

## Introduction & Background

### Problem Statement

Developing a drone-sized vehicle capable of seamless transition and operation in all three environments to solve real-world challenges.

### Constraints

Weight must not exceed 7 kg

Maximum system footprint of 1 m<sup>2</sup> in the base unit

Must operate in ambient temperatures up to 60°C

Must operate on basic rechargeable battery with maximum 10000 mAh capacity

Must rely on ESP32 or similar accessible microcontrollers

Signal transmission must maintain integrity up to 2-meter depth underwater

### Specifications

Maximum air speed of 5 m/s (18 km/h)

Maximum thrust-to-weight ratio of 1.5:1

Total weight is less than 7 kg

Maximum propellers diameter of 9 inch

Land speed of 3 m/s (10.8 km/h)

Maximum power consumption of 2000 W

Control system response time under 100 ms

Maximum air communication range of 500 m

Mode transition time under 5 seconds

Minimum continuous operational time of 12 minutes.

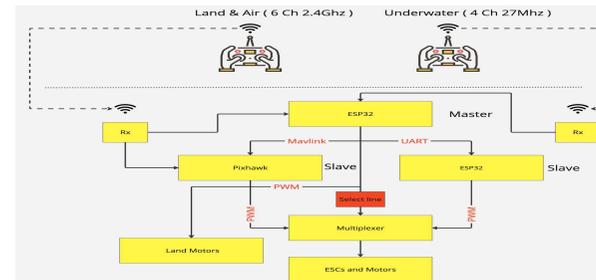
Maximum underwater depth of 2 m

## Prototype Design

### Anticipated Prototype



### Final Design Block Diagram



## Testing & Validation

### Air Test



Maximum air speed of 5 m/s (18 km/h) ✓

Maximum thrust-to-weight ratio of 1.5:1 ✓

Maximum propellers diameter of 9 inch ✓

Maximum air communication range of 500 m ✓

### Land Test



Land speed of 3 m/s (10.8 km/h) ✓

Total weight is less than 7 kg ✓

Minimum continuous operational time of 12 minutes ✓

Control system response time under 100 ms ✓

### Underwater Test



Maximum underwater depth of 2 m ✓

Mode transition time under 5 seconds ✓

Maximum power consumption of 2000 W ✓

Control system response time under 100 ms ✓

## Conclusions

**Versatile Multi-Environment Operation:** The TriRaptor seamlessly transitions between flying, driving, and diving modes in under 5 seconds, achieving all the intended specifications

**Efficient and Compact Design:** With a 12-minute continuous operation, the TriRaptor's ESP32-based control system and optimized components make it ideal for rapid search-and-rescue missions across diverse terrains.