2. DESIGN REQUIREMENTS SPECIFICATIONS

The following section outlines engineering and marketing requirements and all standards and constraints of Jelly-BOT.

2.1. Requirements

Jelly-BOT's requirements are divided into the categories of marketing and engineering and are described in the following subsections.

2.1.1. Marketing Requirements

The marketing requirements for the Jelly-BOT are the following:

1. The device is waterproof to withstand underwater submersion.
2. The device can withstand freshwater debris that may hinder its operation.
3. The device is rechargeable.
4. The device powers multiple sensors.
5. The device notifies the user of the battery power level.
6. Users can remotely control the navigation of the device as needed.
7. The device grabs underwater pollutants such as plastic bags without human aid.
8. The device indicates when it is at full capacity.
9. The device is lightweight enough to be lifted and carried by a single person to the power hub.
10. The device can submerge and emerge in water.
11. The device is insulated to prevent inflow and outflow of water

Figure 2-1 shows the major objectives for Jelly-BOT by outlining the hierarchy of the goals.

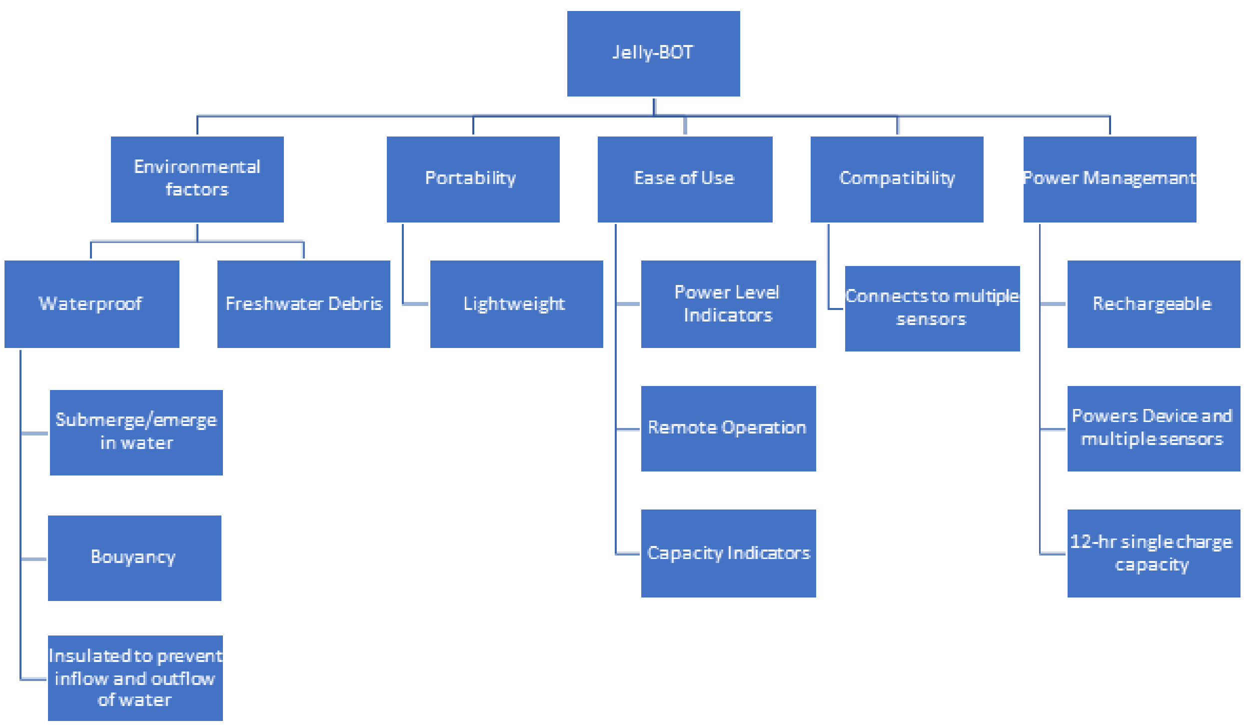

Figure 2-1: Objective Tree for Jelly-BOT

The objective tree provides a representation of Jelly-BOT's objectives and the categories they fall under. The next section details the technical and performance requirements of the Jelly-BOT in the form of engineering requirements.

2.1.2 Engineering Requirements

The engineering design requirements for the Jelly-BOT are shown in Table 2-1 and are related to the marketing requirements. Detailed descriptions of each engineering requirement are also shown.

Table 2-1: Engineering Design Requirements

Marketing Requirements	Engineering Requirements	Description
1,11	The Jelly-BOT's electrical components are housed in a solid dome-like structure covered in insulated material.	The enclosure provides a layer of protection against the environment the robot navigates in. The enclosure is compact enough to limit the space it occupies but large enough to house all electrical components.
2,3	The Jelly-BOT is rechargeable through electromagnetic induction.	To keep it waterproof, all robot charging is wireless so as not to damage the Jelly-BOT or injure the user.
4,7	The Jelly-BOT notifies the user of battery life and capacity.	As the Jelly-BOT is in use, it notifies the user of its internal capacity and battery life. This is done via a light on the robot and the power hub turning on when the power is low, and by an audible noise to denote it has reached full capacity.
5	Users may control the navigation of the device remotely via a controller.	Though the mode the Jelly-BOT uses to move is entirely done without human intervention, cameras and sensors are used to allow users to see the environment and navigate the robot accordingly.
10	Jelly-BOT can submerge and emerge with minimal expended energy.	Jelly-BOT' initially sinks but uses minimal power to submerge, a process that is made possible through pumps. It goes down to about 12 meters as most lakes are at least 10 meters deep.

6	Jelly-BOT grabs underwater pollutants such as plastic and aluminum without human aid.	Other than navigating toward a water pollutant, the collection of waste is done using air pressure, allowing the user to collect waste remotely.
8	The Jelly-BOT is lightweight enough to be carried by a single person to an external power hub.	The enclosure is made of lightweight, insulated material to make transportation of the robot by a user as convenient as possible.

Working under these engineering requirements accomplishes the important goals of Jelly-BOT and correlates the marketing features with major details within the design process.

2.2 Constraints

The Jelly-BOT has constraints imposed upon its design, including operational, economic, and environmental. These requirements, along with other factors, impact the type of materials used, schedule, and goal for the final product. These constraints are included in Table 2-2.

Table 2-2: Constraints

Type	Name	Description
Economic	Cost	The design team has a budget of $1,000 to build the Jelly-BOT.
Economic	Time	The design team is given nine months to design and build the Jelly-BOT, with working subsystems by May 2024 and a fully integrated product by December 2024.
Environmental	Waterproof	The electrical components inside the Jelly-BOT do not contact water.
Manufacturing	Enclosure	The casing protects the device from external factors that cause harm to the user and hinder its operation.
Health & Safety	Electric shock	The enclosure protects the user from electrical shock.
Remote Usage	Remote controller	Using remote controllers with submersibles can cause problems after a certain depth due to the unreliability of radio and other such waves.
Tether Usage	Tether	A tether allows the user to control the maximum depth the robot can reach without affecting remote usage.
Operation	Communications	The Jelly-BOT does not lose communication with the controller despite the attenuation that results from being underwater.
Operation	Buoyancy	Without internal weights, Jelly-bot sinks because of its internal components. Said internal components must be lightweight enough to be carried by a single person and light enough for the internal pump system to allow it to float.

The constraints ensure that the Jelly-BOT meets both individual and industry standards that would affect its development. These limitations allow for modern design improvements that could work towards fulfilling multiple long-term goals.

2.3 Standards

The Jelly-BOT complies to the list of industry standards in Table 2-3 and by doing so, ensures user safety and operability of the device.

Table 2-3: Engineering Standards

Standard	Standard Document	Specification
Ingress Protection X8	International Electrotechnical Commission Standard 60529	Immersion (1 meter or deeper) [1]
Institute of Electrical and Electronics Engineers 45.4	IEEE Recommended Practice for Electrical Installations on Shipboard-Marine Sectors and Mission Systems	Electrical safety practices were followed to prevent shocks. Grounding is required [2] Minimize interference with other systems for reliable communications [2] To avoid damage, use materials that resist corrosion. This protects electrical components from water exposure [2]
Federal Communications Commission (FCC) Part 15	Code of Federal Regulations Title 47, FCC, Part 15	Does not cause interference and can accept any inference that may be received [3]

Following these industry standards allow Jelly-BOT to withstand freshwater environments and electrical interference while communicating with the remote and any other devices.

REFERENCES

[1] B. Haines, "IPX Waterproof Rating Chart: All IPX Codes (0-9) Explained" strorytellertech.com, Sept 20, 2023. [Online]. Available:https://storytellertech.com/ipx-rating-chart/#:~:text=1%20IPX0%3A%20No%20protection%20from%20water%20ingress.%202,Powerful%20water%20jets%20%28increased%20pressure%29.%20...%20More%20items. [Accessed Mar. 6, 2024].

[2] IEEE Standards Association, "IEEE Recommended Practice for Electrical Installations on Shipboard-Marine Sectors and Mission System," standards.ieee.org, Feb. 20, 2019. [Online]. Available:https://standards.ieee.org/ieee/45.4/6138/ [Accessed: Mar 6, 2024]

[3] National Archives, "47 CFR Part 15 Radio Frequency Devices" ecfr.gov, Mar. 4, 2024. [Online]. Available: https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-15. [Accessed Mar. 6, 2024].