Group 07 - SEAMOS

The need for alternative and sustainable products for applications in the food industry, pharmaceutics, and agriculture is more and more pressing these days. Seaweed is a very promising solution thanks to its multidisciplinary use. Seaweed farming is the fastest-growing aquaculture industry and is typically performed in a nearshore environment. However, the increasing interest in seaweed applications requires larger-scale productions and induces the need to expand seaweed farming to off-shore environments. The Seaweed Company came up with the innovative idea to set up a seaweed farm in a large, unused area within the Borssele wind turbine park, thirty kilometres in front of the Dutch coast. In order for large-scale, offshore seaweed production to be financially viable, a solution has to be found to autonomously monitor the farm.

Mission Objective

The purpose of this project is to design a solution that can autonomously and sustainably monitor the structural integrity and seaweed growth in offshore aquacultures. The system shall travel thirty kilometres to the Borssele wind turbine park, monitor the entire seaweed farm on a monthly basis, and bring the data back home. The farm comprises forty, 100-meter-long nets on which the seaweed grows. The system has to observe whether the structural elements of the units are still intact and how the seaweed grows. Furthermore, it will collect a water sample and bring it back to shore.

System Design

The solution that was found goes by the name 'Puffin'. It is a morphing wing drone that flies to the farm, sweeps its wings back and dives into the water to perform the monitoring part of its mission. Afterwards, the Puffin ejects itself out of the water and flies back to the coast. The design is inspired by the eponymous bird that shows similar behaviour. The Puffin monitors ten units per mission and flies out twice on operative days. To cover a forty-units farm in a month, it needs to be able to fly out at least two days a month. It will be launched with a pneumatic catapult and lands in a recovery net. The Puffin is fully powered by lithium polymer batteries. It has one aerial propeller on the nose and three underwater propellers located on the inverted Y-tail. The underwater thrusters can rotate radially, allowing the vehicle to have six degrees of freedom control. A pressurised gas and water chamber works as a waterjet to eject the Puffin out of the water after monitoring. A sonar and a camera sensor are used to monitor and navigate along the seaweed farm. Three-dimensional scans of the seaweed biomass are made with the sonar. Furthermore, the sonar is used to follow the seaweed farm units and to detect structural elements. Once an element is found, its structural integrity is checked by taking a picture with the camera. The sweeping back of the wing is required to limit the impact on the structure during the diving manoeuvre and to reduce drag as the Puffin is moving underwater. Two simple hinges will be used for this mechanism whose design is still being finalised. The tail houses a rudder and two elevons as control surfaces for both flight and underwater motion. Two ailerons are located on the wings for aerial roll control. The next steps are to finalise the Puffin's structure, sizing and buoyancy control. The critical load cases like the impact during diving and the sweeping manoeuvre are being analysed. The final layout and working of the buoyancy system as well as assuring successful water expulsion are the challenges for the team in the coming week.