Requirement list:

1. The system shall perform real-time distance measurements one by one to at least three stationary beacons using ultrasonic signals.
   1. The system shall combine sonar ranging data with RTK-GPS and IMU orientation data to give accurate 3D position.
   2. The system shall achieve a ranging accuracy of ±50 cm.
   3. The system shall provide a structured output dataset suitable for 3D underwater SLAM research.
   4. The system shall implement Frequency Division Multiple Access (FDMA) to distinguish signals from multiple beacons.
   5. The system shall use computational power that is suported by the stm32 chip
   6. The system shall support time synchronization mechanisms to ensure sensor alignment.
   7. The system shall operate at a minimum data acquisition rate of 1Hz (at least one measurement per second).
   8. The system shall resist background noise from water flow or other sonar systems.
   9. The system shall record and store synchronized sensor data (sonar, IMU) for processing and analysis.
   10. The system shall operate in freshwater environments without significant signal degradation.
2. The system shall perform well without error underwater.
   1. The system shall comply with safety regulations for underwater robotics and sonar equipment and environmental protection laws.
   2. The system shall maintain stable operation under varying environmental conditions, including minor water flow disturbances.
   3. The system shall achieve reliable communication with beacons within a range of 100 meters.
   4. The system shall function at depths of up to 50m meters without performance loss.
   5. The system shall be capable of continuous operation for at least 10 hours without failure.
   6. The system shall have redundant data logging to prevent data loss in case of power failure.
   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:

