This project aims to overcome the inherent challenges of underwater exploration and reconstruction by utilizing cutting-edge imaging technology and sophisticated processing techniques. Our primary goal is to accurately reconstruct submerged objects and create precise 3D models of underwater environments, particularly focusing on recreating artifacts and objects from the submerged city of Poompuhar.

Key Objectives:

1. Reconstructing Submerged Objects: Using high-resolution underwater imagery to create detailed 3D models.

2. Enhancing Underwater Imagery: Employing advanced image processing techniques to improve image clarity and quality.

3. Accurate 3D Modeling: Leveraging specialized software tools like 3D Zephyr to ensure precise and comprehensive 3D reconstructions.

Workflow Overview:

1. Image Acquisition:

- Utilize a remotely operated vehicle (ROV) equipped with specialized underwater cameras.

- Capture high-resolution images from various depths and viewpoints to ensure comprehensive coverage.

2. Image Preprocessing:

- Enhance captured images using the Image Enhancement Tool, which incorporates five key algorithms: Automatic Color Equalization (ACE), Contrast Limited Adaptive Histogram Equalization (CLAHE), LAB Color Correction, Non-Local Dehazing (ND), and Screened Poisson Equation (SPE).

3. Feature Extraction:

- Extract significant features from preprocessed images to facilitate accurate 3D reconstruction.

4. Point Cloud Generation:

- Generate a sparse point cloud from the extracted features to establish the initial 3D structure.

- Refine the structure by creating a dense point cloud, ensuring detailed representation of the underwater scene.

5. Mesh Generation:

- Construct a mesh from the dense point cloud, forming the surface geometry of the 3D model.

6. Texture Mapping:

- Apply textures to the generated mesh, enhancing the visual fidelity of the 3D model by incorporating real-world image details.

Technologies and Tools Used:

Imaging Tools: High-resolution underwater cameras and ROVs.

Software: 3D Zephyr for 3D reconstruction and Meshlab for mesh processing.

Programming Languages: MATLAB and Python for implementing image processing algorithms.

Image Processing Techniques: Denoising (using Median, Gaussian, Wiener, and Average filters), Dehazing, ACE, CLAHE, LAB Color Correction, ND, and SPE.

Applications:

Marine Archaeology: Detailed 3D models aid in the study and preservation of submerged artifacts and structures.

Underwater Exploration: Enhanced imaging techniques improve the accuracy and reliability of underwater surveys.

Environmental Monitoring: Precise 3D reconstructions support the monitoring and analysis of underwater ecosystems.

Conclusion:

This project represents a significant advancement in the field of underwater imaging and reconstruction, providing valuable tools and methodologies for researchers and explorers. By combining state-of-the-art imaging technology with sophisticated processing techniques, we aim to illuminate the hidden wonders of the underwater world, contributing to the preservation and understanding of submerged heritage and biodiversity.

Feel free to explore the codebase, and refer to the attached documentation for detailed instructions on setting up and running the project. We welcome contributions and feedback to further enhance and refine our approach.