A MINIATURE UNDERWATER DRONE

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Introduction

What is an underwater drone?

- Capable of executing tasks in underwater environments
- Remotely controlled

Basic functions

- Sensor integration
- Data processing
- Remote control
- Communication

Why we need them?

Safety risks associated with human diving

Traditional underwater exploration face numerous limitations:

- High pressures
- Low temperatures
- High turbidity in deep-sea environments
- Safety risks associated with human diving

Project Aim

Develop a reliable, efficient prototype drone

Capabilities:

- Dive to an assigned depth
- Observe with a camera
- Transmit data

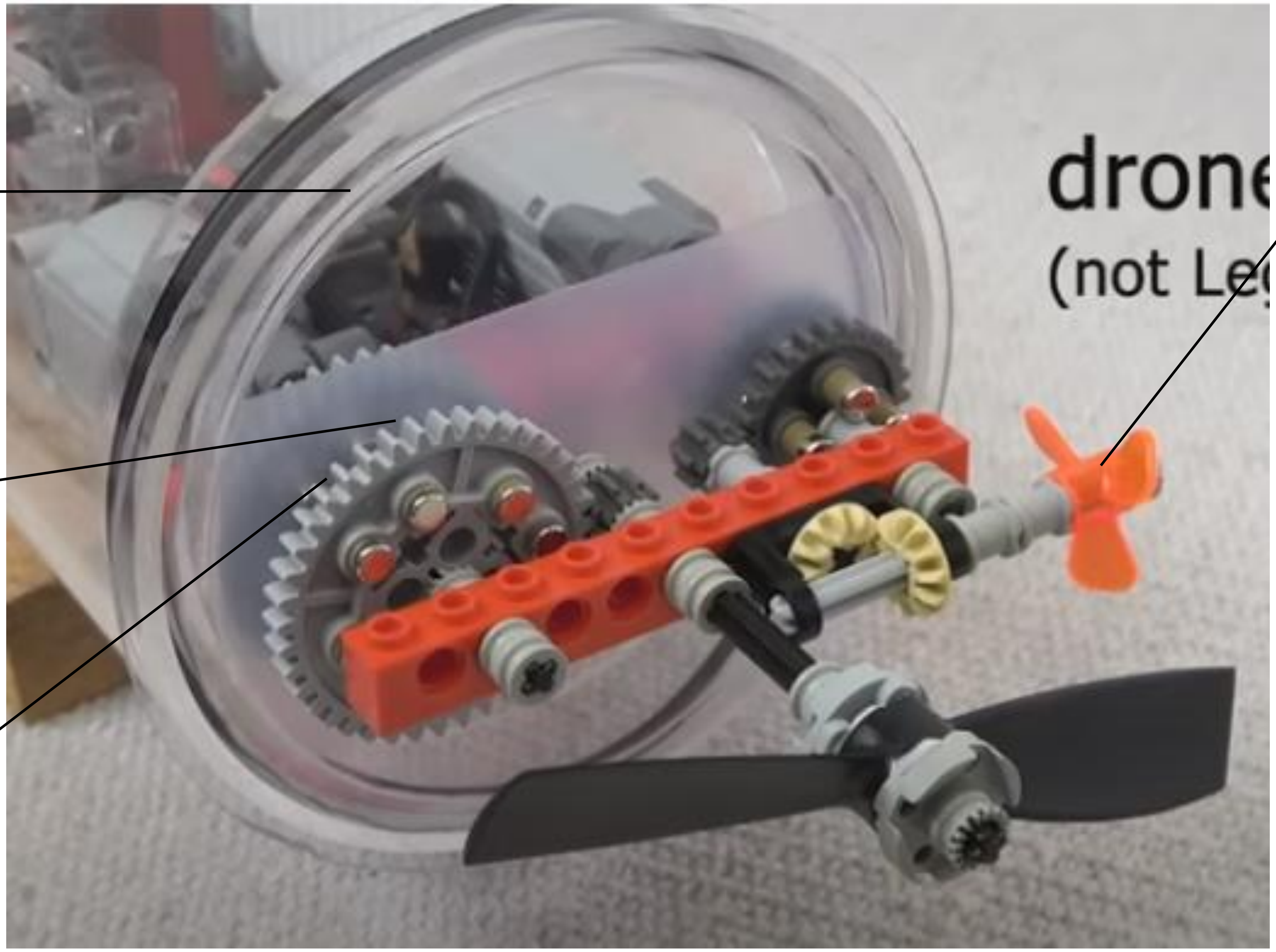
For further improvements and other projects

Physical Structures

Rubber ring for sealing

Transmission (Gears with magnets)

Frictionless tape

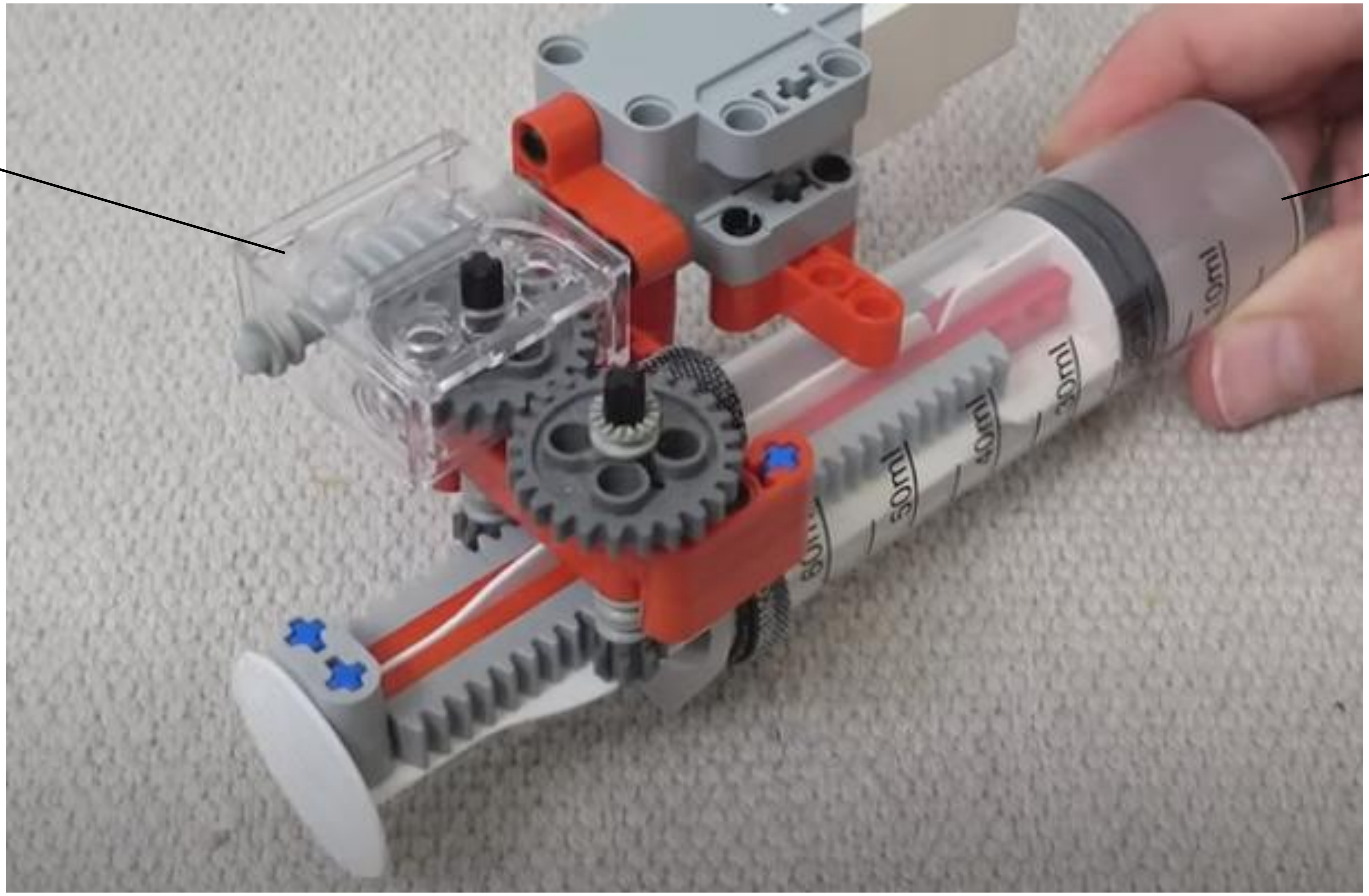


Propeller

Figure 1 Backside concept idea from Lego-powered Submarine [1].

Physical Structures

Transmission
(From motor to
syringe control)



Diving control
(Controlling by
changing weight)

Figure 2 Top view concept idea from Lego-powered Submarine [1].

Physical Structures

Counterweight at the bottom of drone (Replaced with lead or iron bars)

Figure 3 Lead as counterweight [1].

Existing Project

- Inspired by the Lego-powered Submarine project from the Brick Experiment Channel on YouTube.
- Challenge of maintaining a constant depth for a remote-control submarine.
- Implemented PID control and utilized a pressure sensor with a Raspberry Pi as a microcontroller to measure depth.
- Difficulties in closing the end caps of the submarine, insufficient propeller strength, and the inability to maintain a straight path at peak speed.

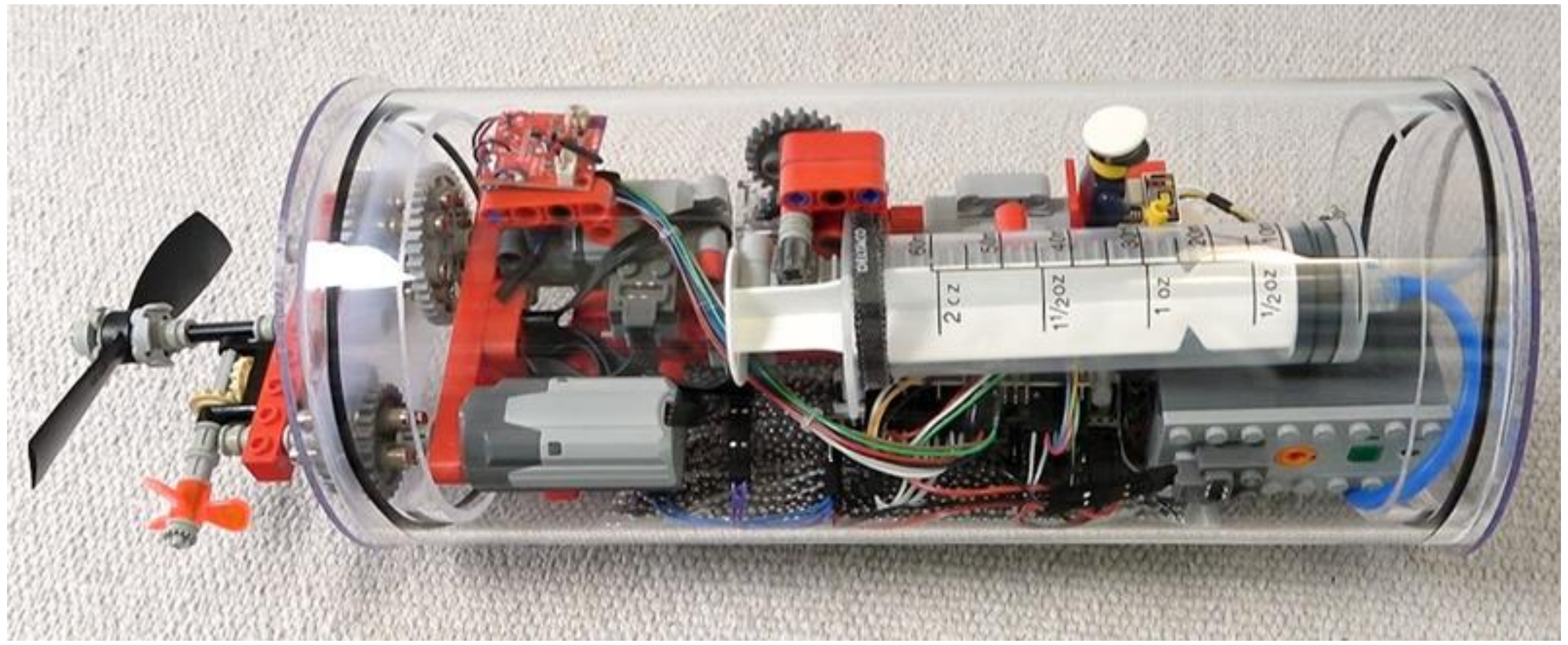


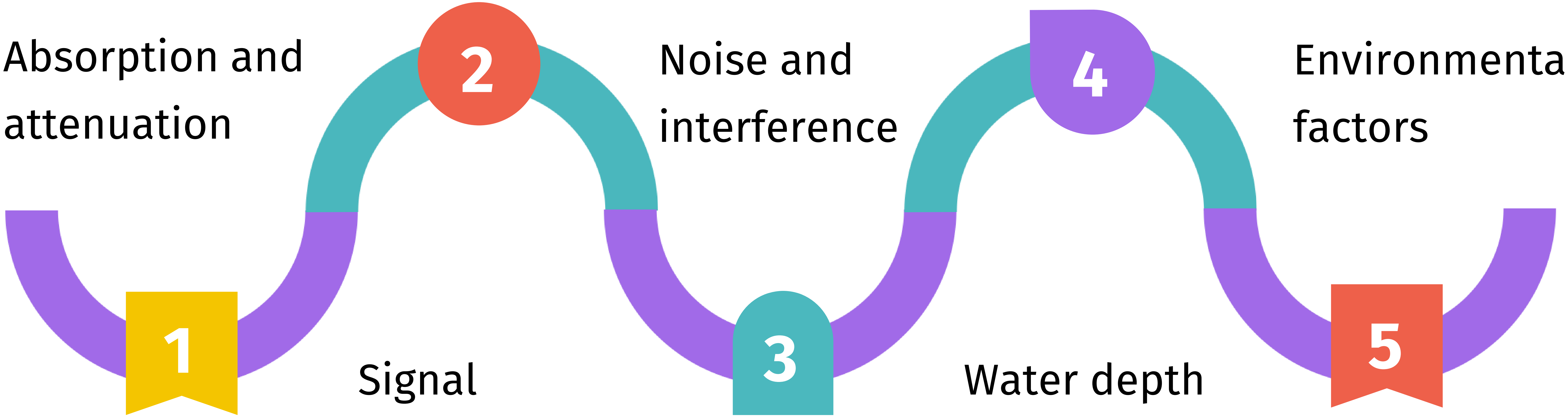
Figure 4 Lego-powered Submarine from Brick Experiment Channel [1].

Type of Communication Underwater

Technology	Pros	Cons
Acoustic	Proven technology. Range: up to 20 km. Energy efficiency. Precision navigation. Low size and cost.	Does not transit water/air. Poor in shallow water. Adversely affected by water aeration, ambient noise and unpredictable propagation. Limited bandwidth. Latency. Impact on marine life. Detectable.
Free Space Optical	Ultra-high bandwidth: Gbps. Low cost.	Susceptible to turbidity & particles. Marine fouling on lens faces. Needs tight alignment. Very short range. Difficulty transiting water/air.
Electromagnetic Radio Frequency	Transits water/air boundary. Transits water/seabed boundary. Signal passes through ice. Unaffected by water depth. Unaffected by turbidity/bubbles. Non-line-of-sight performance. Immune to acoustic noise. Immune to marine fouling. Up to 100 Mbps data rates. Frequency agile capability. Unaffected by multi-path. No known effects on marine animals.	Susceptible to electromagnetic interferences. Limited range through water.

Table 1 Comparison of three type communication underwater [2].

Factors Affecting RF Communication Underwater

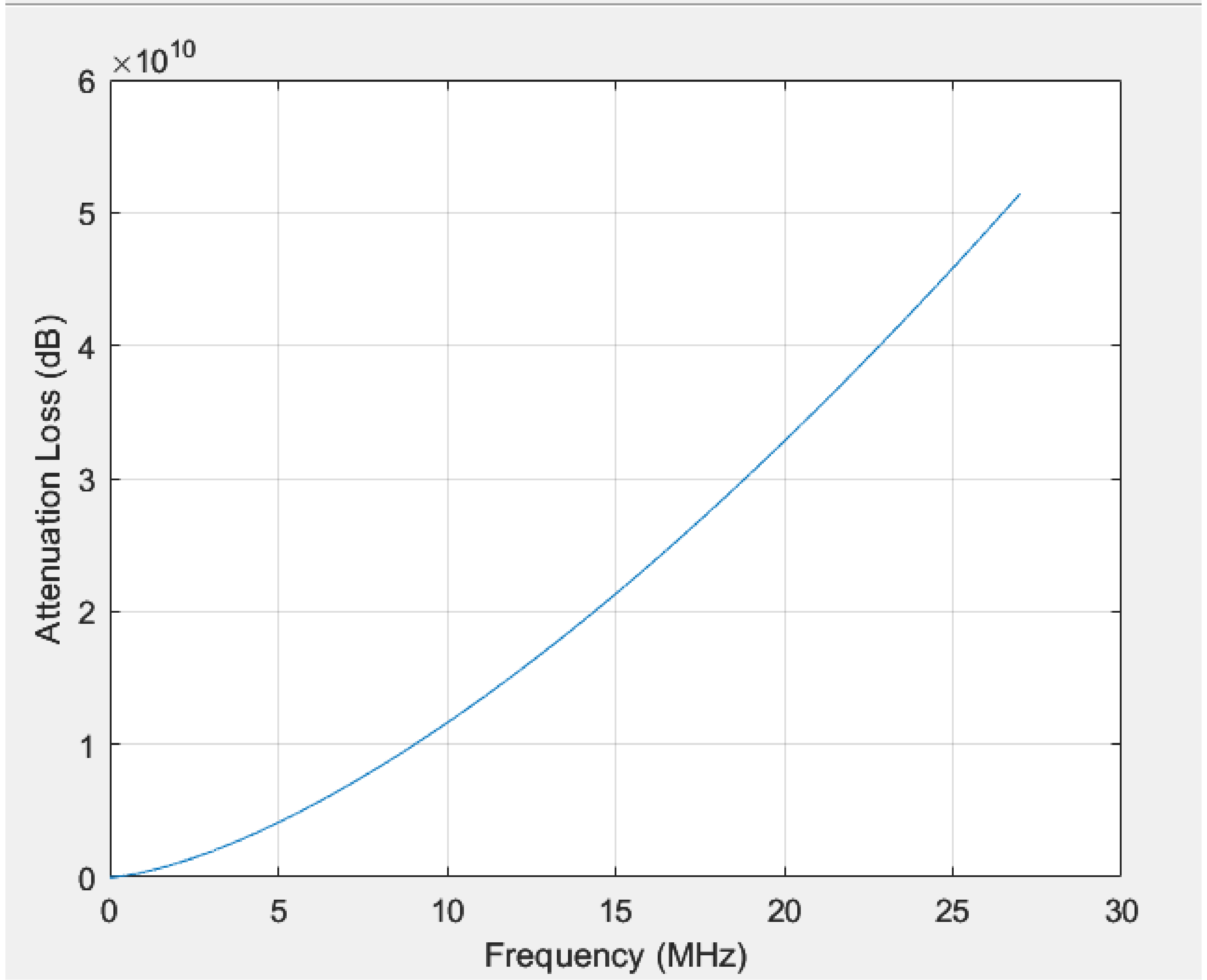


1. Absorption and attenuation
2. Signal degradation
3. Noise and interference
4. Water depth and pressure
5. Environmental factors

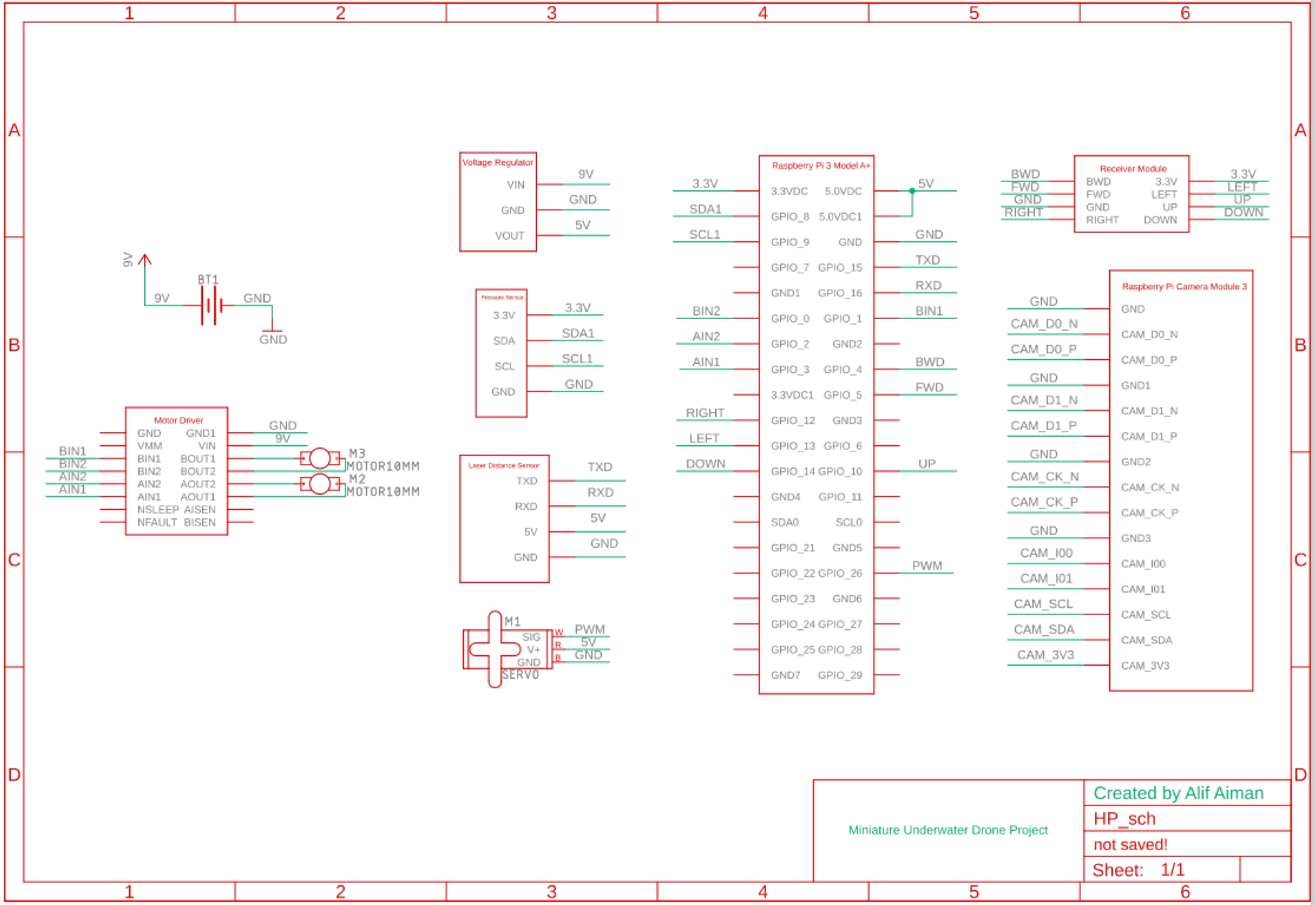
Attenuation Loss Underwater

$$\alpha = 0.11\frac{f^2}{1+f^2} + 44\frac{f^2}{4100+f^2} + 2.75\times 10^{-4} f^2 + 0.003$$

Figure 5 Thorp's equation [3].



Project Schematic

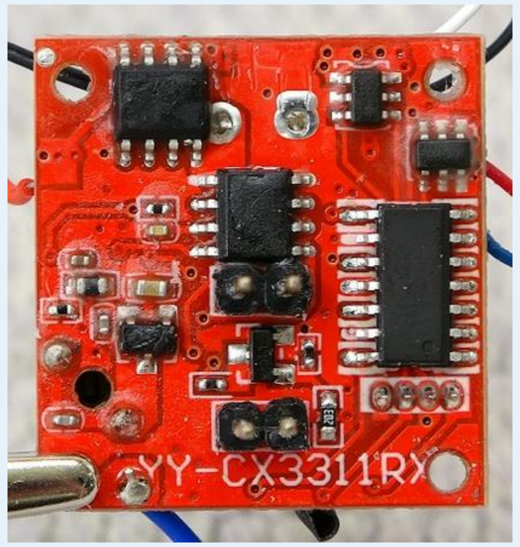


Items and component used

No.	Name	Description	Figure
1.	Single-board computer	Raspberry Pi 3 Model A+	
2.	Pressure Sensor	Honeywell Piezoresistive Pressure Sensor	

No.	Name	Description	Figure
3.	Laser Distance Sensor	TF Mini LiDAR (ToF)	
4.	Li-Po Battery	2200mAh 7.4v 2S 30C Soft Case LiPo Battery	
5.	Servo Motor	Metal Geared 15Kg Standard Servo	

No.	Name	Description	Figure
6.	DC motor	RS PRO Geared, 24.6 W, 3 to 7.2 V dc, 107.3 gcm, 22356 rpm, 2.3mm Shaft Diameter	
7.	Motor Driver	DRV8833 Dual Motor Driver Carrier (1.2A and low voltage)	
8.	Mini Camera	Raspberry Pi Camera Module 3	

No.	Name	Description	Figure
9.	Voltage Regulator	Pololu 5V Step-Up/Step-Down Voltage Regulator S7V8F5	
10.	Receiver module	27 MHz controller dissembled from a toy submarine	

References

1. BrickExperimentChannel et al., "RC submarine 4.0 – background (1/10)," Brick Experiment Channel, Jun. 25, 2022. [Online]. Available: https://brickexperimentchannel.wordpress.com/2022/06/25/rc-submarine-4-0-background-1-10/.
2. A. Palmeiro, M. Martín, I. Crowther, and M. Rhodes, "Underwater radio frequency communications," OCEANS 2011 IEEE - Spain, Santander, Spain, 2011, pp. 1-8. doi: 10.1109/Oceans-Spain.2011.6003580.
3. Y. Kularia, S. Kohli, and P. P. Bhattacharya, "Analyzing propagation delay, transmission loss and signal to noise ratio in acoustic channel for Underwater Wireless Sensor Networks," 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), Delhi, India, 2016, pp. 1-5, doi: 10.1109/ICPEICES.2016.7853300.