OCEAN CONNECT

DESIGN OF AN AMPHIBIOUS BIO-INSPIRED LEGGED ROBOT FOR OBSERVATION AND SURVEILLANCE OF COASTAL AREAS

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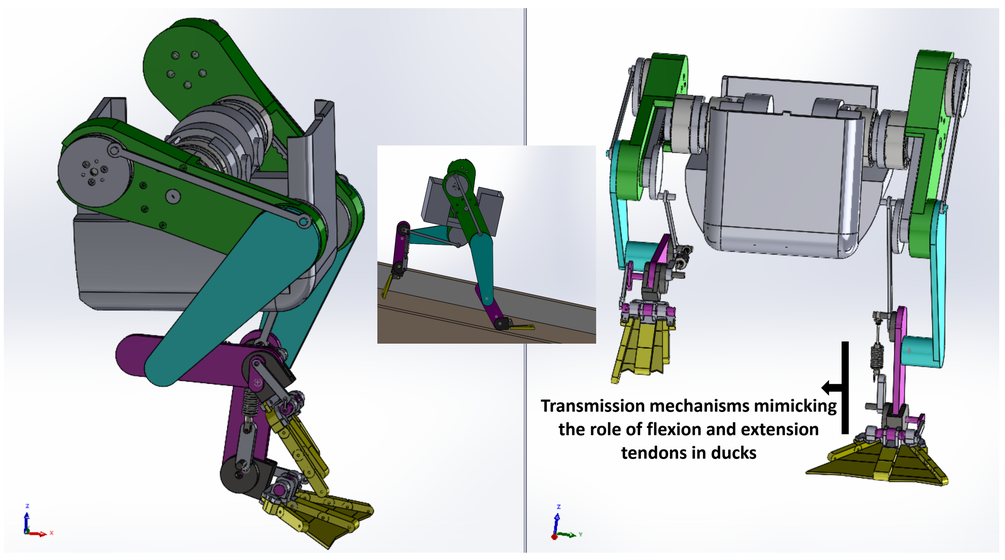
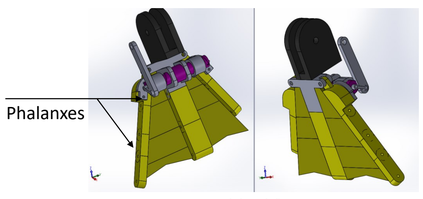
This project aims at **designing an operational robotic** platform with sufficiently efficient locomotion capabilities **to move in both terrestrial and aquatic environments**. The modeling of the articulated leg structure and the design of joint control schemes should be **based on biological data** and employ techniques enabling to faithfully imitate the locomotor behaviors of the biological model.
This project is part of a M2/Engineering research internship in bio-inspired robotics conducted at the laboratory of Robotics and Mechanical Systems Design (**COSMER**), which is affiliated with the Ocean Sciences Institute.

I. COMPUTER-AIDED DESIGN

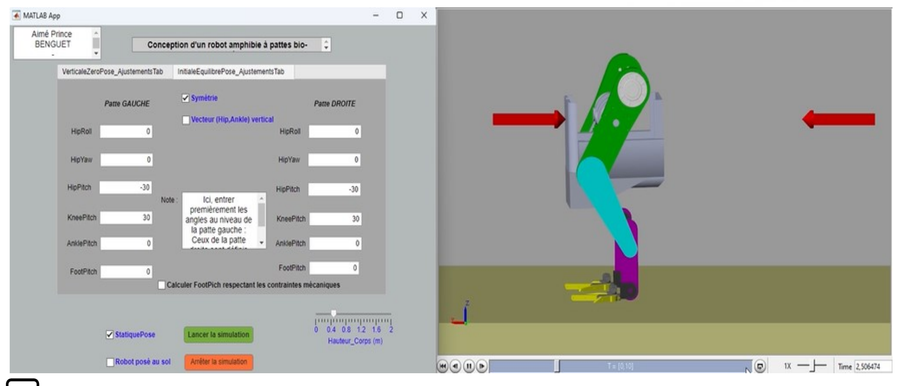




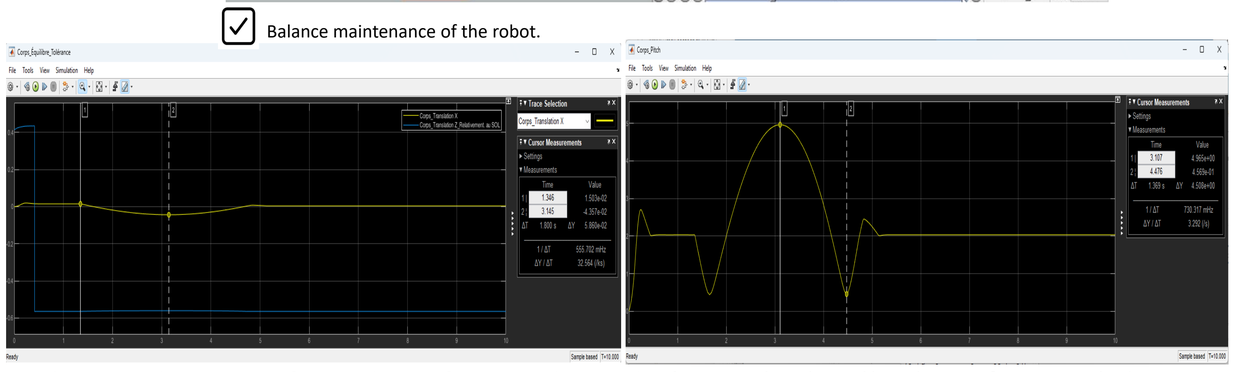
Webbed feet

Micro-CT scan results skeletal view.
Source : From “the Analysis of Anatomy and Locomotor Function of Biological Foot Systems to the Design of Bionic Foot: An Example of the Webbed Foot of the Mallard.”

II. SIMULATION AND TESTING OF THE ROBOT'S DYNAMIC BEHAVIOR



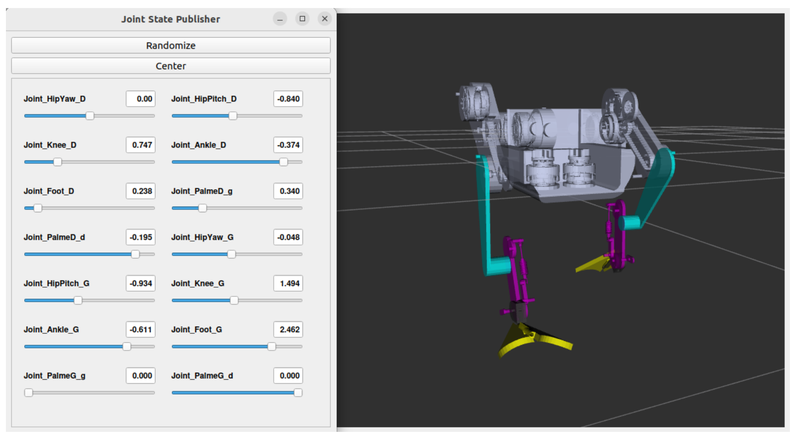
☑ Balance maintenance of the robot.



Disturbance – translation - Center Of Mass : tolerance of approximately 3cm. **Disturbance** - Pitch angle – Ankle : tolerance of approximately 4°.

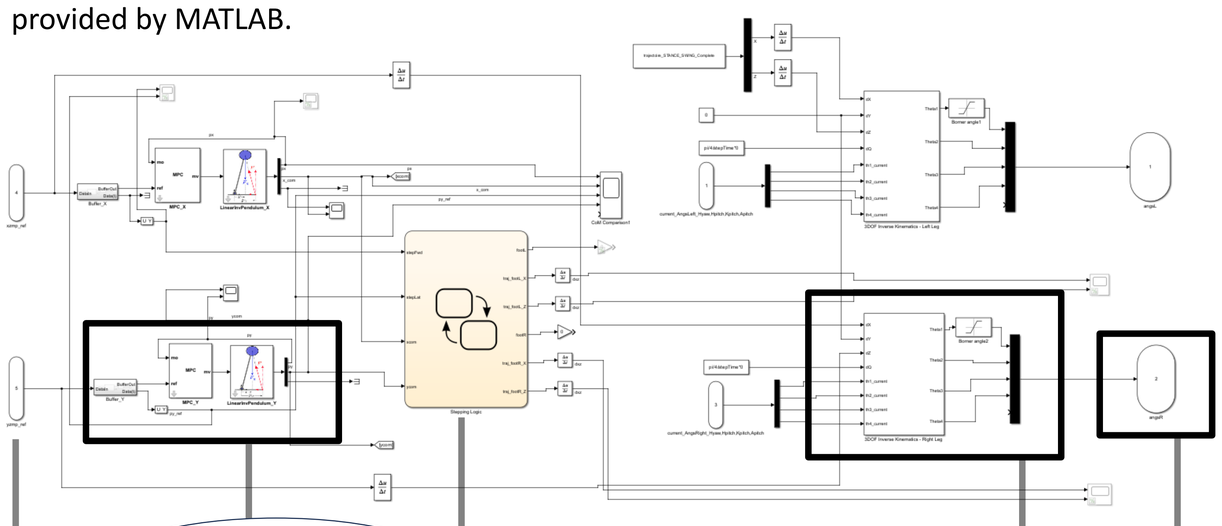
- ☑ Leg design inspired by Duck legs at a 2:1 Scale.
- ☑ Functional mechanical transmissions (Four-bar mechanisms, pulley-belt systems, helical transmissions…).
- ☑ Actuators positioned at the body level rather than at the joints, resulting in reduced resisting torques at the upper actuators.
- ☑ Trajectories derived from Biological data - tested (from a kinematics point of view).
- ☑ Compliance with geometric & Kinematic Constraints.

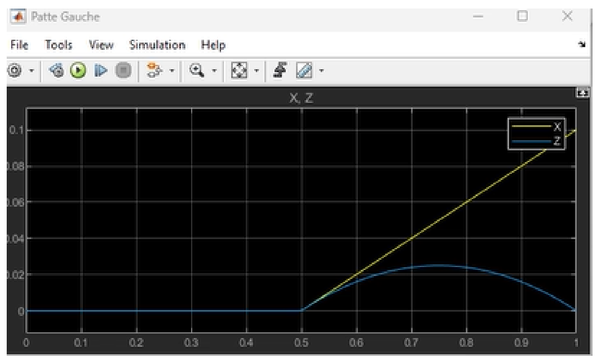
III. SIMULATION–SWIMMING / MARINE ENVIRONMENT

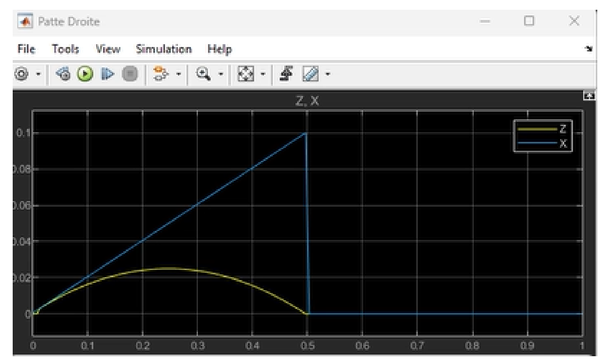


IV. CONTROL & TRAJECTORY TRACKING

The control part on MATLAB is based on tracking the position of the **zero moment point (ZMP)** via **model predictive control (MPC)**, while also tracking the position of the **center of mass (COM)** to generate a physically consistent trajectory based on **3D linear inverted pendulum (LIP)**. The algorithms used are inspired by powerful data and algorithms provided by MATLAB.







STANCE/SWING over one step – Left leg & Right leg.