<u>Problem Statement-1</u>

[Amphibian robot]: UAUV-Unmanned Underwater Vehicle

I. Problem Statement

Design and deploy a fully autonomous aerial and then submersible vehicle capable of detecting, safely acquiring predefined object inside the water, to its initial launch site. The system must execute this mission without human intervention, relying entirely on onboard processing, computer vision, autonomous navigation, and robotic manipulation to secure the payload under adverse aerial and aquatic conditions.

II. Approaches, not linited to the following, may be needed

Computer Vision & Object Recognition: Identifying a known 3D geometry in a visually adverse, refractive, and potentially turbid aquatic environment (Fountain region near PK Kelker library IITK).

Autonomous Navigation & Inference: Real-time decision-making, path planning, and spatial awareness underwater.

Mechatronics & Robotics: Designing a manipulation system capable of securely gripping both rigid and compliant materials without causing damage.

Systems Engineering & Optimization: Balancing form factor compactness, buoyancy control, hydrodynamic efficiency, and power/energy management (BMS: battery management system).

III. Technical Specifications of the problem statement

1. The Target Payload

The submersible must be capable of retrieving an object meeting the following constraints:

Dimensions: Up to 10cm x 10cm x 20 cm.

Weight: Maximum of 1kg (in air).

The object may be highly geometric (Cartesian) or highly irregular (e.g., biologically analogous shapes, such as a human head). Team may consider any of these shape and showcase precise application of whole project's working demonstration.

Application example: The target must be treated as a high-value, sensitive payload (e.g., simulating a fragile biological specimen, a precious artifact, or an unexploded ordnance). It must not be crushed, punctured, or dropped during transit.

2. The Submersible Vehicle

Autonomy: The vehicle must be fully autonomous from the moment it breaks the water's surface. No tethers for communication or external remote controls are permitted.

Depth Capabilities: The system must be capable of operating at submerged depths ranging from 1 meter to 2 meters.

The final prototype demonstration and competitive trials will be conducted in the water feature located in front of the Kelkar Library. Teams must account for the specific environmental variables of this location, including varying light refraction, ambient water currents (from fountain pumps), and specific depth profiles of the fountain basin.

IV. Evaluation Metrics & Competition Criteria

(Single successful retrieval out of 3 trials) Reliability and Safety in Recovery (Primary): The submersible's ability to consistently locate the object, secure it without inflicting structural damage, and successfully return it to the launch coordinates.

Mission Time (Secondary): The total elapsed time from the autonomous launch command to the successful delivery of the payload back to the staging area.

Ingenuity and Cleverness of Implementation: The elegance of the engineering solution. This includes efficient code architecture, innovative gripping mechanisms, and creative use of sensors (e.g., sonar vs. optical).

V. Final Deliverables

Design Report and presentation at mid-term (6 months from start of project): Detailing system architecture, code repositories, CAD models, simulation demo

End-term- Working Prototype Demonstration: A live, autonomous run of the submersible retrieving the designated payload in the Kelkar Library fountain region