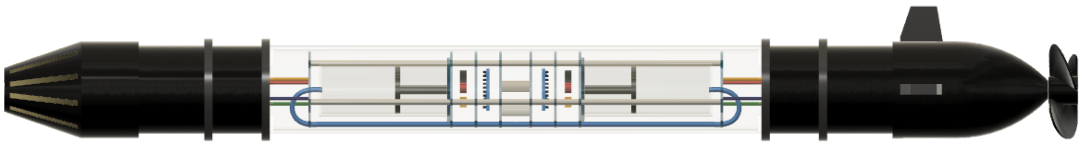
GUJARAT ROBOFEST 4.0
SUBMARINE CATEGORY PROPOSAL

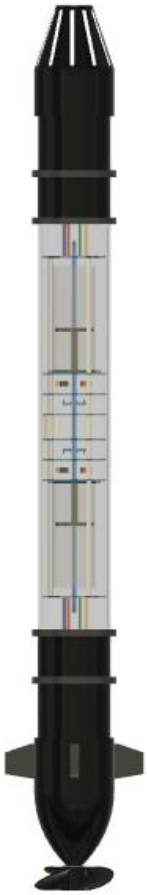
Type of Robot: Submarine

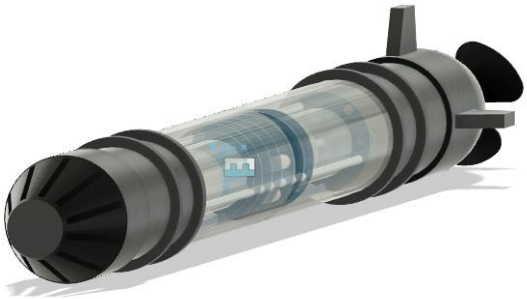
Robot Assembly Design: CAD diagrams of the proposed model

Side View:

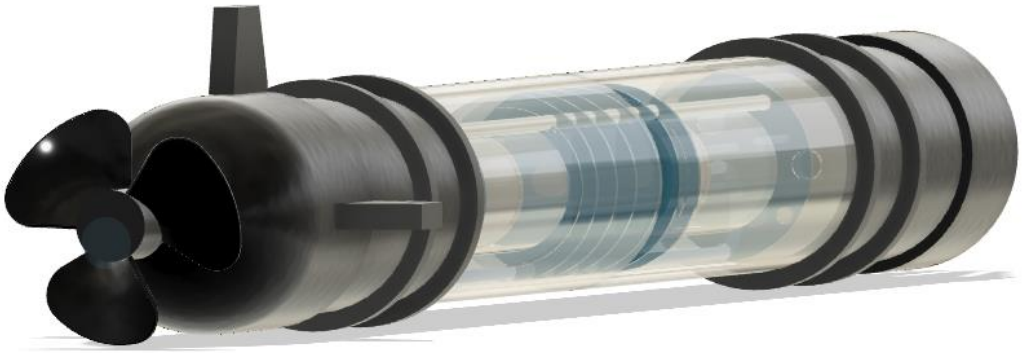


Top View:





Rear View:



Components List:

1. Structural Components:
    a. Acrylic pipe of diameter 14cm
    b. Acrylic pipe of diameter 12cm
    c. Smaller acrylic pipes of varying diameters
    d. Acrylic sheets
    e. Syringes of diameter 10cm & capacity 1Litre
    f. Hexagonal pillar supports
    g. Rubber seals
    h. Rubber endcaps
    i. Threaded rods
    j. Shaft couplers
    k. Ball bearings of varying sizes
    l. Silicone tubing
    m. PVC pipes, pipe joiners, endcaps and fittings
    n. 3D printed components (tail fins, syringe pusher replacement, etc.)
    o. Helical/Pump-jet/Open Propellers
    p. Foam paddings
    q. Epoxy resin & adhesive
    r. CT1 Sealant & adhesive
    s. Nuts, bolts, screws, washers, zip ties, etc.
    t. Thin clothing material to act as mesh.

2. Electronic Components:
    a. LiPo 3s Battery (14.8V, 5000mAh)
    b. Brushless DC Motor (750kv/630kv/320kv)

c. Brushless & Brushed Electronic Speed Controller (20A-40A)
d. High Torque N20 Motors (25RPM)
e. Peristaltic Pump (Brushed Motor, 12V)
f. Normally Open Solenoid Valve (12V)
g. Water Pumps as Jet Thrusters
h. Flysky RC Transmitter & Receiver (6-10 channel, 2.4GHz)
i. Linear Variable Resistors
j. Servo Motor Control Boards
k. LED Light Strips
l. Shielded Cables & Wirings
m. Soldering station, Hot glue gun, Electrical tape, etc.

Principle:

A submarine works on the principle of buoyancy, displacing water equal to its own weight. For vertical movement, the submarine uses “Ballast Tanks” which are filled up with water to increase weight and sink the submarine gradually. The tanks are emptied out when it needs to resurface. Sideways motion and directional control is achieved using water pumps which act as jet thrusters to push the submarine towards the required direction. Propulsion is achieved through propellers (helical, pump-jet or open propellers) rotated using a high torque Brushless DC motor.

We propose one of two types of Ballast Tank implementations:

1. Syringe / Plunger System: Traditional system of implementing ballast tanks where a high torque DC motor pulls back the plunger in a syringe thereby sucking water in and compressing air present inside the submarine to increase weight and thereby sinking it. The plunger pushes water out when required and the submarine resurfaces.

2. Peristaltic Pump / Solenoid Valve System: This system explores vented ballast tank implementation, where a peristaltic pump is used to suck in water to fill up the ballast tank and air escapes out of a hole on the surface of the submarine connected to a normally open solenoid valve. Underwater the solenoid valve remains closed. While resurfacing, enough water is pumped out of the tank which creates a low-pressure region inside it. Once the surface Is exposed to air, the solenoid valve is opened and air gets sucked in, thus allowing the submarine to fully resurface.

Methodology:

1. Acrylic sheets are cut into discs of diameter just under 14cm and connected together with hexagonal pillar supports to create sections for storing batteries, motors and motor controllers.

2. For the Syringe / Plunger system of ballast tank implementation:
    a. 1Litre syringes are used as ballast tanks which have a total diameter of 10cm. The existing plungers are removed and a new one is 3D printed with default rubber seals attached to them. Small acrylic pipe is attached to the plunger to act as handle.
    b. A high torque N20 motor is directly attached to an acrylic disc, which is then attached to a shaft coupler with a ball bearing in between. A threaded rod is attached to the shaft coupler with a bearing between them on one side, and to the plunger handle on the other side.
    c. A linear variable resistor is placed inside the syringe body attached to the plunger and is connected to the control board of a servo motor to allow precise position control.
    d. This system is duplicated on the other side as well to ensure balance is maintained. Both the syringes' inlets are connected to individual silicone tubes so that water intake can be done from a single point, thus minimizing chances of water leakage.

3. For the Peristaltic Pump / Solenoid Valve system of ballast tank implementation:
    a. A 30cm long acrylic pipe of diameter 12cm is taken and its ends are attached to rubber endcaps with 2 silicone tubes passing through them.
    b. One of the tubes is connected to a peristaltic pump and leads to a hole on the underside of the submarine's body which will act as a point for water inlet and outlet during diving and resurfacing respectively.
    c. The second tube is attached to a normally open solenoid valve whose other tube is connected to an opening on the top surface of the submarine, which will act as an outlet and inlet for air during diving and resurfacing respectively.
    d. The solenoid valve is connected to the Flysky RC Receiver which provides actuation signal to the valve.

4. All the required brushed and brushless electronic speed controllers are attached to the acrylic discs using zip ties and their connecting wires extended.

5. To maintain structural integrity, threaded rods are attached through holes in the acrylic discs which ensure all the sections are straight. All the joining points are reinforced with hot glue / epoxy adhesive.

6. The internal structure is then placed within the external 14cm diameter acrylic pipe and secured with rubber endcaps to ensure the internal circuitry is waterproof. Holes is made in the endcaps to allow water intake via the silicone tube in one, and motor controller wires to be passed through the other which is then sealed with CT1 sealant.

7. The endcaps are followed by PVC pipe joiners which bite on the caps to ensure water tightness, and allow a mounting point for a PVC pipe extension which houses the water pumps with their exit tubes pointing towards the required directions for directional control.

8. The pipe is draped with a thin clothing material to filter out grit and a final PVC endcap placed over at each end. Two horizontal and one vertical tail fins are mounted to the endcap, where the vertical tail fin is attached to a servo motor to help in directional control.

9. The Brushless DC motor is mounted directly to the back PVC endcap using screws and a propeller of appropriate type & length attached to it using mounting bullets.

10. All the motor controller wires are attached to the water pumps and BLDC motor. The signal wires of the motor controllers are extended using a shielded cable and attached to the receiver end of the Flysky RC Transmitter & Receiver.

11. All connections are checked for water leakage and connections insulated with either hot glue or epoxy resin. LED light strips are attached to the inside of the transparent acrylic pipes wherever required as a light source when the submarine is underwater.

Application of the Proposed Robot:

1. Underwater Photography: HD camera modules can be attached to take photos or videos underwater and data can be transmitted via shielded cables back to the user.

2. Marine Research and Exploration: Underwater vehicles outfitted with seafloor mapping, bathymetry and magnetic sensors along with digital cameras and ultrasonic imaging devices are often used for purposes like current and temperature measurement, ocean floor mapping and hydrothermal vent detection among several other uses aimed to collect data opening up avenues in marine research and exploration.

3. Investigations: Underwater vehicles are often used in investigations of downed aircrafts, sunken ships or items lost in water bodies by authorities. They are used to explore and locate evidence in regions inaccessible by humans.

Size of the Proposed Robot:

a) Length in cm: 125 cm (approx.)
b) Width in cm: 14 cm (approx.)
c) Height in cm: 14 cm (approx.)

Timeline for Prototype Designing:

Upon selection of project proposal, timeline to be followed for designing prototype:

Serial No.	**Activities**	**No. of Days**
01.	Acquiring necessary materials	10 days
02.	Assembly of internal electrical system	2 days
03.	Assembly of ballast tank system	2 days
04.	Completing internal housing structure along with all subsystems	2 days
05.	Implementing propulsion and directional control systems	3 days
06.	Completing final fittings and water proofing all components	2 days
	Total Time Taken:	21 days