DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING
Department of Mechanical Engineering

Eric AKPAN Darcy SMITH
Adam CURRIE Peter SVIDLER

TEAM 2

ISE International Submarine Engineering Ltd.

UNDERWATER TOWBODY DOCKING SYSTEM

Background

- Autonomous Underwater Vehicles (AUVs) are being deployed on increasingly longer missions which require frequent recharging cycles that cause disruptions to deployments
- Current methods for recovering AUVs are expensive, labour-intensive and weather dependent
- ISE Ltd. are currently exploring alternative methods for AUV deployment and recovery, including underwater docking with a surface vessel-dragged actively controlled towbody
- The behaviour of such a towbody must be autonomously stable to ensure a secure connection with an AUV

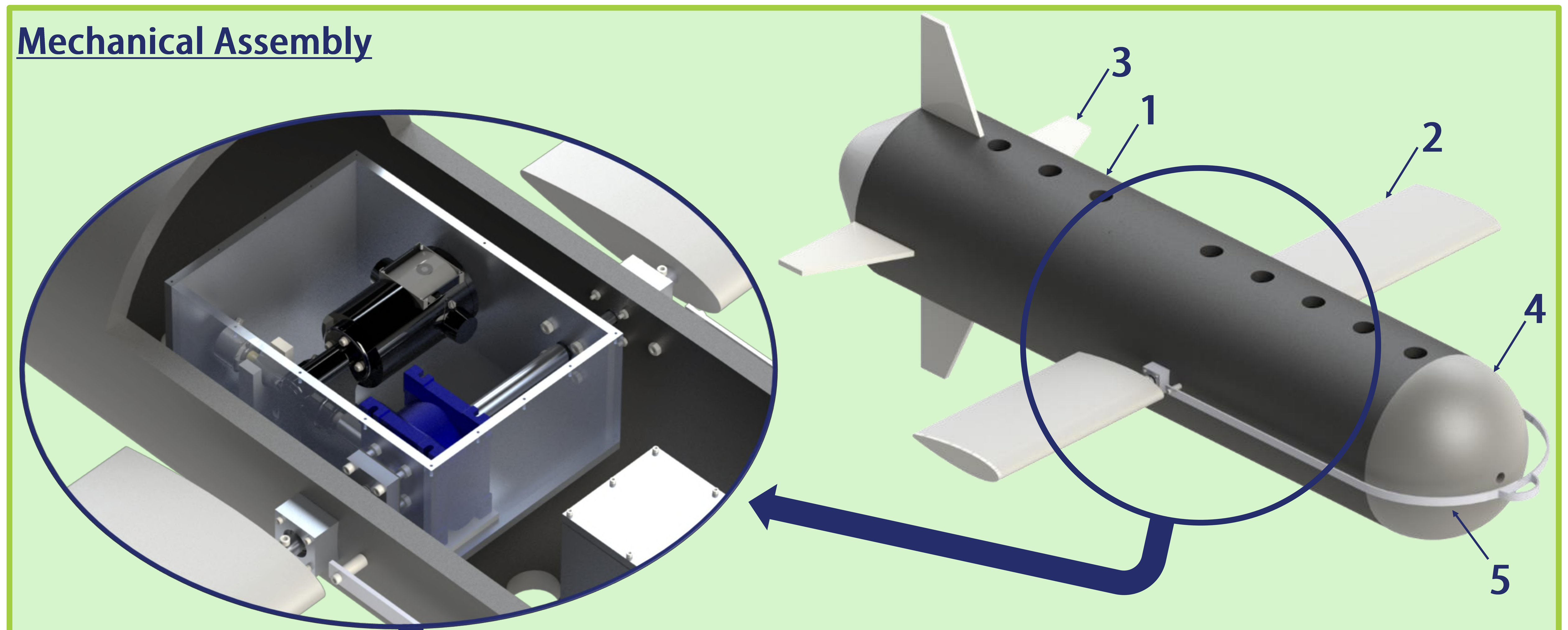
Objectives

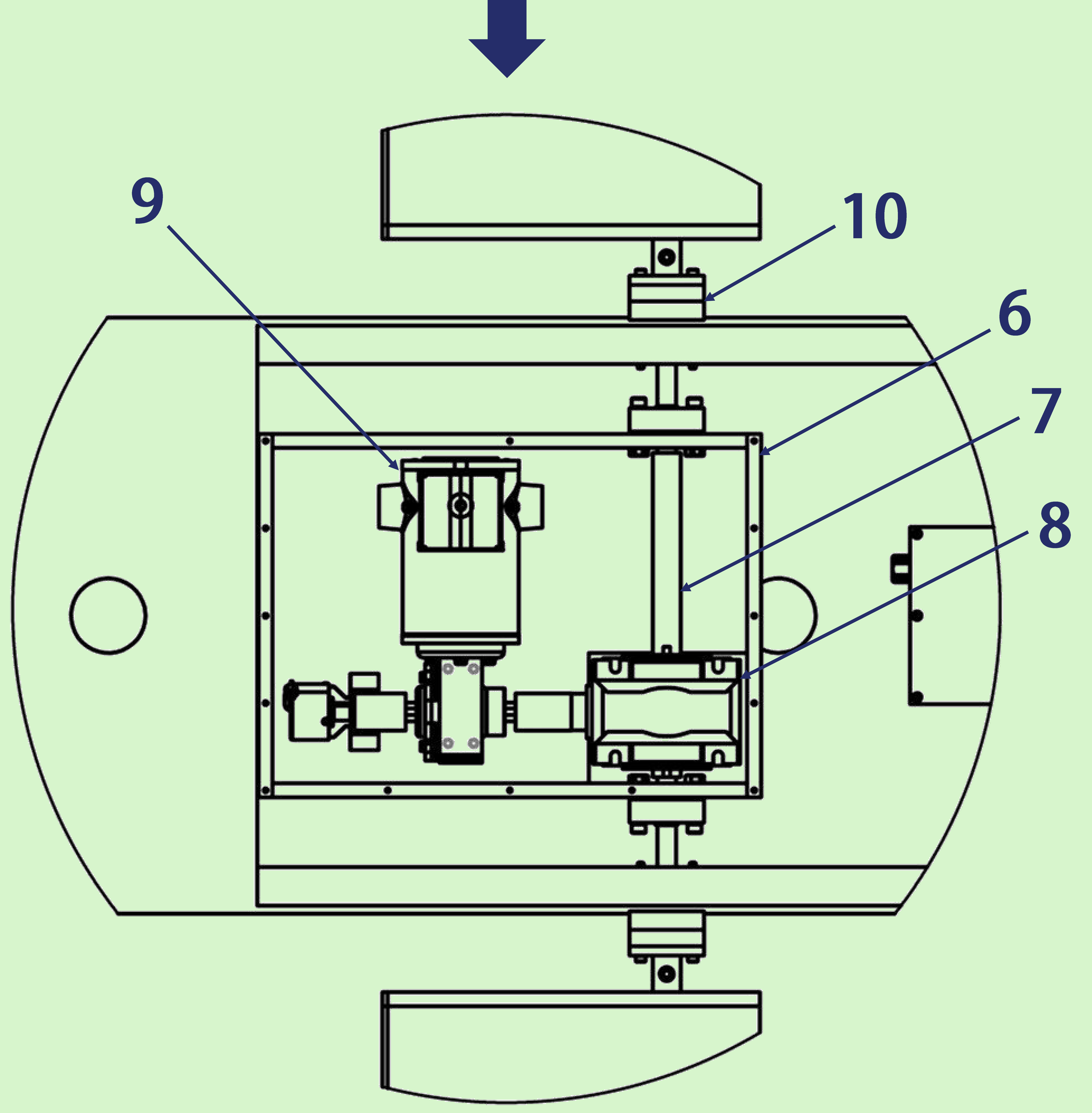
- The scope of the project concentrated on two specific goals:
  - Mechanical Assembly: provide ISE with a dependable representative test platform with which towbody behaviour can be studied
  - Control System: provide ISE with an autonomous control system that is capable of stabilizing the towbody at a desired depth
- Success was measured by the team's ability to deliver on these two objectives

Verification

- Key components of the mechanical assembly were tested for water ingress at the Dalhousie Aquatron Laboratory
- The control system was tested with a simulated depth signal for the response to a step error
- Towbody stability in towing was simulated and analyzed using MATLAB Simscape
- Drag loads, bending loads and stress due to towing were calculated to ensure survivability in future tow tank testing

Mechanical Assembly

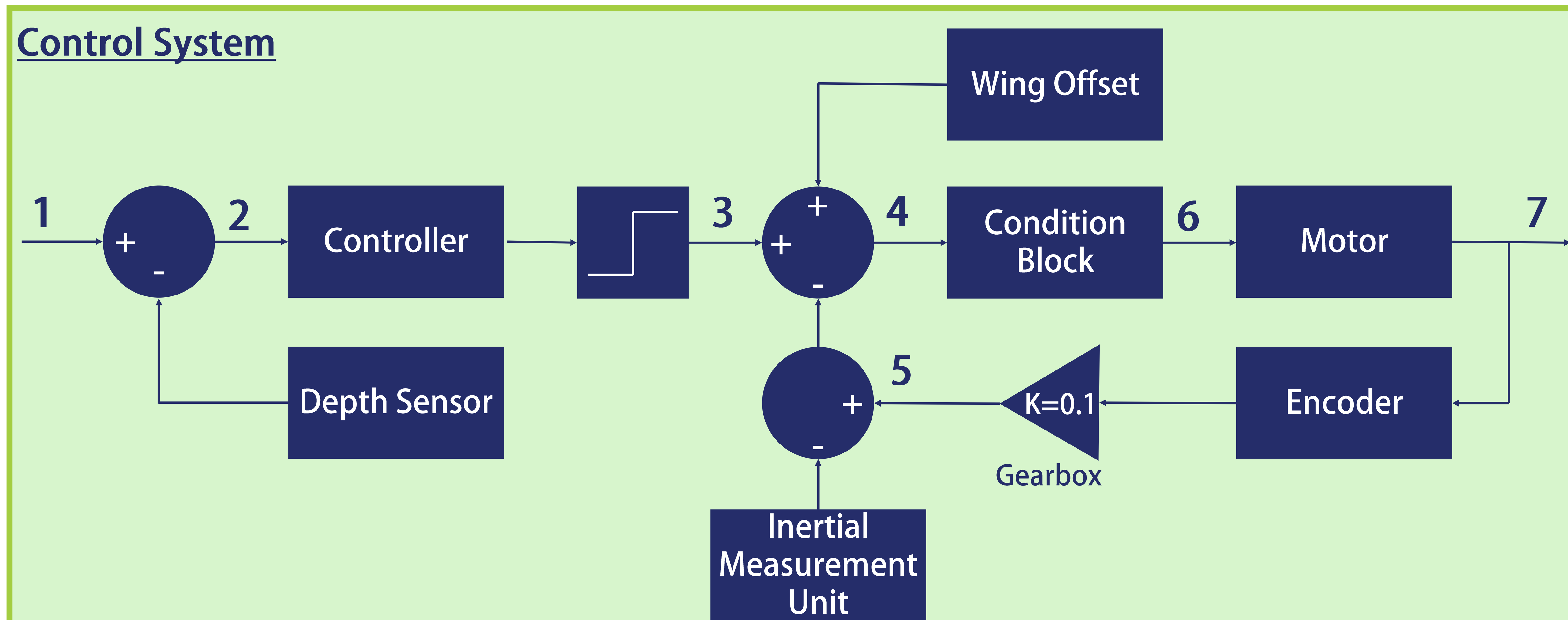




Water Sealing Housing Detailed View

1) Hull: free-flooding HDPE pipe used as the body of the towbody
2) Wings: aluminum-ribbed control surfaces actuated in response to depth changes. NACA0024 wing profile, 2.3:1 aspect ratio
3) Tail Wings: four rear-mounted tapered wings passively stabilize the towbody
4) Fairings: forward and aft foam fairings aid in buoyancy and reduce drag
5) Tow Bridle: tow point. Attaches near the wing's quarter-chord for stability
6) Water-sealed Housings: welded aluminum boxes shield sensitive components from water ingress
7) Output Shaft: machined from a single 50 cm long aluminum rod, features surfaces for O-rings for dynamic sealing
8) Gearbox: right-angle 10:1 speed reducer used to increase output torque
9) Motor: 36 RPM right angle DC motor rotates the wings in response to control system input
10) Wing Assembly: the wings are removable, and are attached to the output shaft

Control System



1) The input to the system is the towbody's desired depth. It is pre-set or varied in real time by the user
2) The desired depth is compared with the depth reading generated by the depth sensor to produce an error signal
3) The controller relates the depth error to a wing angle response, while the saturator block limits the response to the wing's stall angle
4) The wing command is the difference between the wing offset and the wing angle of attack
5) The wing angle correction factor is measured by the encoder, and corrected for the towbody's pitch by the IMU
6) The condition block converts the wing command to an electrical pulse width modulated (PWM) signal which determines the motor's rotation
7) The final system output is the motion of the wing to a desired angle, which causes the towbody to move to the desired depth

Future Recommendations

With the mechanical and electrical assemblies complete, it is recommended that the towbody undergoes buoyancy and balance testing in a controlled test environment before undergoing full tow tank testing for verification and refinement of control system parameters.

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