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Smart Anchorless Marker Buoy (S.A.M.B.)

A small buoy with a big mission.
-RJ Bailey

Group : RJ Bailey, Taha Bilal, James Ward, Brandon Stuck
Advisor: Dr. W. Steven Gray
Funding: ODU ECE Department, Dr. W. Gray,
ODU Engineering Dean's Office

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Outline

1. Design Objectives
2. Design Methodology
3. Project Management
4. Ethics
5. Standards
6. Broader Impact

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1. Design Objective

- Develop an autonomous buoy system capable of maintaining GPS position without a traditional anchor.
- Integrate thrusters to dynamically hold the buoy’s position in varying maritime conditions.
- Incorporate solar panels for sustainable energy storage and continuous operation.
- Utilize microcontrollers for reliable signaling, control, and data communication.
- Enhance safety in marine environments through stable and self-correcting operation.
- Ensure easy deployment and reduced setup complexity compared to anchored systems.
- Provide a sustainable, self-powered solution for coastal and offshore monitoring applications.

2. Design Methodology

- Research and Planning – We first studied how regular buoys work and what causes them to drift. This helped define what features were needed for an anchorless version.

- Subsystem Design – The buoy is divided into smaller parts (power, computer, GPS/indicator, propulsion, safety, and structure). Each team member designs and tests one part before combining them.

- Integration and Control – The computer uses GPS data to detect movement. If the buoy drifts, the control system automatically powers the thrusters to bring it back to its original position.

- Power and Sustainability – Solar panels recharge the onboard battery, keeping the system running day and night without outside help.

- Testing and Refinement – The final design will be tested in calm water first, then adjusted for stronger currents and real-world conditions.

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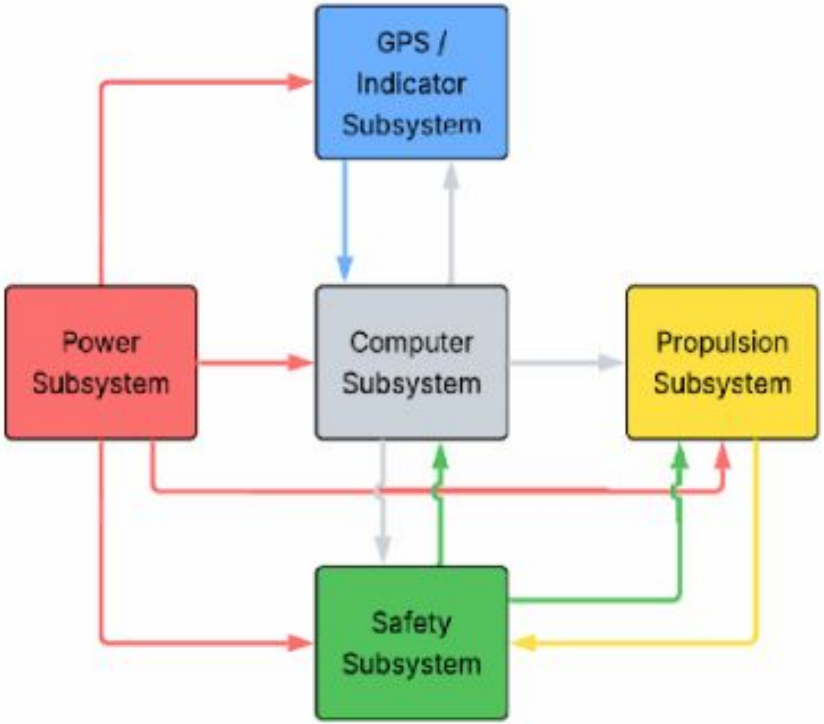
2.1 Functional Block Diagram



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2.1.1 Power Subsystem

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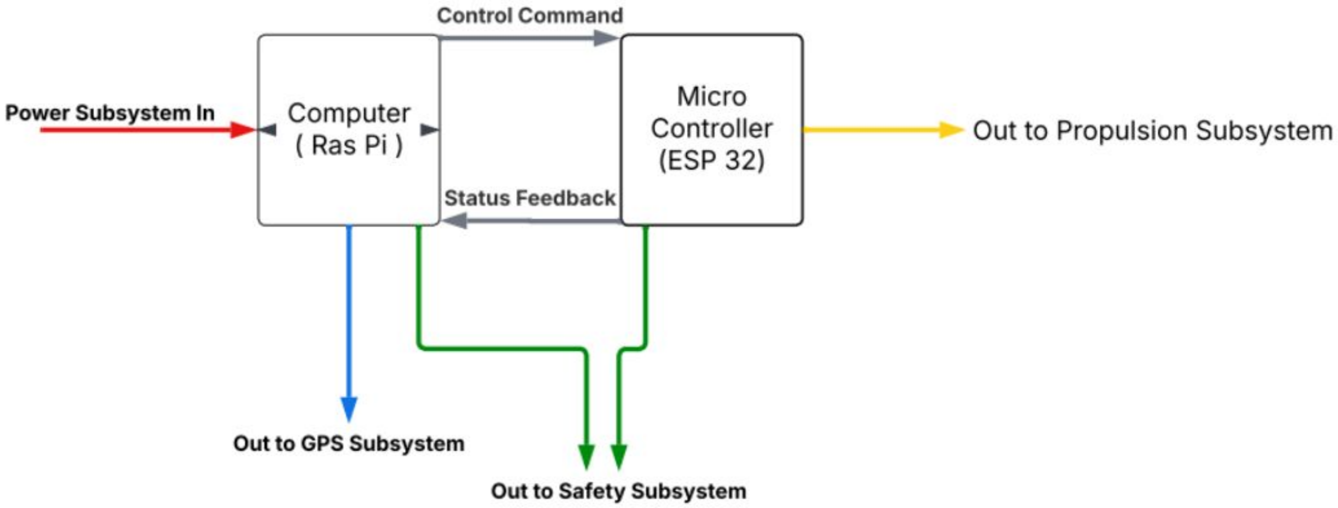
2.1.2 Computer Subsystem



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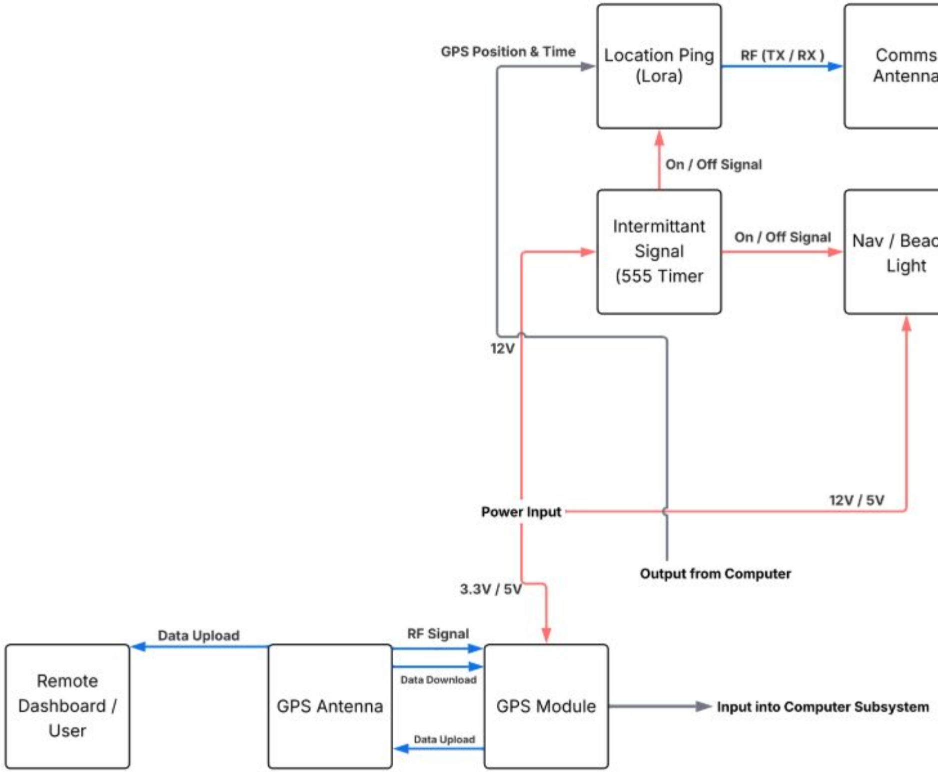
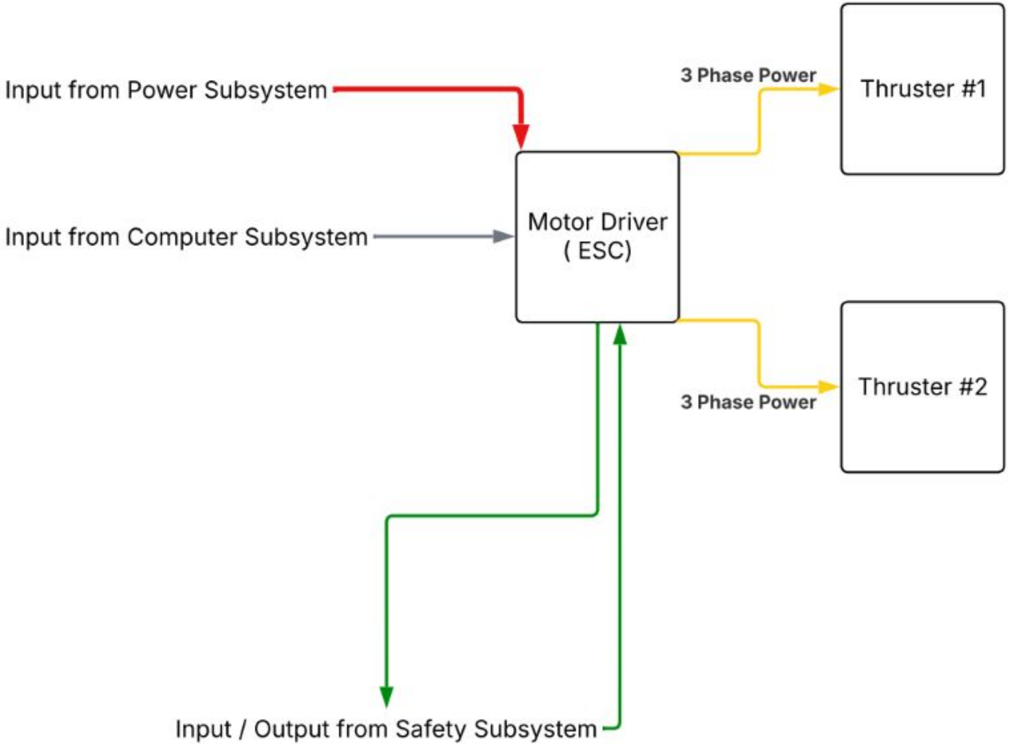
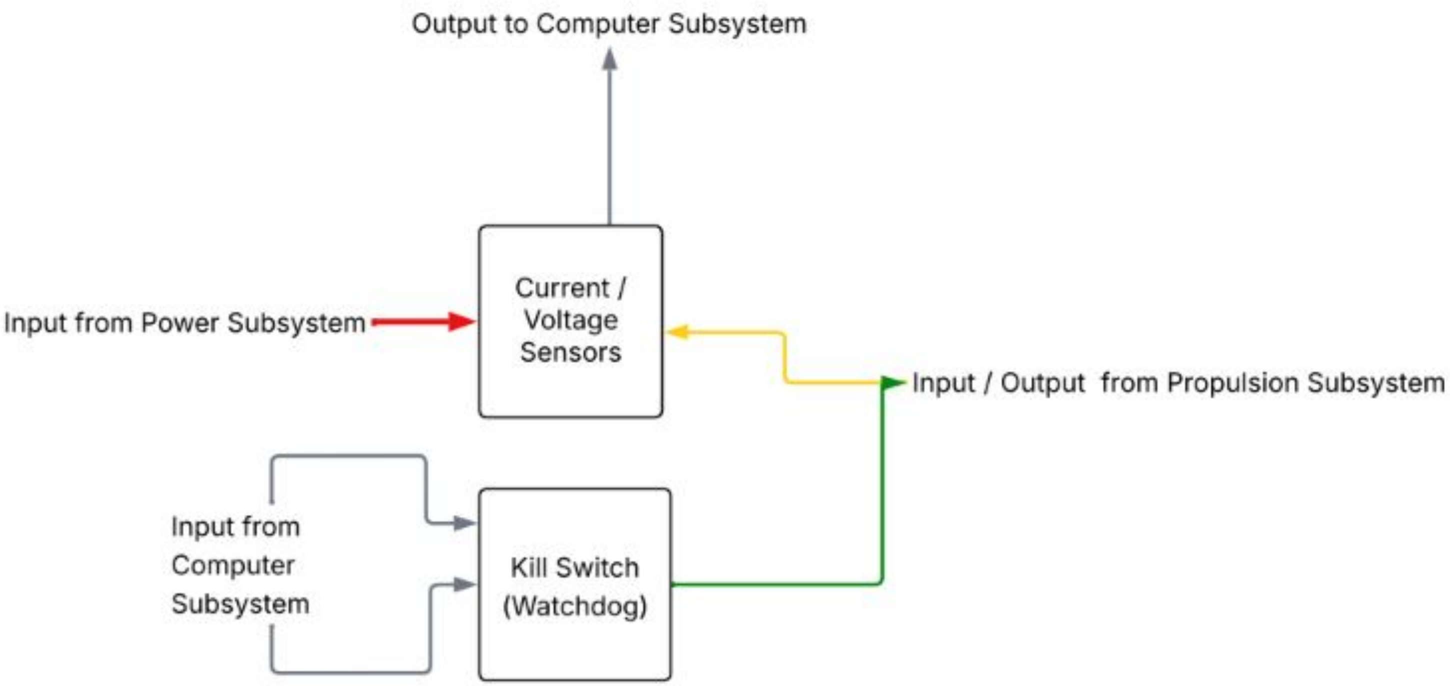
2.1.3 GPS / Indicator Subsystem



2.1.4 Propulsion Subsystem



2.1.5 Safety Subsystem



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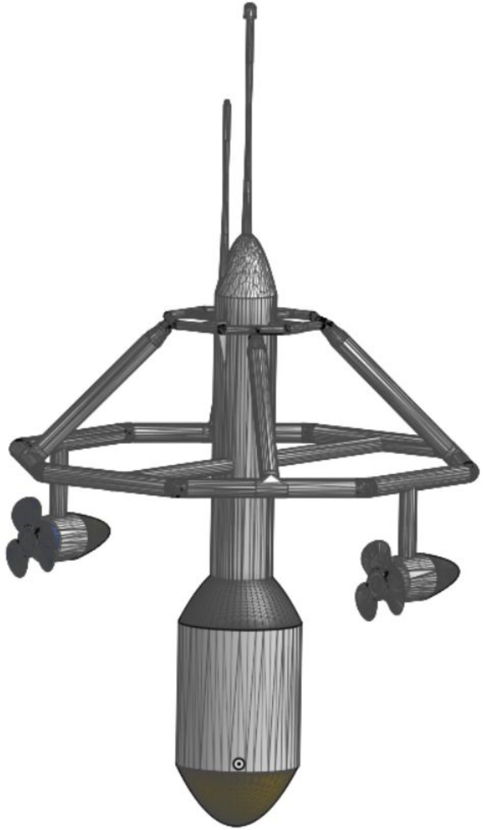
2.1.6 Expected Model



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3. Project Management

- Weekly meetings to coordinate progress and address issues.
- Shared documentation for tracking design changes and integration steps.
- Clear task ownership for each subsystem to avoid overlap.
- Milestone-based workflow: design → build → test → refine.
- Regular check-ins with Dr. Gray for design validation and guidance.
- Continuous integration approach.
- Transparent communication and accountability within the team.

3.1 Timeline

SMART ANCHORLESS MARKER BUOY

Group Members: RJ Bailey, James Ward, Taha Bilal, Brandon Stuck
Advisor: Dr. W. Steven Gray
Legend: Planned Duration | Actual Duration
Project Start Date: 8/26/2025
Project End Date: 5/10/2026

Activity Number	Activity Name	August	September	October	November	December	January	February	March	April	May
1	RESEARCH AND DESIGN										
1.1	System Requirements Definition										
1.2	Subsystem Concept Design										
1.3	Design Simulation and Modeling										
1.4	Power System Design										
2	CLASS ASSIGNMENTS										
2.1	Ethics Paper										
2.2	Standards Paper										
2.3	Midterm Proposal Paper										
2.4	Midterm Presentation										
2.5	Midterm Report										
2.6	Final Proposal Paper										
2.7	Final Presentation										
2.8	Final Report										
3	ORDERING AND REQUISITIONS										
3.1	Submit Component Orders										
3.2	Receive and Inspect Materials										
4	FABRICATION										
4.1	Power Subsystem Assembly										
4.2	Computer & Control System Assembly										
4.3	Thruster and Safety System Assembly										
4.4	Full System Integration										
5	TESTING AND VALIDATION										
5.1	Prototype Dry Testing										
5.2	Field Testing and Data Collection										
5.3	System Validation & Final Adjustments										

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3.2 Individual Work Assignments

Team Member	Role	Responsibilities
RJ Bailey	Team Lead	System architecture, power & compute subsystems, integration, test plans, hardware assembly & hull assembly
Taha Bilal	Member	Movement & safety subsystems, thruster and fuse design, Waterproofing, hardware assembly & hull assembly
James Ward	Member	GPS & UI subsystems, telemetry integration, LoRa and GNSS setup, hardware assembly & hull assembly
Brandon Stuck	Jr. Member	Beacon subsystem, junction box layout, hardware assembly & hull assembly

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3.3 Awarded Funding

Subsystem	***Cost***
ODU Engineering Dean's	$650
ODU ECE Department	$300
Dr. W. Steven Gray	$300
Total	$1250

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3.4 Anticipated Costs

Some ways we could decrease costs to better align with our awarded funding might include:

- Use cheaper materials.
- 3D-print Parts and Brackets.
- Reuse leftover materials from labs or the machine shop.
- Simplify the frame to reduce panels and hardware
  Use off-the-shelf components (PVC elbows, ABS tubing, premade boxes).
- Build a smaller-scale hull for prototype testing.
- Avoid expensive machining; use simple cuts where possible.

Subsystem	***Cost***
Computer	$124
Propulsion	$206
GPS/Communications	$147
Power	$295
Safety	$34
Structural Framework	$598
Cost Per Unit	**$1752**

4. Ethics

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IEEE Code of Ethics I.1:
To hold paramount the safety, health, and welfare of the public,to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment.

IEEE Code of Ethics I.5:
To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others.

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5. Standards

- **IEEE Std 1722 – Audio/Video Bridging Transport Protocol**
  - Provides a framework for time-synchronized, low-latency data transport, helpful for organizing sensor packets, timestamps, and movement commands.
- **IEEE Std 2030.5 – Smart Energy Profile**
  - Supports how the solar panel, charge controller, and battery interact safely.
- **IEEE Std 15288 – System Life Cycle Processes**
  - System-engineering standard that guides the entire life cycle of the buoy, from defining requirements to designing, testing, deploying, and maintaining the complete system.
- **IEEE Std 12207 – Software Life Cycle Processes**
  - Software-engineering standard that defines how the buoy's code should be planned, structured, tested and maintained throughout the full development cycle.

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5.1 Standards - Communication

- ***IEEE STANDARD 802.15.4 – Low-Rate WPANs***
  - Large range network, small data = LR-WAN.
  - Broadcasting must be 915 MHz at 20 dBm power.
  - WAN vs. WPAN: must use different standard for longer range.
- ***FCC AND LORA PROTOCOL***
  - Applies to long-range communication between user and buoy.
  - FCC limits band of radio signals for public use.
  - LoRa serves ranges of radio signals for public use.

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6. Broader Impacts

- ***Environmental – Protecting Marine Ecosystems***
  - Eliminates need for anchors, preventing seabed damage.
  - Uses solar power, reducing carbon footprint.
  - Supports clean, renewable ocean technology.
- ***Economic – Lower Costs and Greater Efficiency***
  - Reduces maintenance trips and fuel expenses.
  - Provides affordable monitoring for marine industries.
  - Promotes innovation with commercial potential.
- ***Societal – Advancing Safety and Research***
  - Improves maritime navigation and safety.
  - Enables real-time data for environmental studies.
  - Encourages STEM education and coastal sustainability.