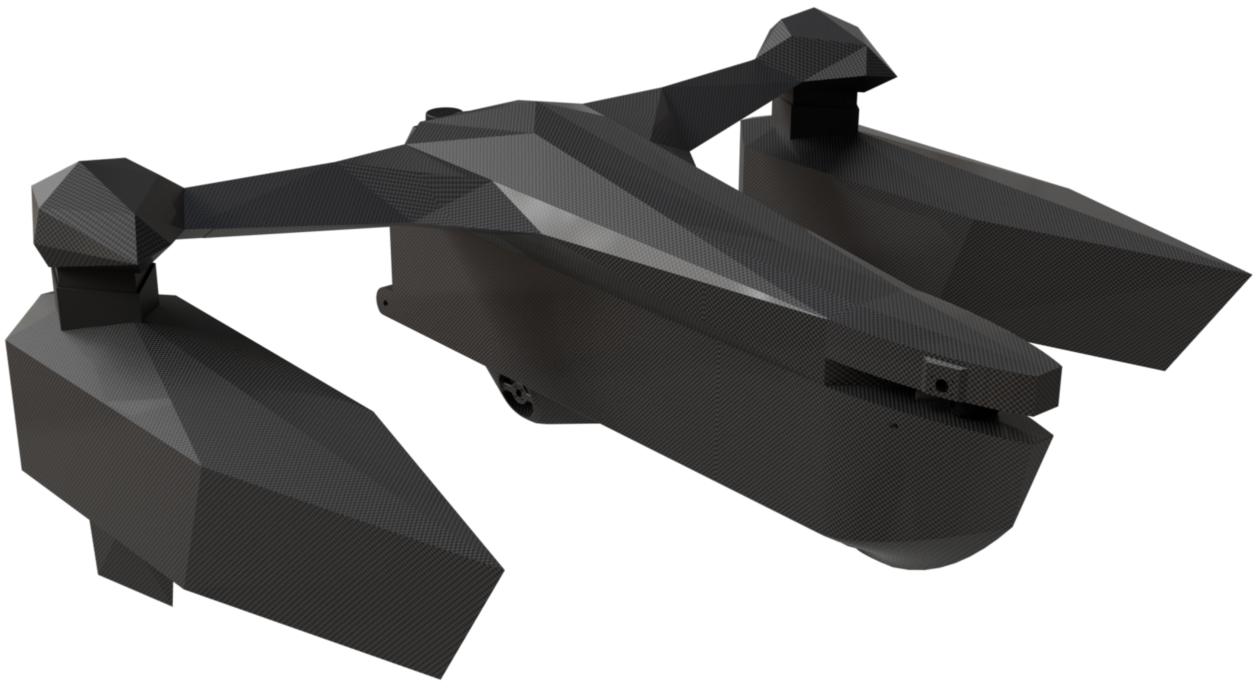
Ligmax Progress Report

May 15, 2026



1 Introduction

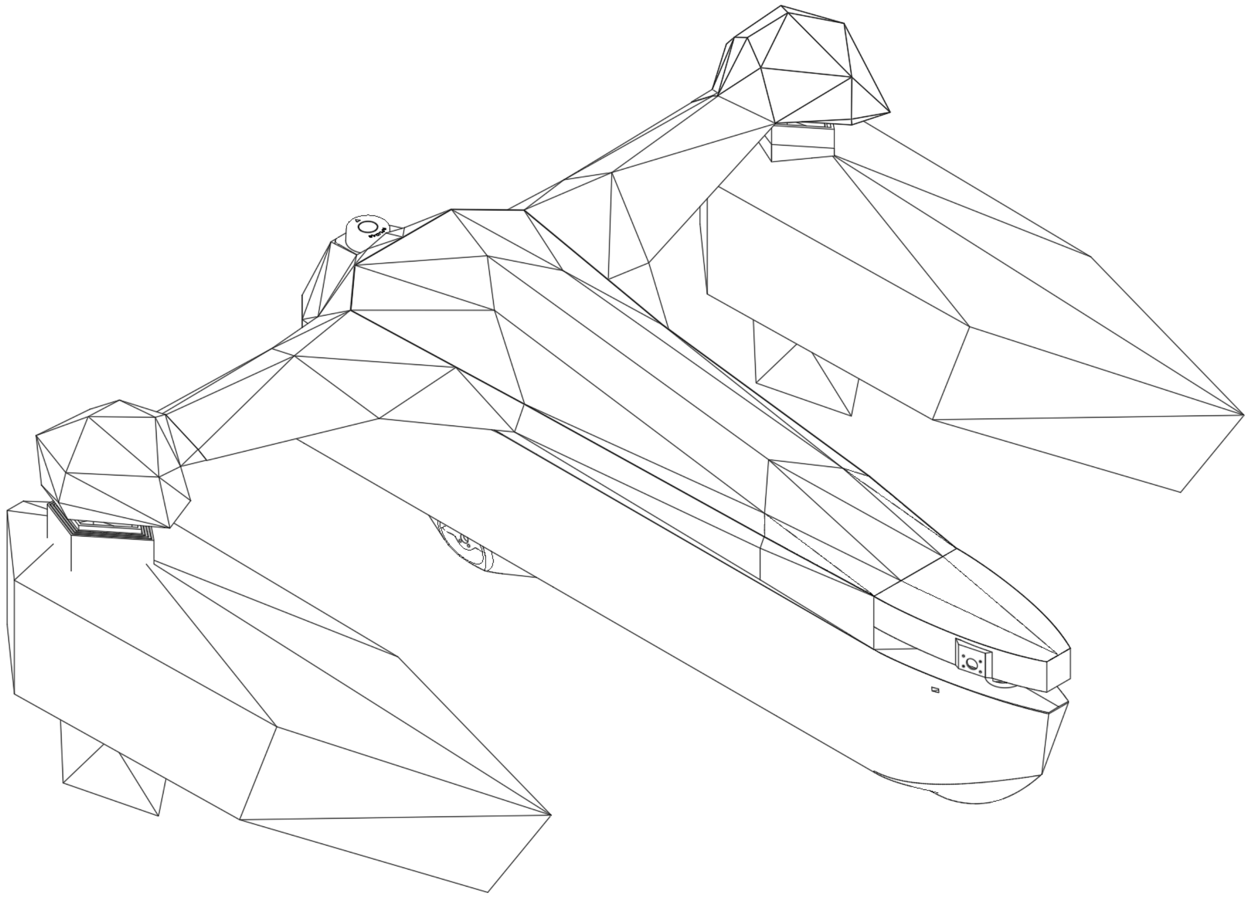
1.1 Description

Ligmax is a multidisciplinary team of students from the NTNU Elsys bachelor and master programs, our ASV is a roll stabilized trimaran with a stabilized sensor package for cleaner data and easy inference. The ASV has a advanced sensor and actuator fleet consisting of stereo cameras, Dual lidars, Dual differential thrust motors and side stern thrusters. The vessel also has a weight shift battery system to counteract waves and allows for easier planing.

1.2 Motivation

Team Ligmax has a strong track record of successfully collaborating on large-scale technical projects. We have been actively seeking a student technical competition to join, and the Njord Challenge stands out as the ideal fit. Its local presence provides us with a concrete milestone to work toward, alongside a premier platform to test our product and compete against international peers. This challenge presents our team with an invaluable opportunity to accelerate our learning during the development phase and to exchange knowledge with fellow students during the competition.

2 Hardware



We chose a low-poly-trimaran for the low drag coefficient and stability. We have the main components in the vaka and around 60% of the total buoyancy in the akas. The centred weight and wide buoyancy creates great stabilization, In the figure under you see the dimensions of the ASV, all measurements in the report is given in mm.

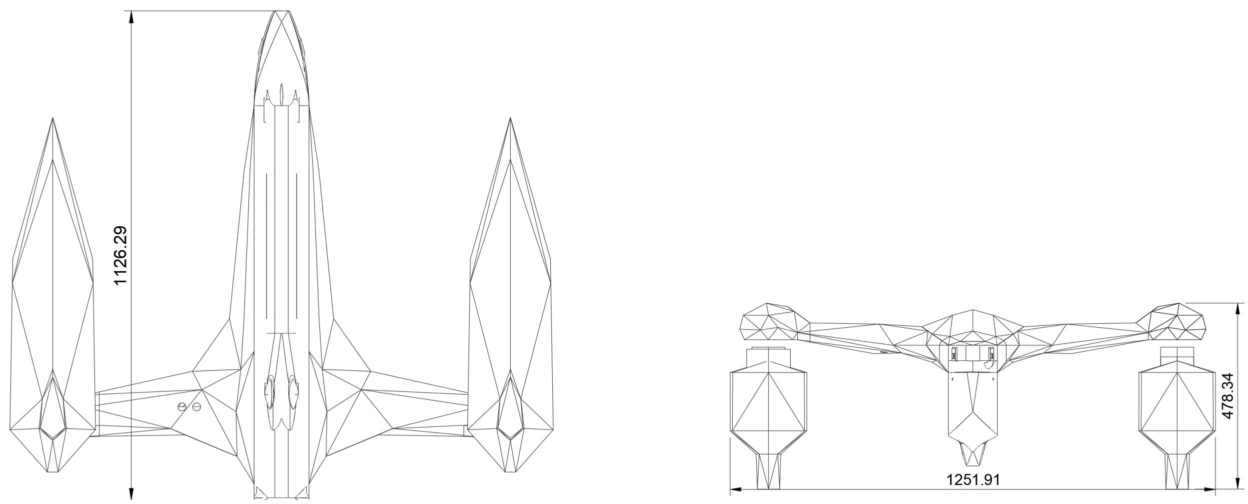


Figure 1: Sketches of main hull, measurements in mm

The ASV has a high end sensor and actuator fleet, the communication between the modules is shown in the flow chart below.

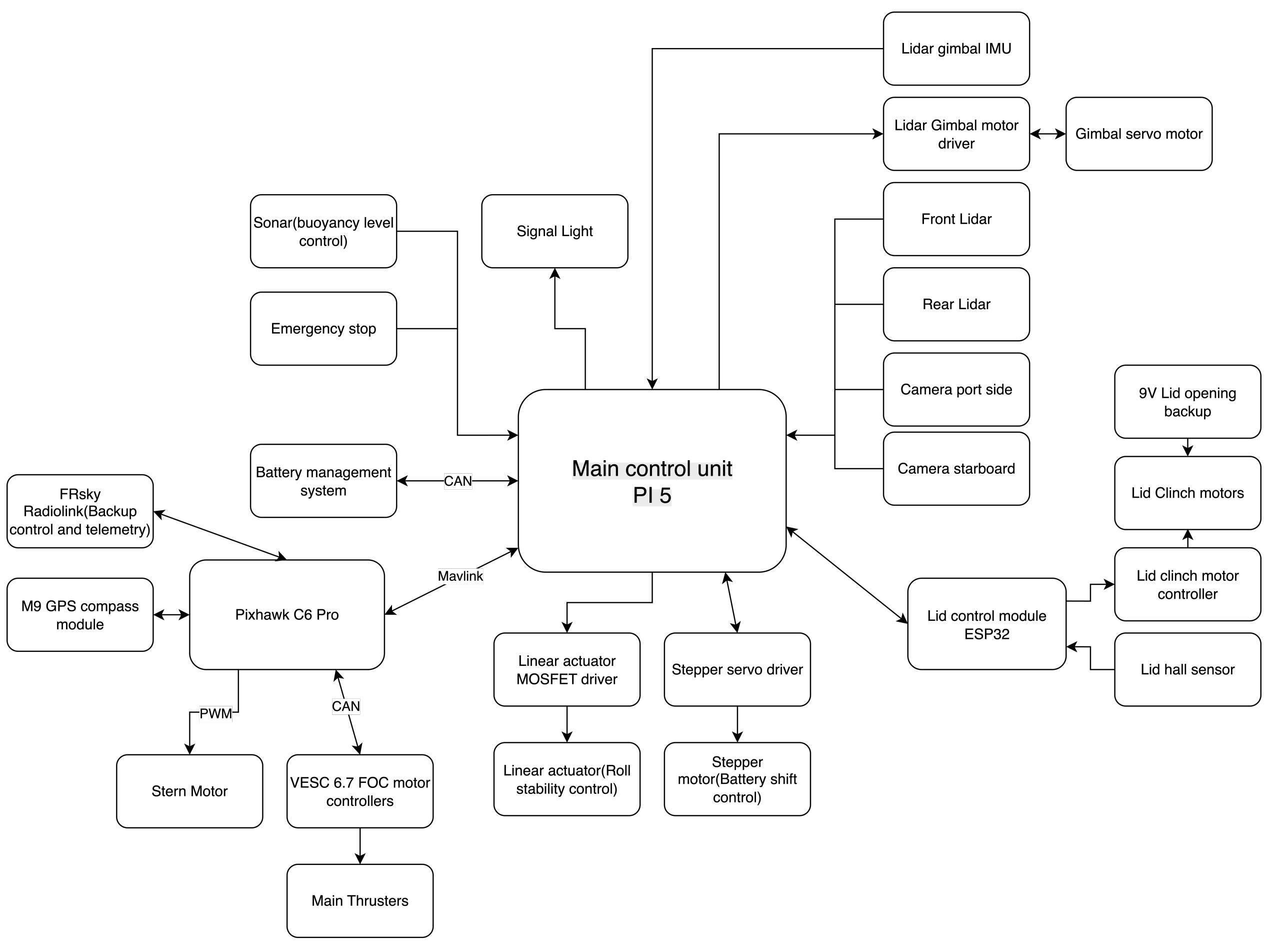


Figure 2: ASV communication and control hardware overview

2.1 Current Hardware Overview

In the figure below you can see the majority of the hardware used in this project.

Figure 3: Relevant hardware laid out

The component name for each item is given in the table below.

Table 1: Main component table

Number	Component
01	PLA Hull Component
02	Battery management system
03	Main Thrusters
04	Carbon Fiber Cloth
05	Epoxy Resin
06	Epoxy Hardener
07	LIION Battery Cells
08	Linear Actuators
09	Lidars
10	Aluminium TIG weld sticks
11	DC - DC Buck converter low voltage
12	DC - DC Buck converter high voltage
13	Battery for system testing
14	5G Router
15	Pixhawk PDB(Power distribution board)
16	Pixhawk 6C Pro(Flight-controller and IMU)
17	VESC 6.7 FOC motor controller
18	Sonar
19	Lidar gimbal motor
20	IMU vibration damping mount
21	Dual Shaft Nema 23 with belt pulleys
22	Idle belt pulleys
23	Screws
24	Pixhawk cables and PWM breakout
25	Gimbal Structural part
26	Stepper-Motor Driver
27	Raspberry PI
28	GPS antenna
29	CAN communication PI 5 HAT
30	Linear Rails
31	Emergency Stop Button

Additional Components Not Pictured, stern thruster, 2040 aluminium profile beam, lid locking mechanism, lights and battery Aluminium plate as well as Mounting hardware, belts, bolt, misc.

2.2 Sensor package

2.2.1 Lidars

We have two lidars, one rear facing and one gimbal-stabilized front facing.

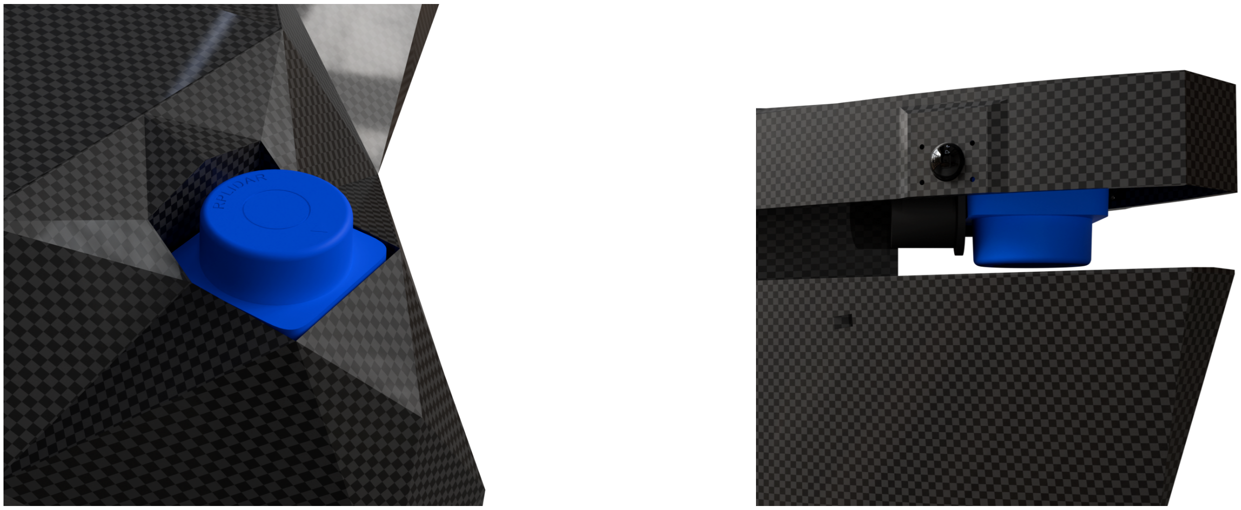


Figure 4: Two lidars for full coverage

The lidars together provide full coverage of every angle around the boat.

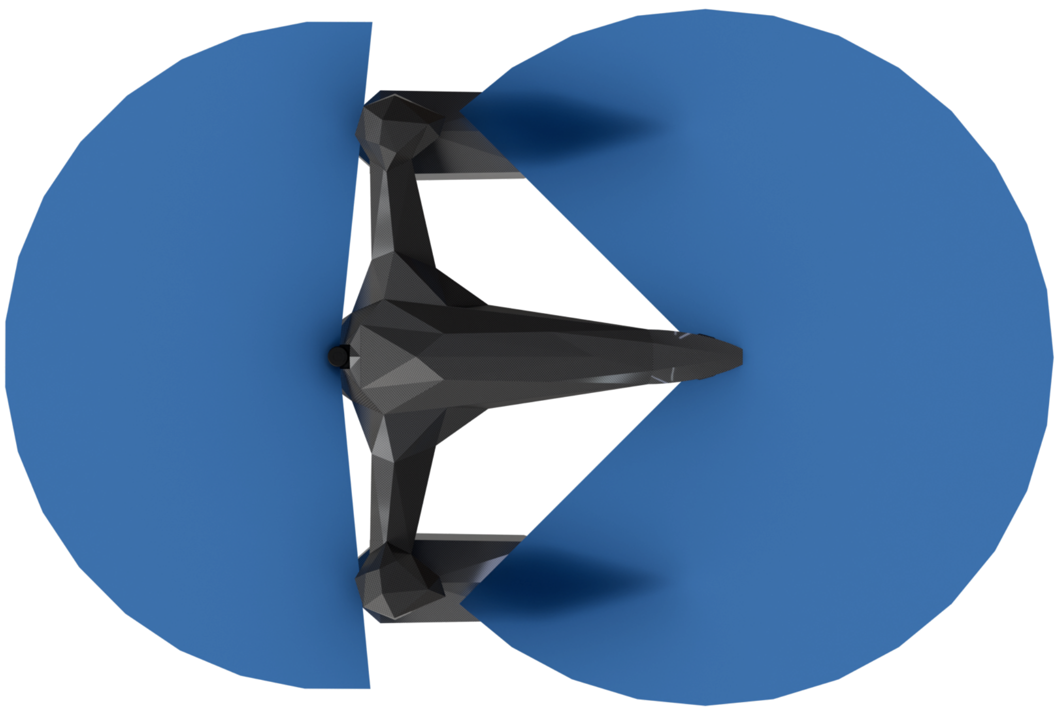


Figure 5: Top down visualization of lidar coverage

The front lidar also has a custom gimbal system, a technical drawing is shown in the figure below.

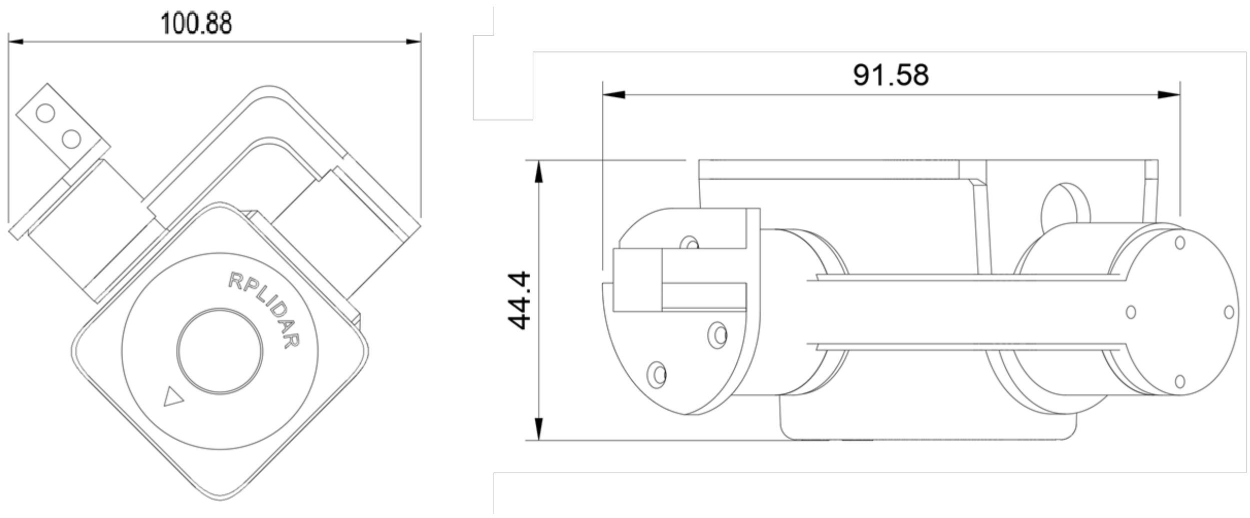


Figure 6: Front gimbal sketch

2.2.2 Cameras

Because lidar is non-color and a part of the course is color dependent, we use cameras to estimate the color of objects detected by the front facing lidar.

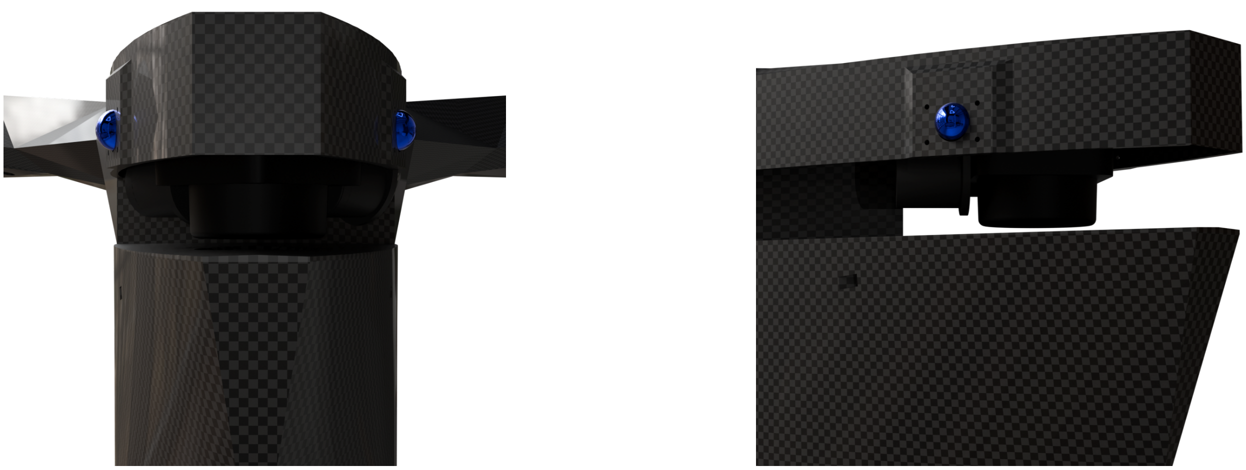


Figure 7: Two cameras for full coverage

The cameras used are 220 degrees wide angle, where about 190 degrees of this are usable, and the rest is severly distorted, the total usable camera coverage area is visualized in the figure below.

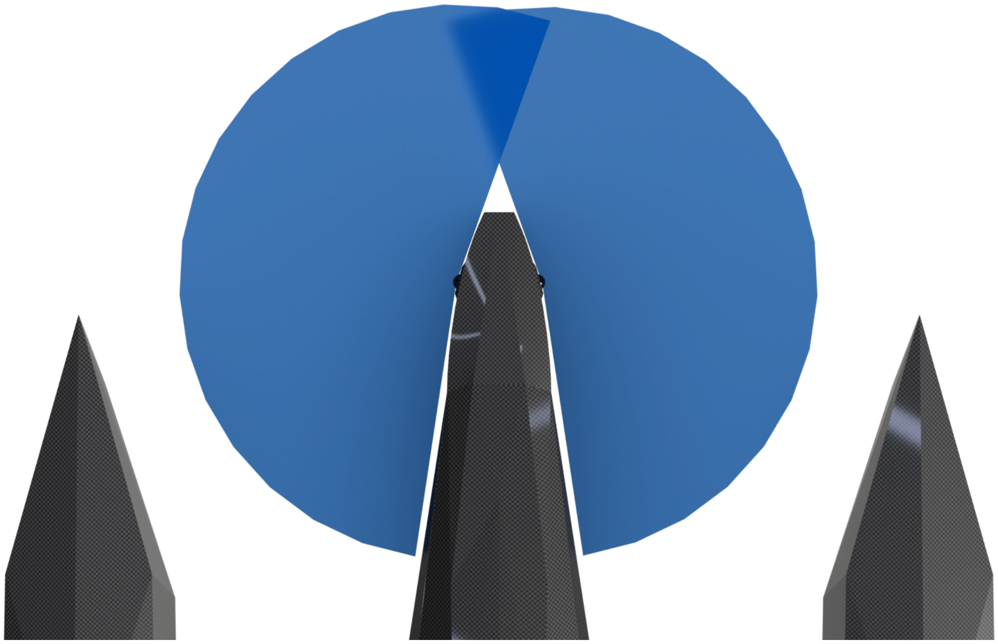


Figure 8: Visualization of viewable area

2.2.3 Extra sensors

The vessel also have some extra sensors not mentioned above for positioning, rotation control, water level estimation and lid closure status confirmation.

2.3 Stabilization

We have implemented a battery that slides for pitch stability control, this is done by a nema23 and two linear rails connection the hull and the battery box.

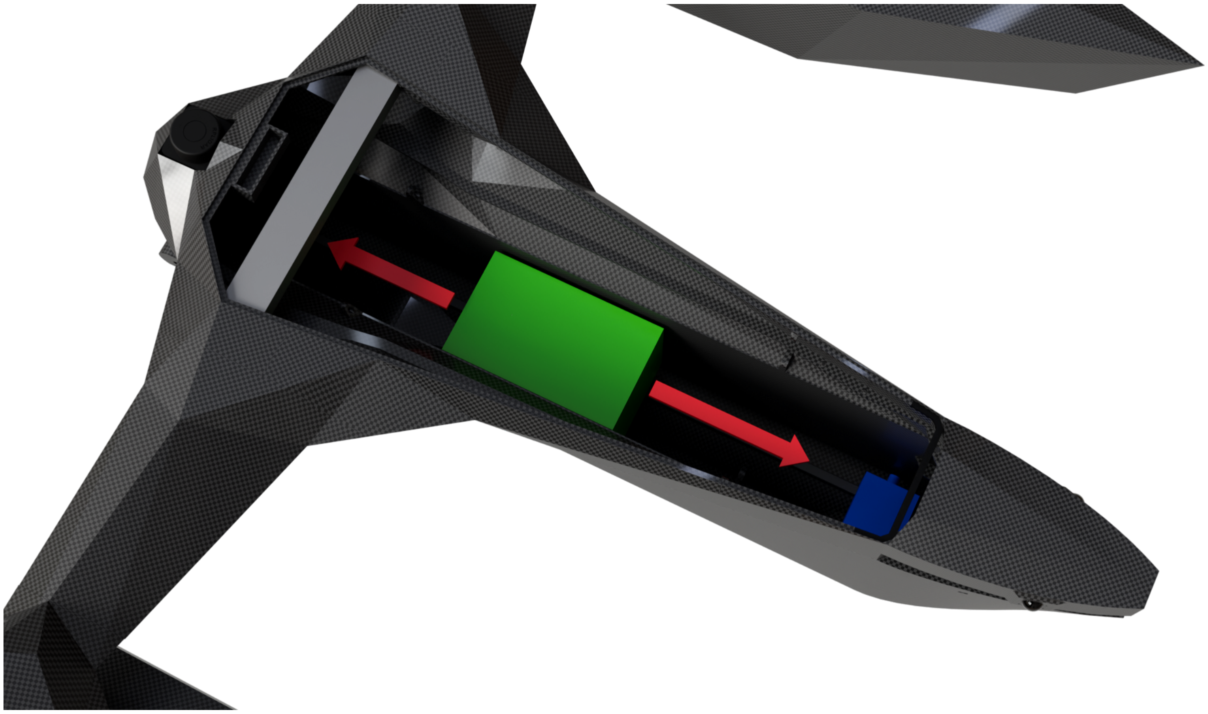


Figure 9: Battery [Green] moved by the nema23 [Blue]

We also have active roll and main hull buoyancy level control by linear actuators in the amas.

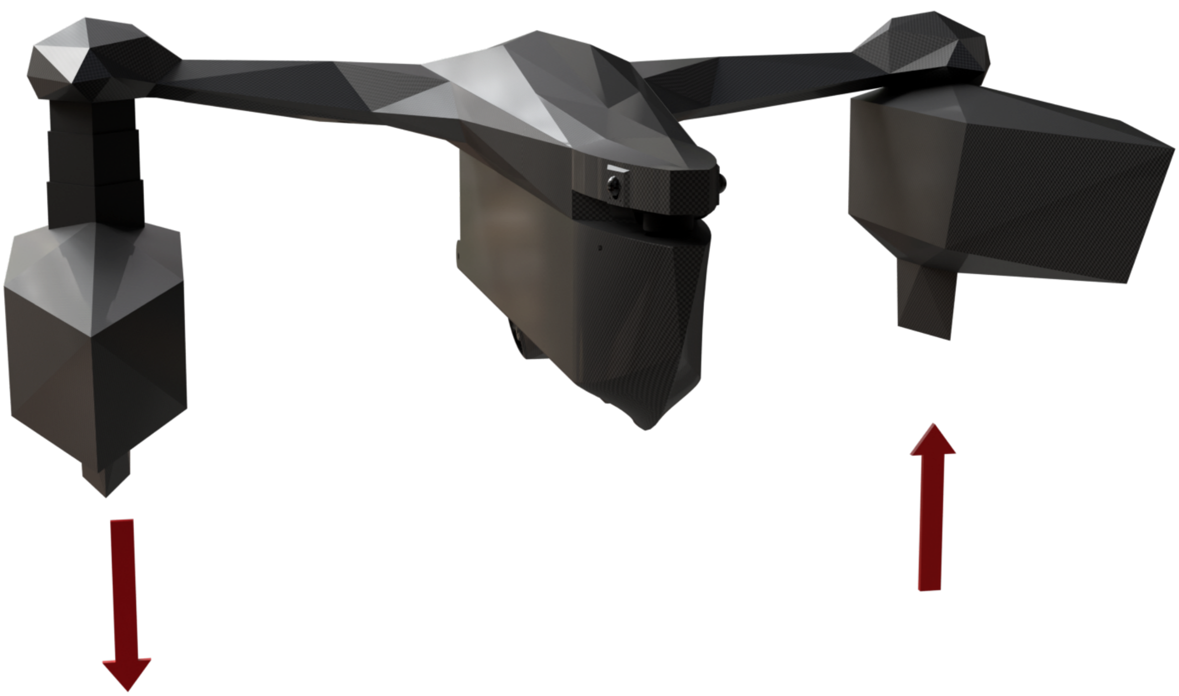


Figure 10: Roll control by extending amas connections

Figure 11: LIION-Battery during assembly

2.4 Control unit

The ASV main controller consist of a Raspberry pi 5 for autonomy perception and pathfinding, and a Holybro pixhawk C6 PRO for PID control, motor motor mixing, GPS positioning and as the main IMU. The Pi and pixhawk communicate over the mavlink Protocol.

2.5 Drivetrain and battery

The ASV is Powered by a 12S12P samsung 35E LIION battery with a 150A BMS(Battery management system) from Daly with CAN communication to the main control unit. The whole battery is encased in a 3mm welded Aluminium fireproof box that also gives the battery a rigid structure to mount the battery to the Weight and pitch shift linear rail system. The 1.8KWh battery powers the main thrusters and the main controller and sensors through DC-DC converters.

The vessel uses two Flipsky 5085 140KV 2500W motors for main thrusters and a F2838 350kv 24V motor as a stern thruster. The boat steers with differential thrust and uses the Stern thruster for position hold and docking. The Motors are controlled using VESC 6.7 70A ESC controlled over the same CAN network as the BMS.

3 Software

3.1 GUI

Ligmax is planning on reusing a solution from a previous Ligmax project involving a 5G controlled UGV. UDP hole-punching was used to establish a direct connection between the UGV and the laptop ground station. The live camera feeds were displayed in a custom program, and the telemetry data was presented on a Flask server. Making a custom program with direct connection resolved in the lowest latency physically possible, something necessary for an UGV and advantage for an ASV interface.

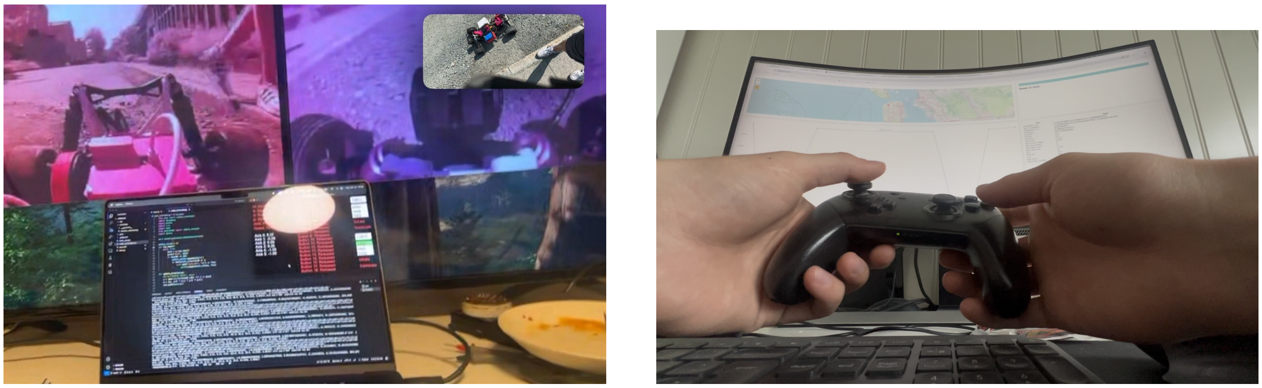


Figure 12: Live low latency camera feeds in custom program and backup control interface.

The UGV was also controlled by using a game controller over the low-latency direct link, a feature that will also be implemented in case backup manual control is needed. An backup flask server will also be created for extra data, ease of use, easy multiple connections, and also include a general safety fallback. This was something we also have a lot of experience using from earlier projects.

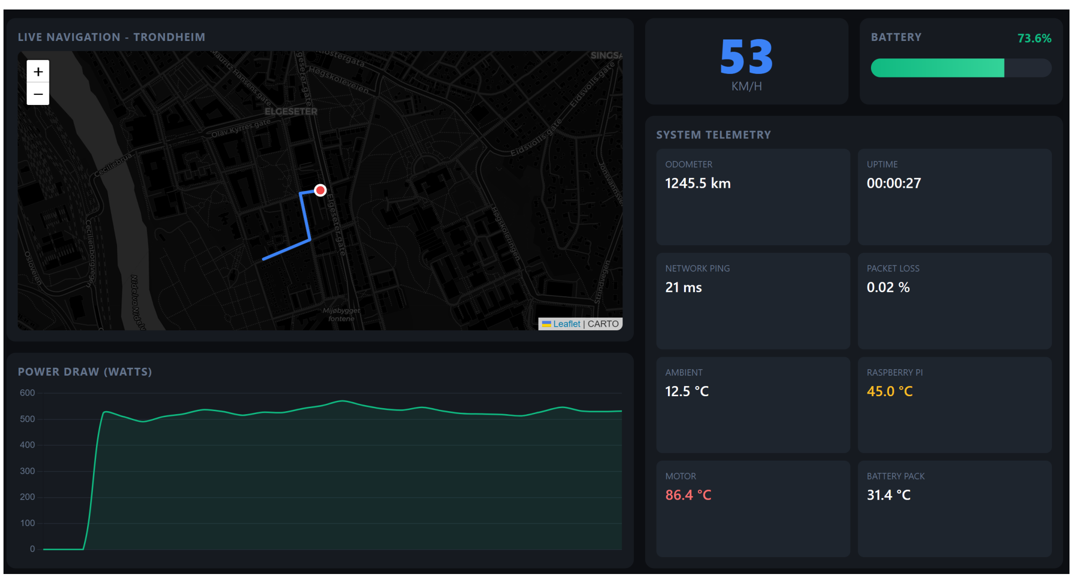


Figure 13: Flask server for UGV

3.2 Autonomy

For the self automatic driving the following technologies will be used, a deterministic algorithm for object detection using the lidar data, most likely an Euclidean Cluster Extraction algorithm. To detect the color of the identified objects, an non neural probabilistic algorithm on the cameras will be used. We will also deploy an small convolutional neural object detection network for fallback and cross referencing. This has proven successful in earlier projects.

4 Testing

4.1 Current testing

We have not tested the fully assembled ASV yet as is is not done, but we have tested a lot of the components individually. The battery is almost fully assembled and works as intended. The motors and ESC has been tested from the CANBUS raspberry pi hat. The Lidar camera and complete sensor system has been tested and communication between all the sensors and the main control unit already works as intended. In the figure below you can see an python plot of one of our lidars during testing.

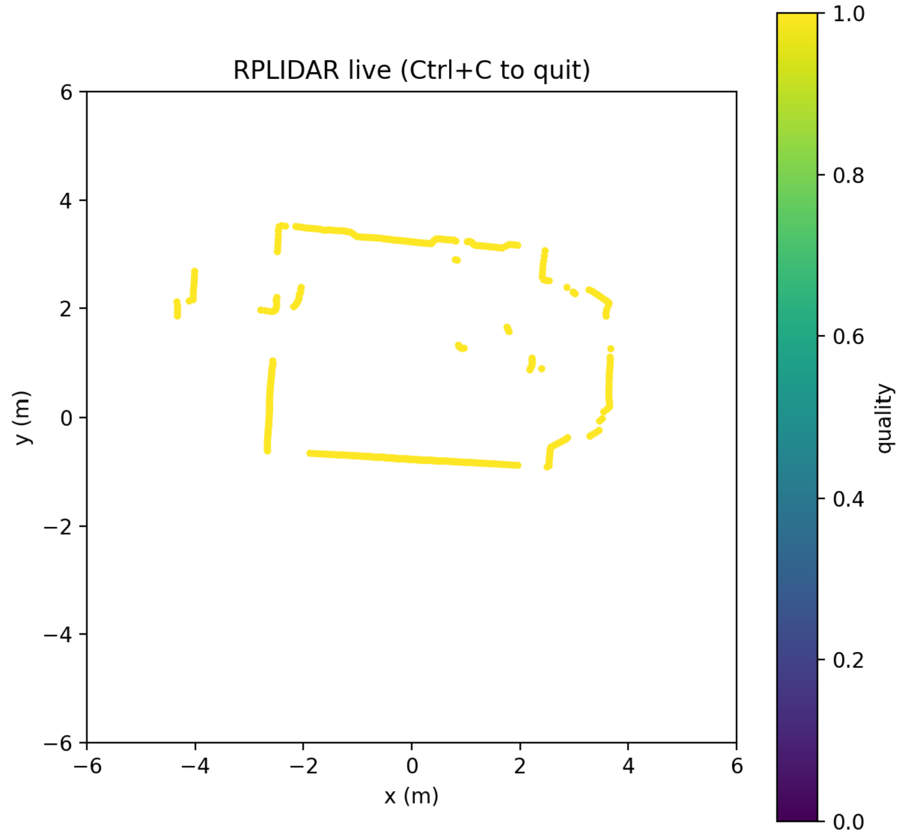


Figure 14: 2D Lidar visualizing a slice of our workshop

In the figure below, there is an example from our buoy detection algorithm.

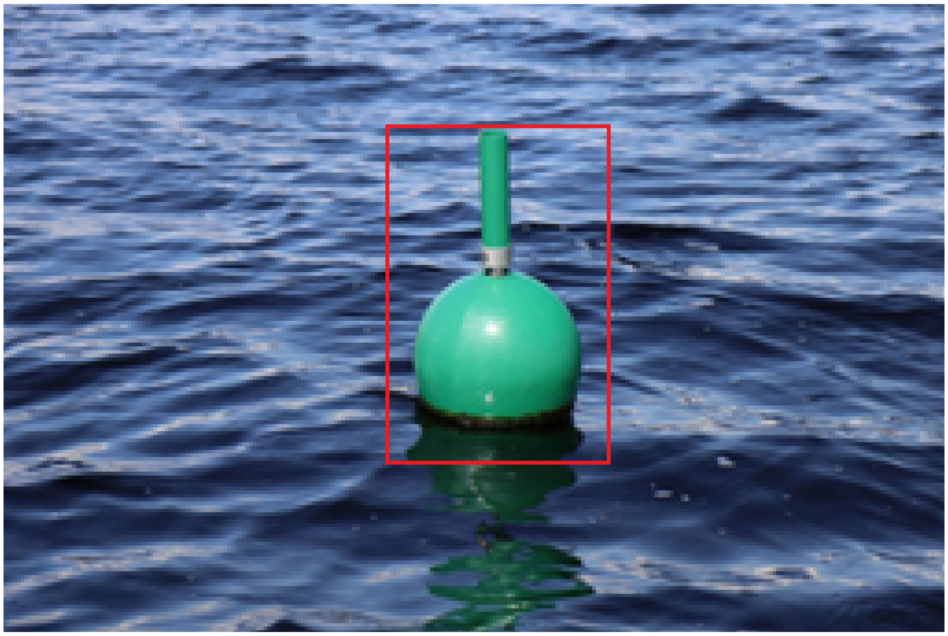


Figure 15: Buoys detection algorithm test

4.2 Future testing

Full system testing and course testing will be done using actual buoys in both Trondheim and Oslo. We also have access to indoor pools in Trondheim for early testing of the vessel.

5 Funding

Ligmax is entirely self-funded without external sponsors. All ASV components are already purchased, fully securing the vessel's equipment. As local Trondheim residents, the team requires no lodging or long-distance travel, and daily venue transport is handled via personal vehicles. Finally, sufficient capital is reserved to cover the deposit.