Georgia State University

Undergraduate Honors Thesis Research

Autonomous Waste Collection Robotic Car Hardware Design Document

Title: **Development of Waste Collection Mobile Robot Equipped with Robotic Arm and Trash Sorting Bin using Robotic Algorithms, Computer Vision, and Deep Learning.**

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1. System Overview

Purpose and Functionalities

The autonomous robotic car is designed to navigate urban environments independently, collecting various types of waste efficiently. Its key functionalities include:

- Autonomous navigation
- Obstacle detection and avoidance
- Communication with the robotic arm
- Communication with a central control system

Operational Environment

The car will operate in a variety of settings, including:

- Urban areas (streets and alleys)
- Parks
- College campuses
- Public squares

It is built to manage urban challenges such as pedestrian traffic, diverse weather conditions, and navigating around parked vehicles.

Usage and Waste Types

The autonomous car will collect different types of waste, such as:

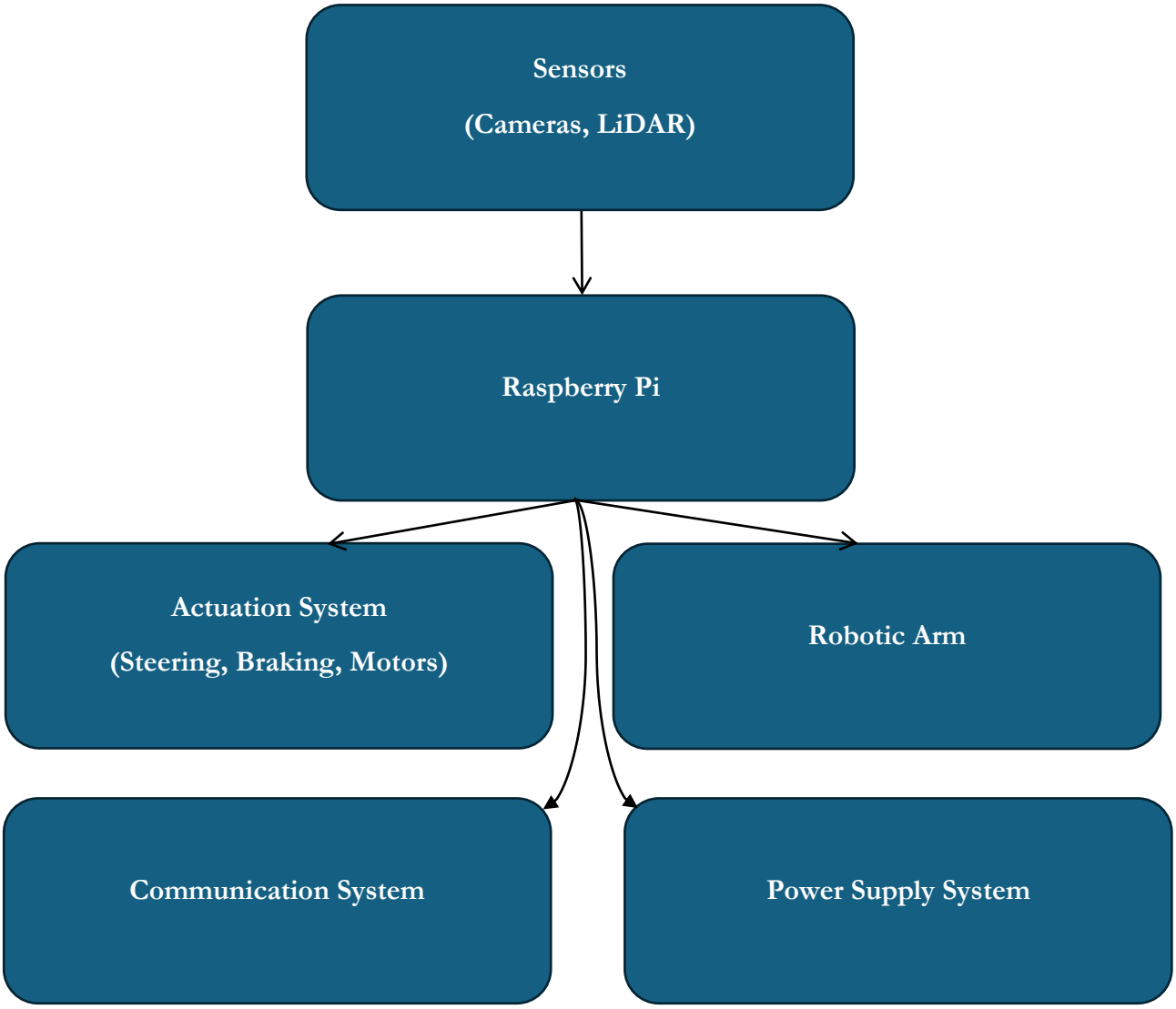
- Napkins
- Bottles
- Half-eaten fruit and other organic trash
- Plastic wrappers
- Paper cups
- Aluminum cans

Size and Capacity

- **Size**: Approximately 2 ft(0.7 m) in length, 1.25 ft(0.38 m) in width and 0.75 ft(0.23 m) in height.
- **Trash Bin**: Will be equipped with an onboard trash bin with a capacity of up to 50 L.
- **Robotic Arm**: Carries a robotic arm for picking up and depositing waste into the onboard trash bin.

2. Hardware Block Diagram

High-Level Diagram



Data Flow Explanation

1. **Sensors (Cameras, LiDAR, RADAR)**: Gather environmental data and transmit it to the Raspberry Pi for processing.
2. **Raspberry Pi**: Acts as the central computing platform, processing sensor data, making real-time decisions, and manages low-level control tasks such as motor control, servo actuation, and sensor interfacing.
3. **Actuation System**: Executes commands from the Raspberry Pi to control steering, braking, and acceleration.
4. **Robotic Arm**: Gets the data sent from the Raspberry Pi and executes its own commands based on the data sent by the Raspberry Pi and its own algorithms.
5. **Communication System**: Enables data exchange between Raspberry Pi, and external systems.
6. **Power Supply System**: Distributes power to all components.

3. Sensor Suite

Sensor Types and Specifications

- **Cameras**:
    - **Type**: RGB and Depth Cameras
    - **Location**: Mounted on the front, rear, and sides
    - **Field of View**: 120 degrees (front), 90 degrees (rear and sides)
    - **Data Output Formats**: RGB images, depth maps
- **LiDAR**:
    - **Type**: 3D LiDAR
    - **Location**: Roof-mounted
    - **Field of View**: 360 degrees
    - **Data Output Formats**: Point clouds

Sensor Selection Factors

- **Range**: LiDAR, Cameras
- **Resolution**: High resolution for detailed object detection and classification
- **Environmental Robustness**: Capable of operating in various weather and light conditions

4. Computing Platform

Central Processing Unit (CPU)

- **Model**: Raspberry Pi 5
- **Specifications**:

5. Actuation System

Components and Specifications

- **Motors**:
    - **Type**: Electric Brushless DC Motors
    - **Control Interfaces**: PWM control signals, CAN bus communication
- **Steering System**:
- **Braking System**:

6. Communication System

7. Power Supply System

8. Environmental Considerations

Addressing Environmental Factors

- **Temperature Control**: Active cooling systems for the Raspberry Pi and battery pack to maintain optimal operating temperatures. (Raspberry Pi Fan)