**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**

**Sensors**

**(Cameras, LiDAR)**

**Raspberry Pi**

**Robotic Arm**

**Actuation System**

**(Steering, Braking, Motors)**

**­­**

**Power Supply System**

**Communication System**

**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)