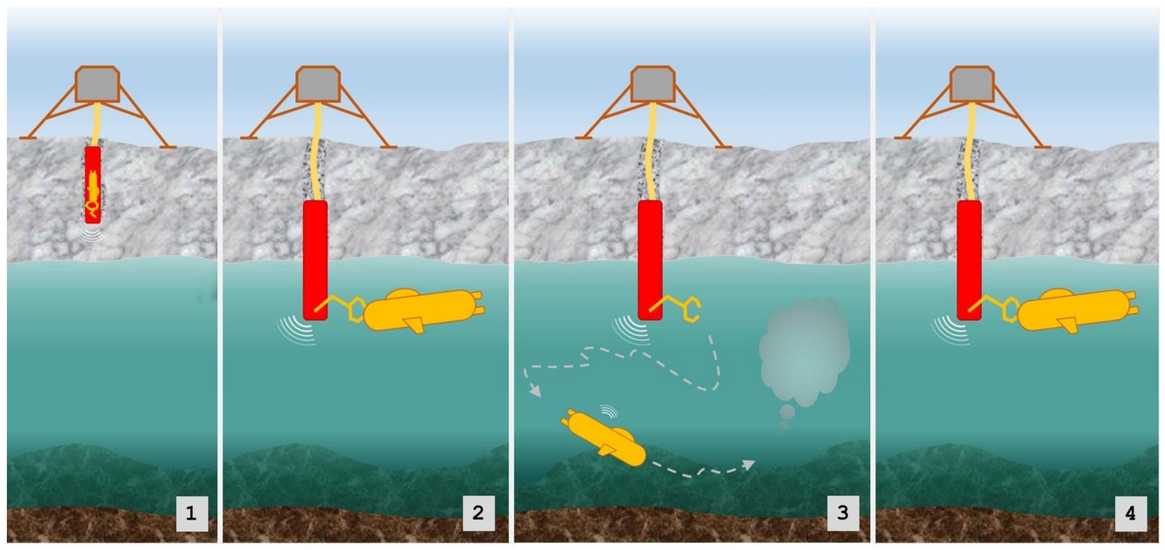
TRIPLE-nanoAUV

A GUIDANCE, NAVIGATION AND CONTROL SYSTEM FOR AN AUTONOMOUS UNDERWATER VEHICLE TO EXPLORE THE OCEANS OF ICY MOONS

Mission Scenario

- Exploration of Ocean Worlds like Europa and Enceladus
- In-situ search for biosignatures
- Challenge - ice shell of several to dozens of kilometres
- Combined operation of surface station, melting probe and nanoAUV, a mobile robotic underwater platform
- High degree of autonomy and strong dependence on fault-tolerant GNC system



Reliable Navigation System

- Tactical-grade IMU + magnetometer triad
- Depth/pressure sensor
- Ultra-short baseline (USBL) system
- Dynamic motion model
- Combination of full-state navigation filter and AHRS
- Voter algorithm for plausibility and integrity checks

Perception

- No integration of sonars due to limited space and power
- 3D acoustic imaging with self-supervised learning from available acoustic systems (USBL and echosounders)
- Generation of an occupancy map only with acoustic data
- Image enhancement with High Dynamic Range Imaging (HDRI) against limited lighting, motion blur and turbidity
- Temporal and spatial annotation of scientific data

Decision Making

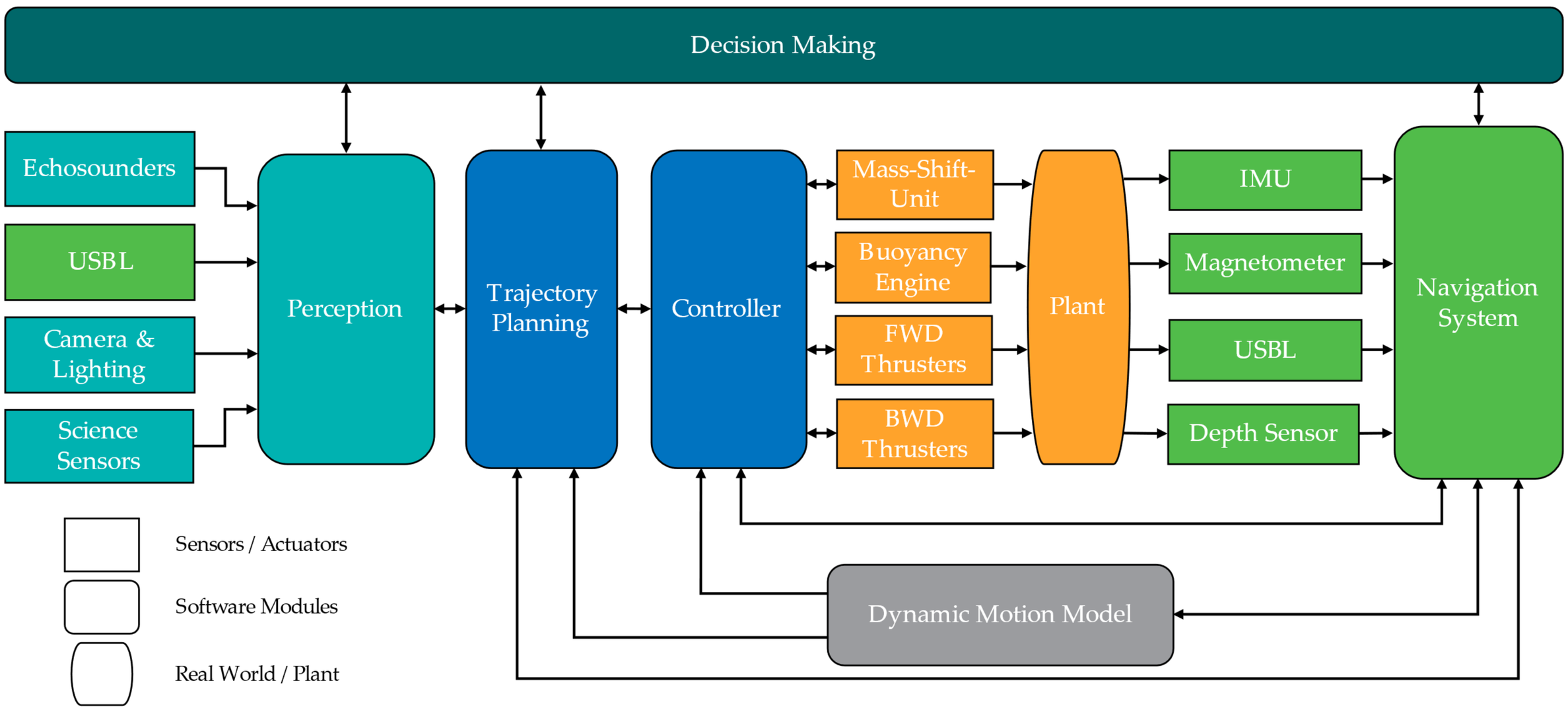
- Autonomously plan, execute and monitor the mission
- Scientific exploration of the water column and the boundary interfaces ice/water and water/seabed
- Identification of Regions/Points of Interest promising for scientific investigation
- Control sampling
- Fallback strategies for safe return

Trajectory Planning and Control

- Trajectory planning minimizes energy consumption while considering obstacle vehicle dynamics
- The guidance system resolves the underactuation
- Feedback and feed forward control use modeled dynamics
- Thruster and actuator configuration enables active/passive locomotion and static/dynamic diving

Simulation and Testing

- Gazebo based UUV Simulator serves as a tool for system integration, testbed for development and demonstration
- Simulation of chemical particle distribution allows testing of odor tracking algorithms
- Breadboard model tests in water basins and simulative validation accompany development
- Demonstration mission in Antarctica planned for 2025/2026



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