Food-Carrying Juggernaut: A Line-Following and Remote-Controlled Robot Inspired by Star Wars

June 2023 Residency - Maker's Asylum - Team 3 (Yohan Vinu, Dhruv Shah, & Lakshya Bajaj)

Problem Statement:

Design and develop a line-following and remote-controlled robot, inspired by the A6 Juggernaut from Star Wars, with a built-in compartment to securely hold and transport food items. The robot should exhibit autonomous line-following capabilities while also allowing remote control operation for enhanced user interaction. The primary objective is to create an entertaining and functional robot that combines the joy of Star Wars aesthetics with practicality by providing a reliable and secure compartment for transporting food items.

Constraints:

- The robot must be able to follow a line that is drawn on the floor.
- The robot must be able to deliver food to a specific location.
- The robot must be modeled after the A6 Juggernaut from Star Wars.
- Weight capacity should be defined for the food compartment.
- Size limitations should accommodate common food containers.
- Design should prioritize easy cleaning and food safety.
- Power efficiency must be maximized for extended operation.
- Maneuverability on different surfaces and stability are crucial.
- Remote control range should allow operation from a distance.
- Safety sensors for collision detection and emergency stop.
- Adherence to a specific budget or cost constraints.
- Intuitive and user-friendly interface for easy operation.

Solution:

- Implement a robust and reliable power management system to efficiently utilize and monitor the battery life.
- Integrate a microcontroller, such as the ESP32, to serve as the central control unit, managing sensor inputs, motor control, and communication.
- Develop a PID algorithm to provide precise and smooth line-following capabilities for improved accuracy and stability.
- Install an ultrasonic sensor for obstacle detection and avoidance, allowing the robot to navigate around objects in its path.

- Utilize an onboard camera and servo motor to enable a pan-tilt functionality, providing a wider field of view for remote monitoring or surveillance purposes.
- Design a user-friendly web interface accessible through the robot's web server to control and monitor its functions remotely.
- Implement safety mechanisms such as emergency stop buttons or collision detection sensors to ensure the well-being of users and prevent accidents.
- Use sturdy and durable materials for the robot's construction to withstand the rigors of transportation and handling of food items.
- Incorporate noise reduction and vibration damping techniques to minimize disturbances and ensure smooth and quiet operation.
- Develop a secure locking mechanism for the food compartment to prevent accidental opening or spillage during transportation.

Benefits:

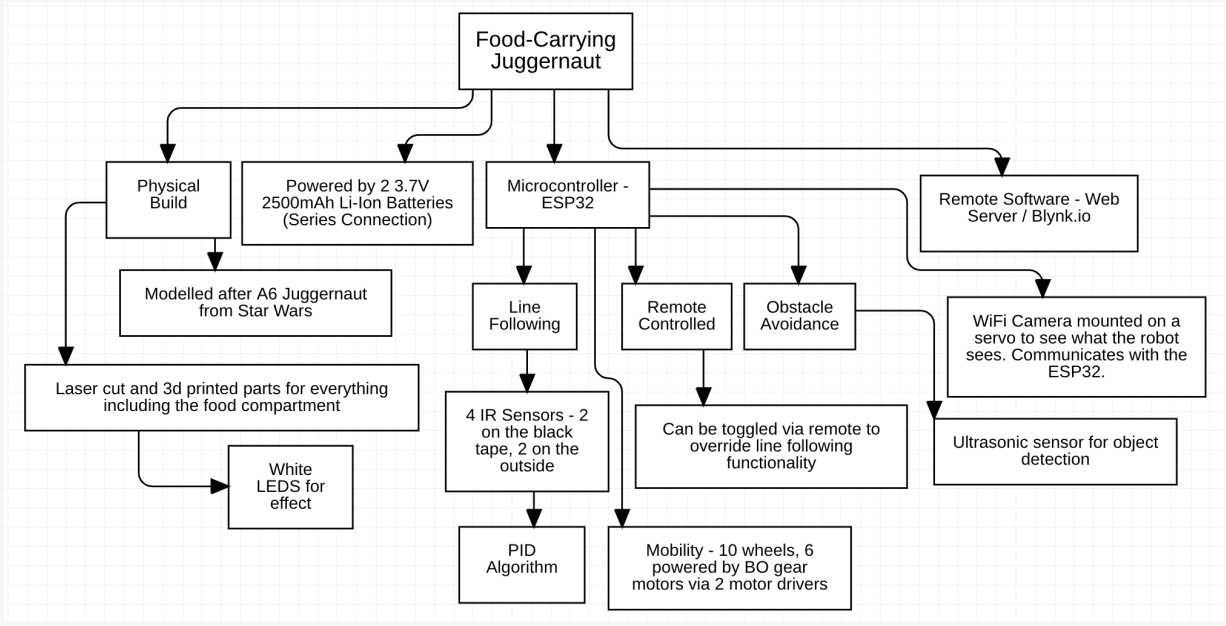
- Efficient Food Transportation: The built-in compartment in the robot enables efficient transportation of food items, making it convenient to deliver snacks, drinks, or small meals without the need for human intervention. This can be particularly useful in settings such as parties, events, or even at home.
- Novelty and Entertainment: The robot's resemblance to the A6 Juggernaut from Star Wars adds a fun and entertaining element to the project. It can attract attention and spark conversations, providing a unique and enjoyable experience for users and spectators alike.
- Versatility: While primarily designed for food transportation, the robot can be modified or expanded for other purposes. It can be adapted to carry different items such as small packages, toys, or even personal belongings, offering flexibility in its usage.
- Technological Showcase: The project serves as a technological showcase, demonstrating the integration of line-following and remote-controlled capabilities. It highlights the practical application of robotics in everyday scenarios, showcasing the potential for advancements in autonomous systems.

Technical Objectives:

- Utilize 4 IR sensors for accurate and fast line-following capabilities, incorporating a PID algorithm.
- Drive 6 BO gear motors using 2 L298N motor drivers for efficient and controlled movement.
- Incorporate an ultrasonic sensor to provide object detection and implement basic obstacle avoidance functionality.
- Use the ESP32 microcontroller as the main control unit for processing and managing the robot's operations.

- Mount a basic camera on a servo motor to enable a panoramic view of the robot's surroundings, accessible via a web server.
- Set up a web server to allow users to control the robot remotely through a web-based interface.
- Implement an override mechanism to switch from line following to remote control mode, providing manual control of the robot's movements.
- Power the entire system using a series connection of 2 3.7V 2500mAh batteries, ensuring sufficient energy for prolonged operation.

Block Diagram:



Materials List:

RC & Line Following A6 Juggernaut Robot - Materials List		
Item Name	**Quantity**	**Link**
ESP32 Board	1	ESP32
HCSR04 - Ultrasonic Sensor	1	Ultrasonic Sensor
IR Sensor (Line following functionality)	4	IR Sensor
Motor Driver L298N	2	L298N Motor Driver
Wheels	10	Wheels
DC Motors	6	BO Motors
Tower Pro Servo Motor	1	Servo Motors
ESP CAM	1	ESP32 CAM
Battery Holder	1	Battery Holder
Batteries	2	3.7V 2500mAh Li-ion Battery
Jumper Wires		
Glue gun, Soldering equipment		
Paint, Markers, Stickers		
3D Printed Parts		