CT studies automatic control of AWE system trajectories using advanced Deep Learning technologies

CT is making progress with the IADGENOL R&D project aimed at researching Deep Learning models for the automatic control and characterisation of AWE (Airborne Wind Energy) systems for wind energy generation, forming part of the framework of the Red.es call for proposals.

In this project, the CT team is investigating the use of state-of-the-art Deep Learning technologies to enhance control and gain a deeper understanding of wind energy generation systems known as AWES.

The primary objective here is the creation of a Deep Learning-based control model for the automatic trajectory control of AWE systems, as well as employing these models to understand and characterise the dynamic challenges faced by such systems.

CT has already completed three of the four work packages that were defined, spanning nearly two years of the project's duration. The remaining aspects include the testing and validation of the developed solution. The project is expected to end in May 2024, and its findings will be presented at the forthcoming Airborne Wind Energy Conference 2024. This event is among the most significant in the sector globally and will be held at Carlos III University in Madrid from 24th to 26th April.

Phase 1: State-of-the-art study and definition of requirements

In this phase, we explored the current state of airborne energy systems and established the requirements for controlling these systems using advanced technologies. Our work revealed a scarcity of existing research in this field, prompting us to adopt a solution that incorporates reinforcement learning and deep neural networks. We also studied similar models to predict wind at high altitudes.

Phase 2: Solution design

Here, we established the technological baselines for addressing the automatic control challenges of airborne wind systems. Utilising a simulator and experimental data, we developed and tested our solutions. Various network architectures were evaluated, and a process for data formatting was defined. In partnership with UC3M, this phase included conducting tests to collect real flight data, later used for training the AI models that control the aircraft.

Phase 3: Solution development

This stage involved implementing and refining the algorithms developed in the previous phase. We focused on creating models for dynamic system characterisation, high-altitude wind prediction, and an automatic controller based on reinforcement learning. These models were trained using both simulated and experimental data. Additionally, we worked on an interface for training and testing these algorithms in a digital environment before their use in the actual system.

Phase 4: Testing and validation

The final phase involved conducting tests both in the simulated environment and on the actual machine. Tests are to be performed between the months of February and May at our flight test centre in Santa Maria de la Alameda. The aim is to evaluate the performance of the controllers that have been developed and to derive valuable insights for improving and refining our airborne wind system.

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