantic Web Company from Austria; SINTEF Industry and SINTEF Energy Research from Norway; Flanders Make from Belgium; and COBRA and PLOCAN from Spain.

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AGENDA

09:30-09:45	Welcome and introduction Video release of the final validation	Nalu Franco (PLOCAN)
09:45-10:05	WATEREYE Concept and Final validation of the corrosion monitoring system	Ainhoa Cortés (CEIT)
10:05-10:25	Machine learning tool to analyse corrosion and corrosion patterns	Robin Vacher (SINTEF-I)
10:25-10:45	Coffee break	
10:45-11:05	Diagnosis and Prognosis algorithms for RUL prediction	Thibault Crepain (FMAKE)
11:05-11:25	Wind Farm Control	*Zhixin Feng* (TUD)
11:25-11:45	Control & maintenance strategy at wind farm level	Konstanze Kölle (SINTEF-E)
11:45- 12:05	WATEREYE Exploitable results	Ignacio Romero (COBRA)
12:05-12:30	Q&A and Open discussion. Event closure.	Adriana García (PLOCAN)

Online registrations are open here.

We look forward to your attendance!

Conference on Decision and Control - Dec. 6-9, 2022, Cancun, Mexico

The 61st IEEE Conference on Decision and Control (CDC 2022) will be hosted in Cancun, Mexico, from December 6 through December 9, 2022.

The IEEE CDC is recognized as the premier scientific and engineering conference dedicated to the advancement of the theory and practice of systems and control. The CDC annually brings together an international community of researchers and practitioners in the field of automatic control to discuss new research results, perspectives on future developments, and innovative applications relevant to decision making, automatic control, and related areas.

The IEEE CDC is hosted by the IEEE Control Systems Society (CSS) in cooperation with the Society for Industrial and Applied Mathematics (SIAM), and the Japanese Society for Instrument and Control Engineers (SICE).

At this conference, TU Delft will be presenting two papers:

- *"An Economic Model Predictive Control Approach for Load Mitigation on Multiple Tower Locations of Wind Turbines",* Zhixin Feng, Alexander J. Gallo, Yichao Liu, Atindriyo K. Pamososuryo, Riccardo M.G. Ferrari and Jan-Willem van Wingerden.
- *"Convex Model Predictive Control for Down-regulation Strategies in Wind Turbines",* Jean Gonzalez Silva, Riccardo Ferrari and Jan-Willem van Wingerden.

More info about the event can be found here.

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Partner's corner

TU Delft

TU Delft is the academic partner in the WATEREYE consortium and is responsible for developing control algorithms at wind turbine and wind farm level that optimally considers each turbine's health and maintenance constraints.

Delft University of Technology is built on strong foundations. As creators of the world-famous Dutch waterworks and pioneers in biotech, TU Delft is a top international university combining science, engineering, and design. It delivers world class results[1] in education, research, and innovation to address challenges in the areas of energy, climate, mobility, health, and digital society. For generations, our engineers have proven to be entrepreneurial problem-solvers, both in business and in a social context.

At TU Delft we embrace diversity as one of our core values and we actively engage to be a university where you feel at home and can flourish. We value different perspectives and qualities. We believe this makes our work more innovative, the TU Delft community more vibrant and the world more just. Together, we imagine, invent, and create solutions using technology to have a positive impact on a global scale.

Our motto is: Challenge. Change. Impact!

The researchers involved in WATEREYE are part of the Delft Center for Systems and Control (DCSC), which is hosted by the Faculty of Mechanical, Maritime and Materials Engineering (3mE). The faculty of 3mE carries out pioneering research[2], leading to new fundamental insights and challenging applications in the field of mechanical engineering. From large-scale energy storage, medical instruments, control technology and robotics to smart materials, nanoscale structures and autonomous ships. The foundations and results of this research are reflected in outstanding, contemporary education, inspiring students, and PhD candidates to become socially engaged and responsible engineers and scientists. The faculty of 3mE is a dynamic and innovative faculty with an international scope and high-tech lab facilities. Research and education focus on the design, manufacture, application and modification of products, materials, processes, and mechanical devices, contributing to the development and growth of a sustainable society, as well as prosperity and welfare.

TU Delft researchers

Zhixin Feng (PhD student), Jean Gonzales-Silva (PhD student), Riccardo M.G. Ferrari (Tenured Asst. Prof.) and Jan-Willem van Wingerden (Full Prof.) are the four researchers behind TU Delft contributions to WATEREYE. All are part of the Data Driven Control group at DCSC. Within this group the focus is on the integrated design, analysis and decision making for large-scale (in physical size) multi-disciplinary dynamical systems. We address the fundamental question about what model complexity and actuator/sensor configuration is necessary for all individual system components in order to use these models for reliable and robust model based diagnostics, parameter estimation, monitoring, parametric system optimization and control. Uncertainty quantification and disturbance modelling are essential parts of the integrated design of these

[1] TUDelft ranked 21st worldwide in the subject of engineering, according to the THE University ranking in 2021.

[2] Click here to go to the website of the Faculty of Mechanical, Maritime and Materials Engineering.
Do you want to experience working at our faculty? These videos will introduce you to some of our researchers and their work.

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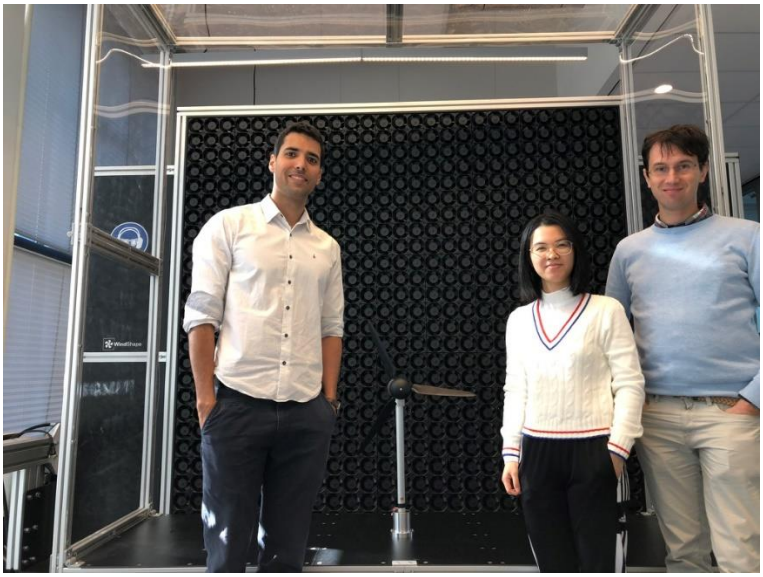
multi-disciplinary systems. Therefore, the combination of measurement data with multi-disciplinary system models is essential to enable reliable, robust and efficient decision making.
This fundamental framework makes it possible to develop robust integrated control systems for demanding industrial application fields, where there is a clear need for integrated system designs with embedded prognostics and diagnostics. Examples are: large-scale mechatronic systems, dynamic positioning systems, ocean-energy-harvesting systems, and wind-energy-harvesting systems.

The DCSC laboratory includes state of the art facilities that will allow to test the algorithm developed during the WATEREYE project. In particular, we operate a Windshape "wind wall" for testing scaled down wind turbine and wind farms models in a custom made wind tunnel. The Windshape unit includes hundreds of small fans that can be operated independently, thus allowing to generate arbitrary wind profiles over time and space.



Jean-Gonzales Silva (left), Zhixin Feng (center) and Dr. Riccardo Ferrari (right) in front of the Windshape unit and a scaled down wind turbine model.