Overview

At WINLAB, there are many projects that involve self-driving cars in the Orbit Smart City. In the past, these projects utilized remote control cars and smart car kits, which lack accuracy in modeling the functionality of a real car.

In our project, we hope to provide greater simulation accuracy with our design for a 1:15 scale platform for miniature smart cars such that they can be repeatedly tested in the Orbit Smart City environment. This places a necessity for repeatability and precision using sensor feedback while adhering to the mechanics of a real car.

Our design includes many such mechanisms, such as Ackerman steering and a single drive motor running the back wheels through a differential gearing system and drive train, as well as sensors to calculate odometry data.

Our project involves:

- 3D modeling and printing of as many parts as possible
- Prototyping electrical systems and hardware
- Interfacing between hardware components through different means of communication to control the hardware as well as collect sensor information
- Cross-functional collaboration with teams within the intersection group (Remote Control, Autonomous Infrastructure, and Multi-CAM Teams)

Design Principles

To emulate the behavior of a real car as closely as possible, there are several principles that must be incorporated into the design.

Overall Form Factor

To conform to the size and shape a car would have in the Orbit Smart City environment, the goal was to design the dimensions to be ~1/5 the size of an average car. In our final design, the wheelbase is 150 mm and the track width is 125 mm. Due to some limitations with receiving parts, this makes our car slightly wider than an average car to scale. In the future, the track width can be lowered using the required hardware.

Differential Drive

In a back wheel drive car, when the car executes a turn, the outside wheel (red) must travel further than the inside wheel (blue) since its arc radius is larger. To solve this, our design incorporates a differential gearing system, which allows the motor to drive the two sides at different speeds since they are loosely coupled.

Differential Mechanics

The drive gear is the input which turns the bevel gear. When the car is driving straight, the spider gears don’t rotate. This causes the side gears and bevel gear to rotate equivalent amounts. When the car turns via the front steering, one side is forced to turn more than the other. This causes the spider gears to rotate, which adds rotational speed to one side and subtracts from the other.

Acknowledging Steering

Another complication with turning is that the wheels must turn different amounts. Since the outer wheels travel a longer distance, their arc radius is larger with a shallower angle than the inner wheels. This is achieved by an Ackerman steering linkage.

Final Design

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