AMITY UNIVERSITY MUMBAI

Techfest 2024

RowBoatics Design Report

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1. Introduction

This report details the design, structure, and functional aspects of an RC boat designed by team Octaknight. The design aims to achieve optimal hydrodynamic efficiency, stability, and manoeuvrability through precise dimensioning and strategic component placement.

2. Overall Structural Design

2.1 Proportional Dimensions

- Length: 20 cm.
- Width: 10 cm, calculated as half the length for proportional stability.
- Height: 7.5 cm, calculated as 75% of the width to maintain a low centre of gravity and minimize wind resistance.

Consistent Scaling Ratio: The scaled-down RC boat follows a **2:1:0.75** ratio like full-sized boats, ensuring predictable handling characteristics and uniform performance.

2.2 Sectional Division

The hull is divided into three primary sections:

- **Bow Section (0-7 cm):**

  Deadrise Angle: 22-24° for wave cutting.

  Height: Gradually increases from 3 cm at the tip to reduce water resistance and facilitate smooth entry into the water.

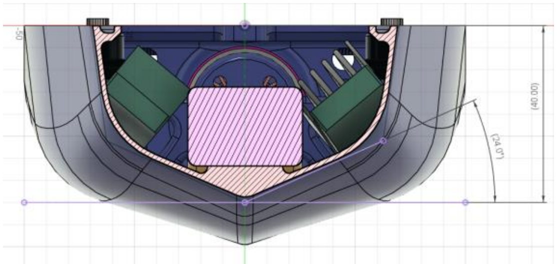

Fig 2.2.1: Cross section of Bow section.

- **Mid-Section (7-14 cm):**

  Deadrise Angle: 16-18°, acting as the primary planning surface for stability.

  Height: Reaches a maximum of 5.5 cm, allowing optimal space for key components and ensuring the centre of gravity is maintained low.

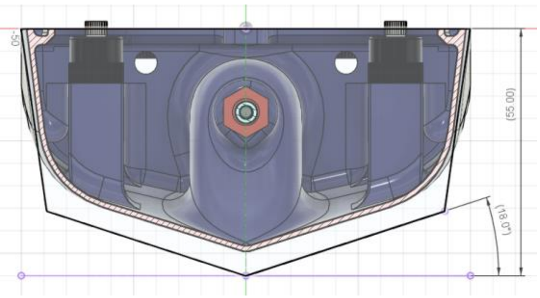

Fig 2.2.2: Cross section of Mid-section.

- **Stern Section (14-20 cm):**

  Deadrise Angle: 10-12° for speed enhancement.

  Height: Gradually decreases to 4 cm to facilitate smooth water release, reducing drag and preventing proposing.

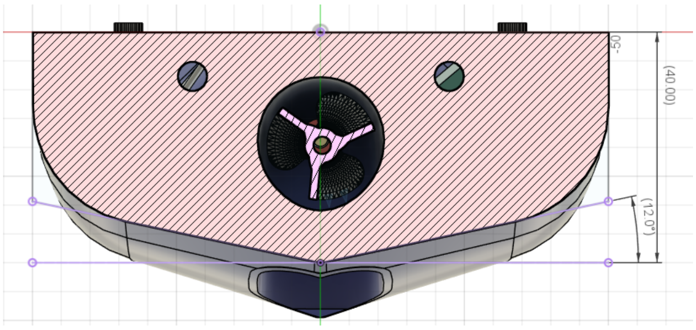

Fig 2.2.3: Cross section of stern section.

2.3 Height Transition

The boat's height transitions smoothly across sections:

- Bow (0-5 cm): Starts at 3 cm for a low profile and reduced wave resistance.
- Mid (5-15 cm): Peaks at 5.5 cm, offering space for electronics, motor, and battery placement while keeping the centre of gravity low.
- Stern (15-20 cm): Reduces to 4 cm, ensuring hydrodynamic efficiency and smooth water exit.

3. Key Components and Placement Strategy

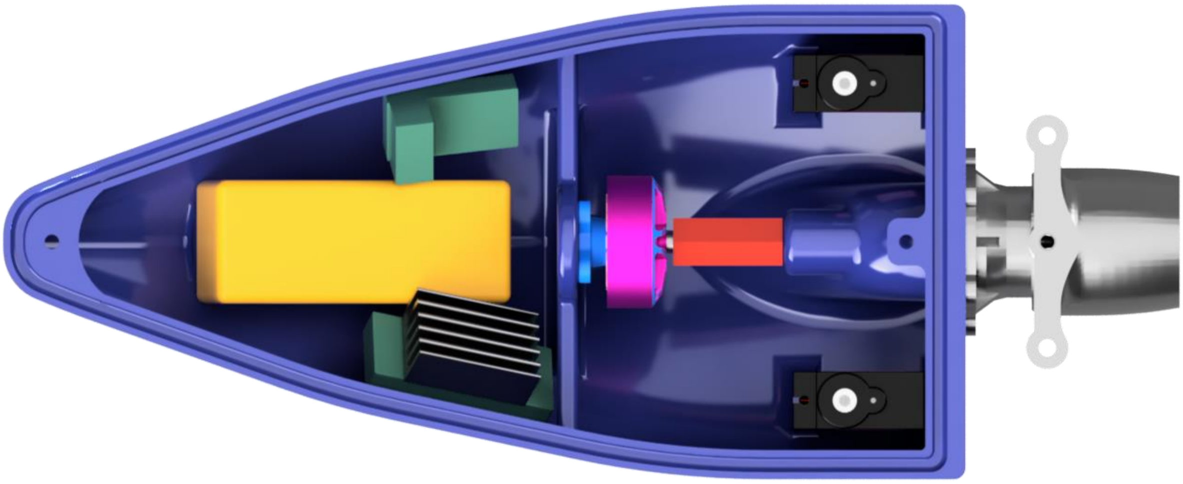

Fig 3.1: CAD render for component placement.

3.1 Battery Placement

Location: Positioned centrally above the keel line, just in front of the motor mount.

Purpose: Ensures a low centre of gravity, which helps with stability and reduces pitch sensitivity during acceleration and deceleration.

3.2 Motor Placement

Location: Placed slightly aft of the midpoint to align with the propeller shaft for efficient power transfer.

Purpose: Maintains weight balance, minimizing weight shift during thrust application.

3.3 Electronics

Design Principles:

- Use compact, lightweight components to prevent interference with the centre of gravity.
- Ensure all components are waterproofed with conformal coating and housed in modular compartments for ease of access and maintenance.

Features: Water-resistant conformal coating and plug-and-play wiring for quick assembly and repairs.

4. Materials and Construction

- Hull Material: The entire hull of the RC boat has been 3D printed using PLA (Polylactic Acid), chosen for its rigidity, ease of printing, and dimensional precision. PLA's compatibility with 3D printing allows for complex geometric shapes, ensuring accurate implementation of design features like deadrise angles, height transitions, and compartmental sections.
- Waterproofing: All electronic compartments are sealed with waterproof gaskets. Conformal coating applied to circuit boards protects them from moisture and corrosion.
- Propeller and Shaft: Stainless steel M3 Allen head bolt to maintain durability and prevent rusting.

5. Hydrodynamic Analysis

5.1 Deadrise Angles and Water Flow

The deadrise angles in each section are optimized for specific purposes:

Bow Section: The 22-24° angle is sharp enough for effective wave cutting, reducing forward resistance.

Mid-Section: The 16-18° angle offers stability and serves as the main planing surface, allowing the boat to maintain lift while minimizing drag.

Stern Section: The 10-12° angle flattens out to encourage high-speed planing, providing an efficient water release that prevents the stern from dragging.

5.2 Height and Stability

Height Progression: The gradual change from 3 cm at the bow to 4 cm at the stern ensures that the boat transitions smoothly through the water, maintaining balance and directional control.

Centre of Gravity: The design ensures a balanced centre of gravity to prevent tilting and promote stable movement even at high speeds.

6. Electronics and Control Systems

- Motor: RCINPOWER GTS V2 2207 Plus Motor - 2500KV

Fig 6.1: RCINPOWER GTS V2 2207 Plus Motor - 2500KV.

- Battery: Orange 11.1V 1000mAh 30C 3S LiPo Battery

Fig 6.2: 11.1V 1000mAh 30C 3S LiPo Battery.

- RF receiver: RadioMaster ER5C 5Ch 2.4GHz ELRS PWM Receiver

Fig 6.3: RadioMaster ER5C 5Ch 2.4GHz ELRS PWM Receiver.

- Servo Motors: Towerpro MG90S Micro Digital Servo Motor

Fig 6.4: Towerpro MG90S Micro Digital Servo Motor.

- ESC (Electronic Speed Controller): Racerstar RS80A V2 80A BLheli S Brushless ESC.

Fig 6.5: Racerstar RS80A V2 80A BLheli S Brushless ESC.

7. Propulsion and control system

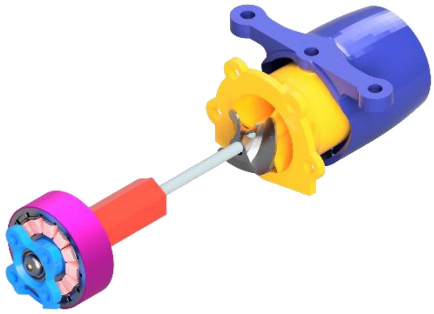

Fig 7.1: CAD render of propulsion system.

The BLDC motor is connected to the propeller shaft using a 3D-printed coupler. The shaft, a 40mm M3 Allen head bolt, is threaded into the propeller and secured with a nut. The yellow component in the diagram includes a flow-straightening structure designed to reduce rotational turbulence in the water flow exiting the propeller.

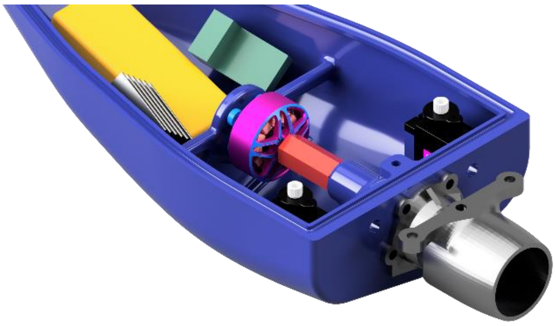

Fig 7.2: CAD render of control system.

The gray component shown in the diagram is a nozzle that swivels laterally, controlled by servos linked through control rods. This setup enables thrust vectoring, allowing the direction of the water flow exiting the propeller to be adjusted, which manoeuvres the boat in the desired direction.

8. Final CAD renders

Fig 8.1: Isometric view with top cover.

Fig 8.2: Top view without cover.

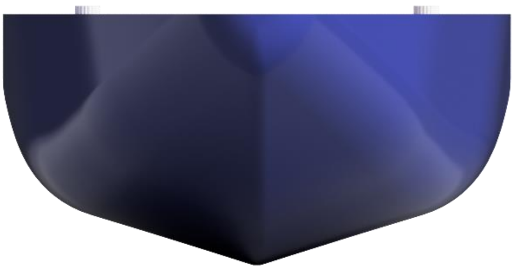

Fig 8.3: Front view.

9. Practical Testing and Expected Performance

Initial Testing: A water basin or pool test to evaluate balance, component placement, and waterproofing effectiveness.

Performance Metrics:

Speed: Achieved through efficient power-to-weight distribution and streamlined hull design.

Manoeuvrability: Tested through sharp turns and acceleration/deceleration trials.

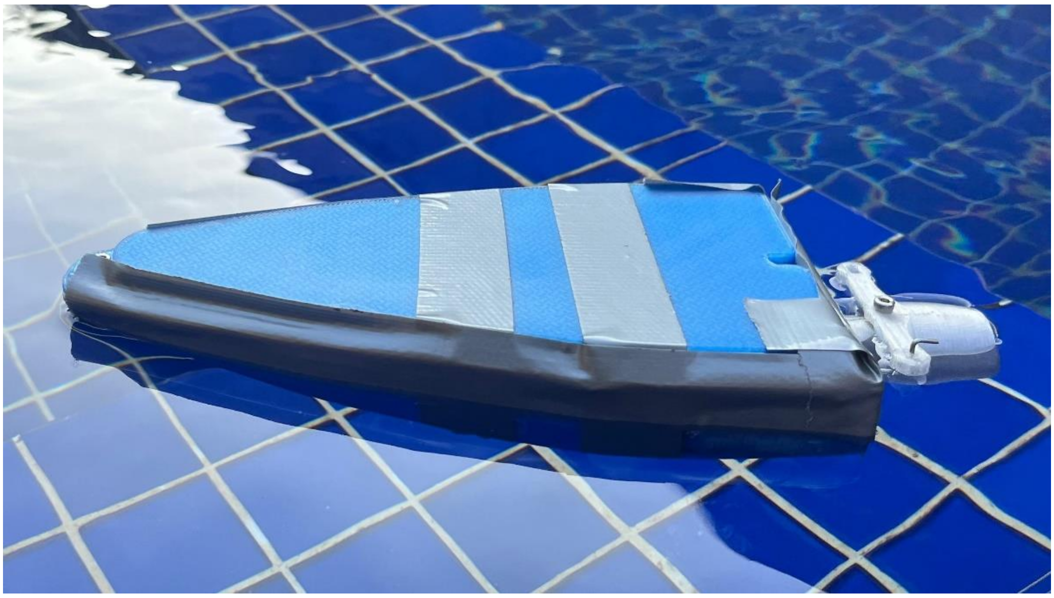

Fig 9.1: Practical testing 1

Fig 9.2: Practical testing 2

10. Safety and Waterproofing Features

Coating: Conformal coatings applied to protect circuits.

Sealing Mechanism: Rubber gaskets and secure latches prevent water ingress.

Emergency stop switch: A magnetically activated emergency stop switch to cut off battery power to all the electronics.

11. Conclusion

In conclusion, the RC boat by Team OctaKnight successfully combines stability, manoeuvrability, and efficient propulsion in a compact design. With its precise 2:1:0.75-dimensional ratio, the boat maintains a low centre of gravity, enhancing stability and reducing drag. The BLDC motor and thrust-vectoring nozzle enable responsive control, allowing sharp turns without the need for additional rudders. The hull's progressive deadrise angles provide smooth wave cutting, stability, and optimized speed, resulting in a well-balanced, high-performance model. Overall, this project reflects a carefully engineered approach to creating a robust and agile RC boat for controlled navigation.