Requirement list:

1. The system shall perform real-time distance measurements one by one to at least three stationary beacons using ultrasonic signals.
    - 1.1 The system shall combine sonar ranging data with RTK-GPS and IMU orientation data to give accurate 3D position.
        - 1.1.1 The system shall achieve a ranging accuracy of ±50 cm.
    - 1.2 The system shall provide a structured output dataset suitable for 3D underwater SLAM research.
    - 1.3 The system shall implement Frequency Division Multiple Access (FDMA) to distinguish signals from multiple beacons.
    - 1.4 The system shall use FFT-based spectral analysis and/or band-pass filtering to process sonar signals and extract time-of-flight (ToF) data.
    - 1.5 The system shall support time synchronization mechanisms to ensure sensor alignment.
        - 1.5.1 The system shall operate at a minimum data acquisition rate of 1Hz (at least one measurement per second).
    - 1.6 The system shall resist background noise from water flow or other sonar systems.
    - 1.7 The system shall record and store synchronized sensor data (sonar, IMU) for processing and analysis.
    - 1.8 The system shall operate in freshwater environments without significant signal degradation.

2 The system shall perform well without error underwater.
    - 2.1 The system shall comply with safety regulations for underwater robotics and sonar equipment and environmental protection laws.
    - 2.2 The system shall maintain stable operation under varying environmental conditions, including minor water flow disturbances.
    - 2.3 The system shall achieve reliable communication with beacons within a range of 100 meters.
    - 2.4 The system shall function at depths of up to 50m meters without performance loss.
    - 2.5 The system shall be capable of continuous operation for at least 10 hours without failure.
    - 2.6 The system shall have redundant data logging to prevent data loss in case of power failure.
    - 2.7 The system shall be designed for easy maintenance and allow replacement of

individual sensors or processing units.

Need list:

N1: locate underwater robot accurately.

N2: no cross talking between beacons.

N3: Real time tracking while robot is moving.

N4: avoid transmission error via signal encoding and processing.

N5: cause no damage to the environments.

N6: Good underwater performance and ability to be used for long periods of time.

RBS: