

JALTHAL

Smart and Resilient Communities
Disaster Management

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The Problem

Floods are one of the most devastating natural disasters, affecting millions of people globally every year. In India alone, over 20 million individuals face the dire consequences of flooding annually, including loss of life, displacement, and damage to infrastructure. As climate change accelerates, the frequency and intensity of floods are increasing, overwhelming rescue services and leaving many stranded without immediate assistance.

Despite the growing threat, there is a lack of accessible, affordable, and adaptable solutions for personal vehicles to navigate submerged roads safely. This gap in preparedness puts lives at risk and creates a heavy dependence on emergency response teams, which are often delayed or unavailable during crises.

There is an urgent need for a practical, scalable solution that empowers individuals and reduces reliance on external help during flood situations.

The Solution: Overview

Jalthal is an attachable kit that can be mounted to work on any commercial car on the market. The kit that we will be providing will consist of Air Tubes, Multiple Depth Sensors, and Big Air Pumps. With this system, we can enable the car to float in the case of severe floods.

Our Objectives

1. Ensures Safety and Mobility
2. Reliable in Calamities
3. Affordable to the Public
4. Decreases Dependence on Emergency Vehicles

Working

- Depth sensors are strategically positioned around the vehicle, constantly monitoring water levels.
- When floodwaters rise above a critical threshold, Jalthal activates its Floatation Mechanism.
- The inflatable tubes, in order to provide essential buoyancy, allowing the car to float in this critical situation.

- We may also include customized paddle-like spokes to enable movement in water, mimicking the powerful strokes of a swimmer to push water backward and drive the vehicle forward.
- The driver will be able to manually deploy the floatation system, for redundancy.

Advantages

Ensures Safety: Prevents vehicle submersion, safeguarding passengers.

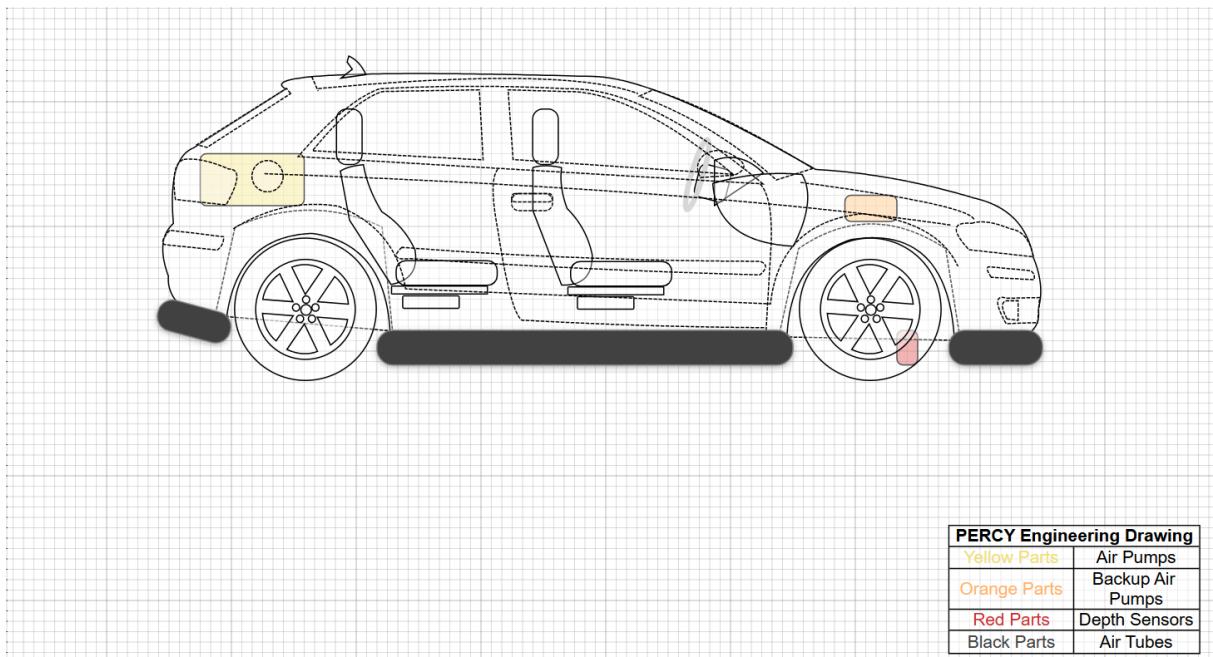
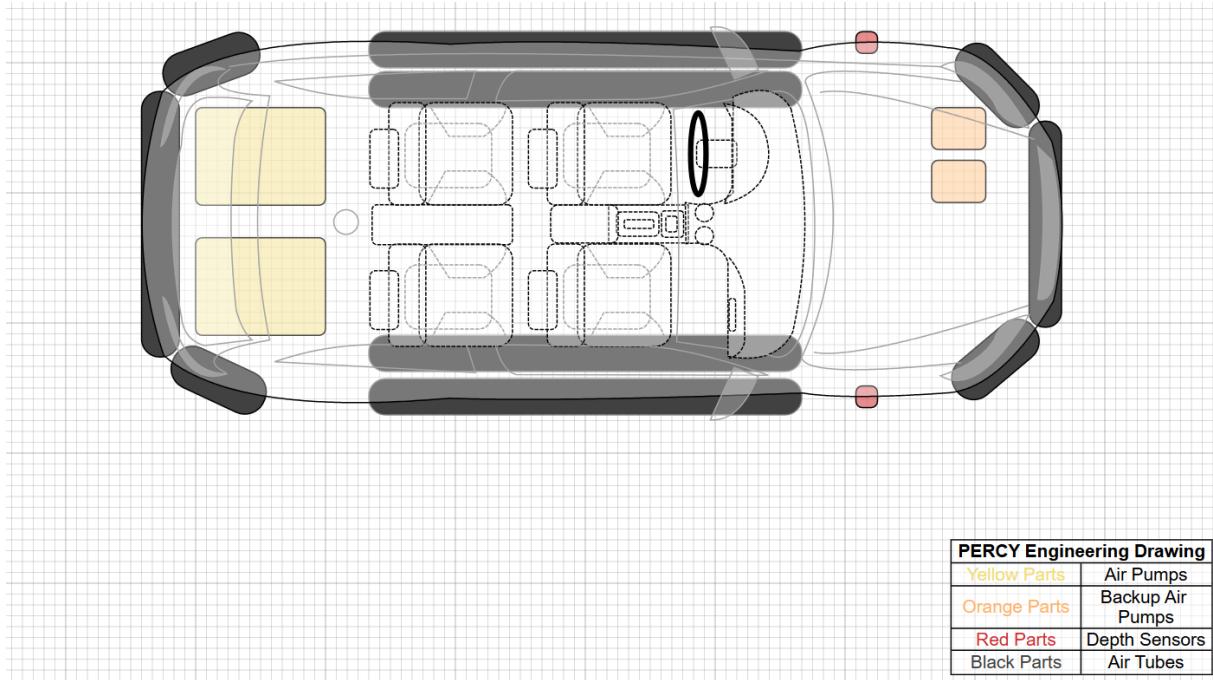
Universal Fit: Compatible with most commercial vehicles.

Cost-Effective: Affordable design for widespread accessibility.

Reduces Dependence: Minimizes reliance on emergency services.

Enhanced Mobility: Optional paddles enable navigation in flooded areas.

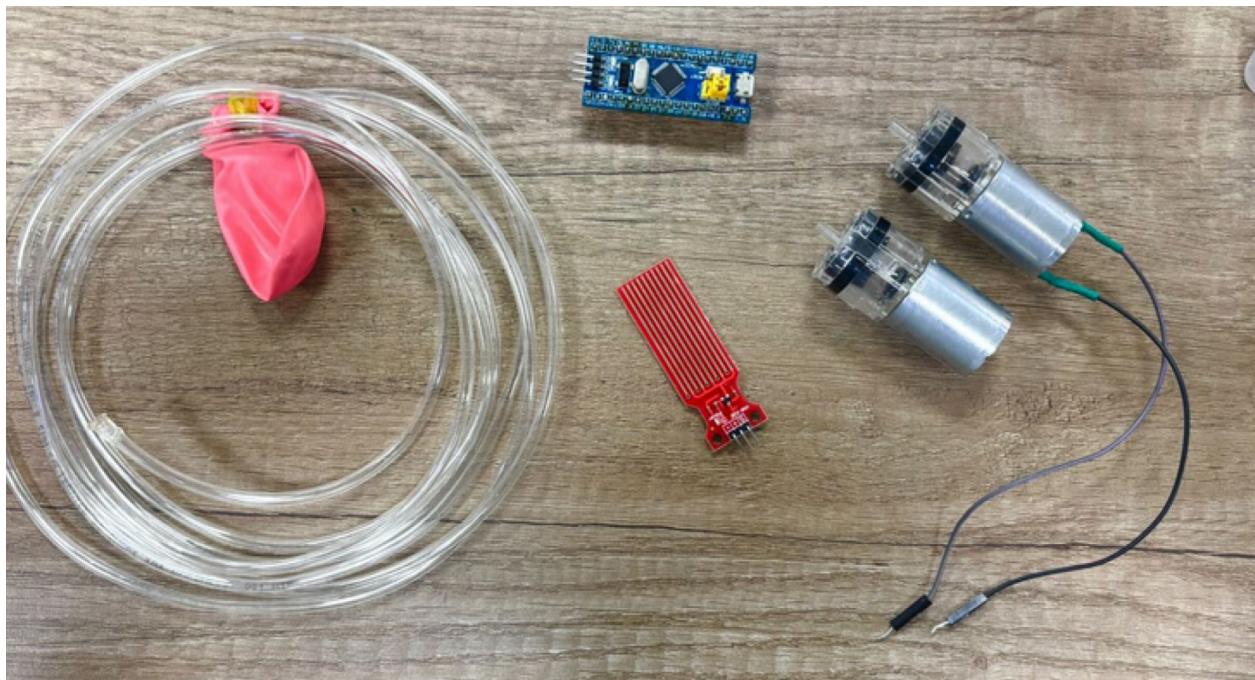
CAD Engineering Drawings

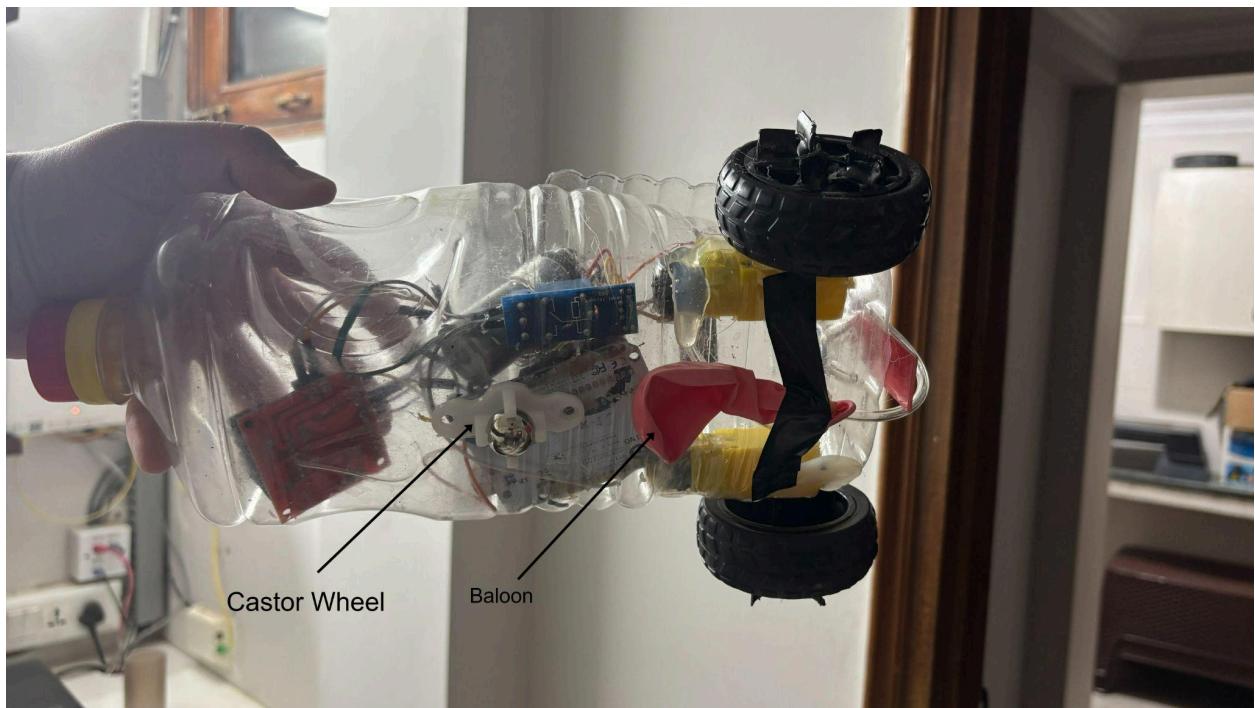


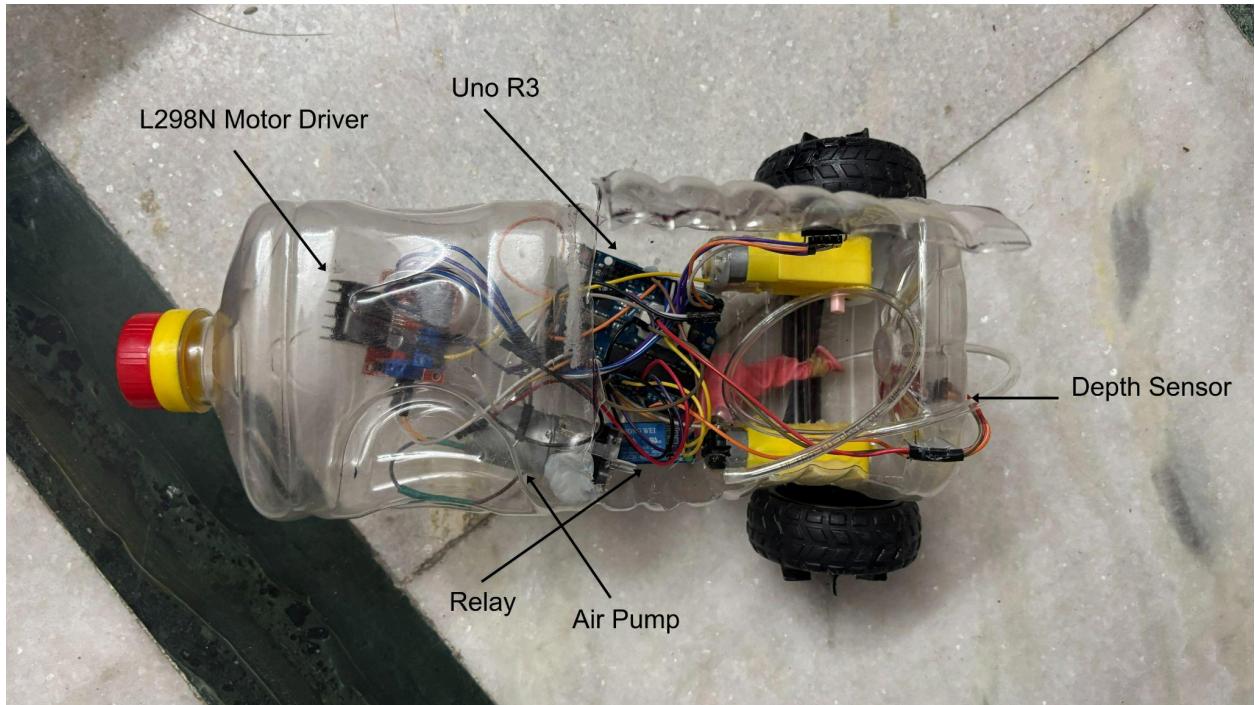
Our Mock-up Prototype

Components Used

Name	Quantity	Cost
Depth Sensor Arduino	1	Rs. 25.00
Uno R3 Clone Board	1	Rs. 205.00
Mini Air Pump	1	Rs. 69.00
Relay Module	1	Rs. 29.00
12V Li-ion Battery	1	Rs. 109.00
BO Motors	2	Rs. 112.00
Wheels for BO Motors	2	Rs. 24.00
Motor Driver	1	Rs. 70.00
HM-10 BLE	1	Rs. 109.00
Miscellaneous Parts (Includes Bottle, Glue, etc.)	1	Rs. 50.00
Total		Rs. 802.00







Potential Future Developments

- **Integrated Anchor System (IAS):** Designed to stabilize and secure the vehicle during floods. This provides users with the ability to fix their vehicle in place when needed. The anchor system ensures safety in strong currents and prevents drifting, offering greater control and peace of mind in extreme flood conditions.
- **GPS module with an SOS button:** This feature will enable users to transmit their real-time location to rescue teams or emergency contacts during floods, ensuring timely assistance in critical situations.

Buoyancy Calculations

Assumptions

1. **Car Weight (Unloaded):** 1,025 kg
 2. **Weight of Passengers (5 people):** $100 \text{ kg/person} \times 5 = 500 \text{ kg}$
 3. **Weight of Trunk Load:** 70 kg
 4. **Weight of Pumps (2 units):** $4.5 \text{ kg} \times 2 = 9 \text{ kg}$
 5. **Volume Submerged:** 1/6th of the car's volume is submerged in water, meaning buoyancy offsets 1/6th of the car's weight.
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Volume Submerged

Buoyancy Offset (from Archimedes' Principle)

- **Density of Water:** 1,000 kg/m³
 - **Submerged Volume:**
 $\text{Submerged Volume} = (1/6) \times (\text{Car Weight (Unloaded)} / \text{Density of Water})$
 $\text{Submerged Volume} = (1/6) \times (1,025 / 1,000) = 0.1708 \text{ m}^3$
 - **Buoyancy Offset:**
 $\text{Buoyancy Offset} = \text{Submerged Volume} \times \text{Density of Water} \times \text{Gravity}$
 $\text{Buoyancy Offset} = 0.1708 \times 1,000 \times 9.8 = 1,673.84 \text{ N}$
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Total Weight After Buoyancy Offset

Total Mass Without Headroom

- **Total Weight Before Offset:**
 $\text{Total Weight Before Offset} = 1,025 \text{ kg} + 500 \text{ kg} + 70 \text{ kg} + 9 \text{ kg} = 1,604 \text{ kg}$
- **Weight After Buoyancy Offset:**
 $\text{Weight After Offset} = \text{Total Weight Before Offset} - (\text{Buoyancy Offset} / \text{Gravity})$
 $\text{Weight After Offset} = 1,604 - (1,673.84 / 9.8) = 1,434.93 \text{ kg}$

Total Mass With 30% Headroom

- **Headroom:**
 $\text{Headroom} = 0.3 \times \text{Total Weight After Offset} = 0.3 \times 1,434.93 = 430.48 \text{ kg}$

- **Final Total Weight:**

Final Total Weight = Total Weight After Offset + Headroom = 1,434.93 + 430.48 =
1,865.41 kg

Buoyant Force Required

- **Buoyant Force:**

Buoyant Force = Total Weight × Gravity
Buoyant Force = 1,865.41 × 9.8 = 18,283.02 N

Updated Buoyancy Calculations

Total Volume of Tubes Required

- **Volume Displaced:**

Volume Displaced = Buoyant Force / (Density of Water × Gravity)
Volume Displaced = 18,283.02 / (1,000 × 9.8) = 1.864 m³

Tube Volume Calculation

- **Volume per Tube (2 tubes):**

Volume per Tube = Total Volume / 2 = 1.864 / 2 = 0.932 m³

- **Radius of Tube (Length = 4 m):**

Radius = $\sqrt{(\text{Volume} / (\pi \times \text{Length}))}$
Radius = $\sqrt{(0.932 / (\pi \times 4))} = 0.273 \text{ m}$

- **Diameter of Tubes:**

Diameter = 2 × Radius = 2 × 0.273 = 0.546 m (54.6 cm)

Pump Specifications and Fill Time

Air Pump Details

- **Capacity per Pump:** 110 L/min = 0.11 m³/min

- **Total Capacity (2 pumps):**

Total Capacity = 0.11 m³/min × 2 = 0.22 m³/min

Time to Fill the Tubes

- **Fill Time:**

Fill Time = Total Volume / Total Pump Capacity

Fill Time = $1.864 / 0.22 = 8.47$ minutes

Pressure Requirements

At a Depth of 1 Meter

- **Pressure Required:**

Pressure Required = Density of Water \times Gravity \times Depth

Pressure Required = $1,000 \times 9.8 \times 1 = 9,800$ Pa (9.8 kPa)

- **Design Pressure (30% Headroom):**

Design Pressure = $1.3 \times$ Pressure Required

Design Pressure = $1.3 \times 9,800 = 12,740$ Pa (12.74 kPa)

Material Selection

The material for the tubes must:

1. Handle internal pressure of 12.74 kPa with a safety margin.
2. Be lightweight to minimize load.
3. Be corrosion-resistant for underwater use.

Candidate Materials

1. High-Density Polyethylene (HDPE):

- a. Tensile Strength: 25 MPa
- b. Density: 950 kg/m^3
- c. Advantages: Cost-effective, corrosion-resistant, lightweight.

2. Aluminum Alloy (6061):

- a. Tensile Strength: 275 MPa
- b. Density: $2,700 \text{ kg/m}^3$
- c. Advantages: Strong and lightweight, higher cost.

3. Fiber-Reinforced Polymer (FRP):

- a. Tensile Strength: 300 MPa
- b. Density: $1,800 \text{ kg/m}^3$
- c. Advantages: Excellent strength-to-weight ratio.

Wall Thickness Calculation

Using the hoop stress formula for cylindrical pressure vessels:

$$\text{Wall Thickness} = (\text{Pressure} \times \text{Radius}) / \text{Tensile Strength}$$

For Each Material:

1. **HDPE:**

$$\text{Wall Thickness} = (12,740 \times 0.273) / (25 \times 10^6) = 0.00014 \text{ m (0.14 mm)}$$

2. **Aluminum:**

$$\text{Wall Thickness} = (12,740 \times 0.273) / (275 \times 10^6) = 0.000013 \text{ m (0.013 mm)}$$

3. **FRP:**

$$\text{Wall Thickness} = (12,740 \times 0.273) / (300 \times 10^6) = 0.000012 \text{ m (0.012 mm)}$$

Final

1. **Material Choice:**

- HDPE is sufficient for cost-effectiveness and corrosion resistance.
- Aluminum or FRP can be used for higher durability.

2. **Wall Thickness:**

- Minimum of **0.14 mm** for HDPE, including a 30% safety margin.

3. **Pump Selection:**

- Use **2 Hailea ACO-009 pumps**, providing a fill time of approximately **8.47 minutes**.

4. **Design Considerations:**

- Ensure pressure tolerance up to **12.74 kPa** with provisions for dynamic forces.