RoboEX: Advanced Meshing Project for Deep-Sea Mineral Harvesting

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Company Overview

RoboEX is a pioneering company dedicated to advancing deep-sea mineral harvesting technologies. Our cutting-edge solutions integrate robotics, AI, and marine engineering to facilitate the safe and efficient extraction of valuable minerals from the ocean floor. With a focus on sustainability and innovation, we aim to redefine subsea exploration and resource utilization.

Project Background

As part of our ongoing research and development efforts, RoboEX is working on deploying two key components into deep-sea environments:

1. **A Submersible Spherical Tank** – Designed to withstand extreme underwater pressures while securely storing harvested materials.
2. **A Humanoid Robot** – Engineered to perform delicate underwater operations, including mineral extraction and sample collection.

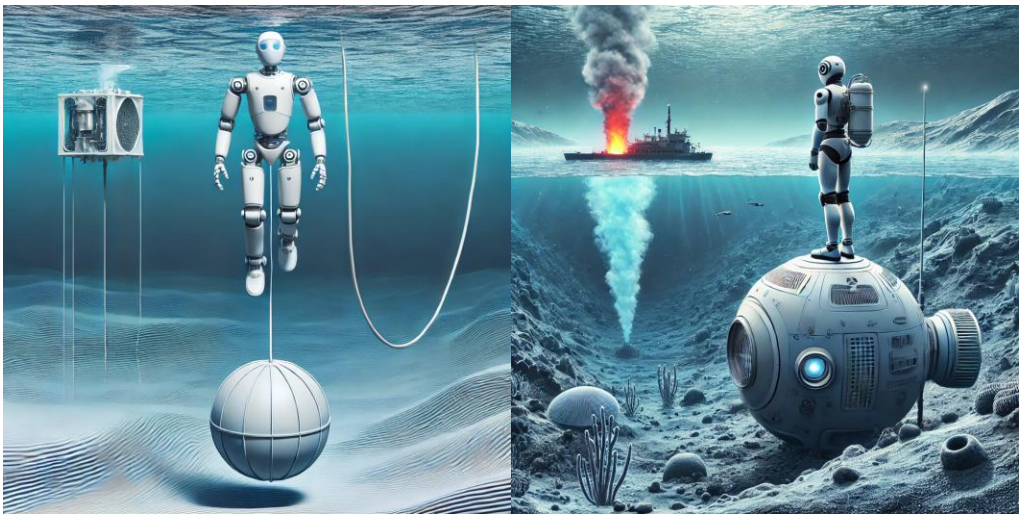
To ensure the structural integrity and hydrodynamic efficiency of these systems, we require high-quality meshes for computational simulations.

Updated Project Details

The problem initially involves lowering the humanoid robot and sphere into the ocean to a depth of about **4 km**. They will descend at an average speed of approximately **2 m/s**. During this descent, the primary concern is the **pressure effects** rather than viscous effects. The system must regulate the internal pressure of these objects to match the surrounding ocean pressure, requiring an accurate **pressure solution** around the objects.

Once at the bottom of the ocean, the robot will **attach inside the sphere**. A lava vent at the ocean floor generates **substantial temperatures and thermal gradients**, necessitating careful **thermal management** of the system. The integration of the two objects is determined by their **relative centroid positions**, and a **thermal solution** for the combined system's behavior is required.

A **set of properties** for the surface mesh can be provided, but the contractor must determine specific properties necessary for the simulations.



Current Status & Challenges

A previous engineer initiated the development of a custom meshing algorithm capable of generating volume meshes from a given surface representation. A set of two meshes that the contractors may find useful is also available upon request. However, due to unforeseen circumstances, the engineer departed from the project before any further clarification regarding the mesh and development strategies was communicated. As a result:

- The meshing code exists but remains untested and unverified.
- The company lacks internal expertise to evaluate, debug, and optimize the mesh manipulation and storage.
- Efficient **storage, manipulation, and handling** of large meshes must be ensured to facilitate **high-performance simulations** and minimize computational overhead.

Scope of Work

We are seeking an experienced **computational geometry and meshing specialist** to:

1. Review & Validate Existing Code and Mesh

- Identify any potential flaws, inefficiencies, or missing functionalities.

2. Enhance, Optimize, or Develop a New Mesh Manipulation and Management Strategy

- Ensure efficient storage, retrieval, and manipulation of large-scale meshes.
- Optimize computational efficiency, ensuring minimal memory overhead and fast processing times.
- Implement **efficient data structures** to handle large unstructured meshes for seamless integration.
- If the existing algorithm proves inefficient or impractical, propose and develop an alternative.

3. Generate & Deliver High-Quality Meshes

- Produce or use existing meshes for both the **spherical tank** and **humanoid robot**.
- Demonstrate the efficacy of mesh storage and handling architecture quantitatively.

Ideal Candidate Qualifications

- Strong background in **computational geometry, meshing algorithms, and numerical simulations**.
- Proficiency in **C++/Python** for mesh generation and computational modeling.
- Experience with **mesh viewing tools such as Paraview**.
- Knowledge of **CFD, FEA, and structural analysis techniques**.
- Expertise in **efficient data structures** for large-scale mesh handling and storage.
- Knowledge of **ocean engineering, hydrodynamics, and underwater robotics** is a plus.

Project Timeline & Deliverables

We aim to have a **functional and verified meshing system within 3 weeks**. Key deliverables include:

- A presentation with a live coding demo and a **report on findings**.

- Optimized **data structures** for efficient mesh storage and manipulation.
- **Demonstrate ability to manipulate meshes** for both submersible components.
- **Comprehensive documentation** demonstrating manipulation of the generated mesh and usage instructions.

Compensation & Engagement

This position is open for **contract-based work**, with **competitive compensation** depending on experience and project deliverables. Remote collaboration is acceptable, but occasional in-person meetings may be required.

How to Apply

For further inquiries, please contact **makessense@tamu.edu**.