Design Proposal: Driverless Car

Introduction:

In recent years, self-driving cars have gained tremendous popularity and have become an active research area in computer science (Ni, et al., 2020). The software used in autonomous vehicles needs to provide the capability to support different types of operations (Atakishiyev, et al., (2021). This document presents a software design proposal for supporting the operation of a driverless car, outlining three key operations that the software will facilitate. Additionally, rationales for the design choices and key decisions are provided.

Object Model:

Based on the conducted research, the following classes are proposed for the system design:

- **Sensor Class:** This class includes the attributes related to different sensors used in the vehicle, such as cameras, lidars, and radars. It also includes methods for detecting and recognizing objects in the environment (Caesar, et al., 2020).
- **Decision Class**: This class includes the attributes related to the decision-making process, such as the current state of the vehicle, perception data, and the decision made by the system. It also includes methods for making decisions based on the perception data and the current state of the vehicle.
- **Control Class:** This class includes the attributes related to controlling the vehicle, such as actuator commands, vehicle speed, and vehicle trajectory. It also includes methods for executing the decisions made by the system by controlling the actuators of the vehicle.

Operations/Scenarios:

1. **Lane Detection:** Lane detection is a critical component of self-driving cars as it helps the car to maintain its position within the lane and to navigate safely on the road. According to a study by (Zhang et al., 2018), lane detection is essential for road recognition, path planning, and motion control in autonomous vehicles.

2. **Obstacle Avoidance:** Obstacle avoidance is a crucial aspect of autonomous driving as it helps the vehicle to detect and avoid obstacles in its path. According to a study by (Qian, et al., 2022), obstacle avoidance is an essential component of self-driving cars as it helps to improve safety and reduce accidents.
3. **Traffic Signal Recognition:** Traffic signal recognition is important for self-driving cars as it helps the vehicle to detect and respond to traffic signals such as stop signs and traffic lights. According to a study by (Ciuntu, et al., 2020), traffic signal recognition is a crucial component of autonomous driving as it helps to improve safety and reduce accidents.

UML models:

The UML models for the design and operation of the system are as follows:

Use Case Diagram:

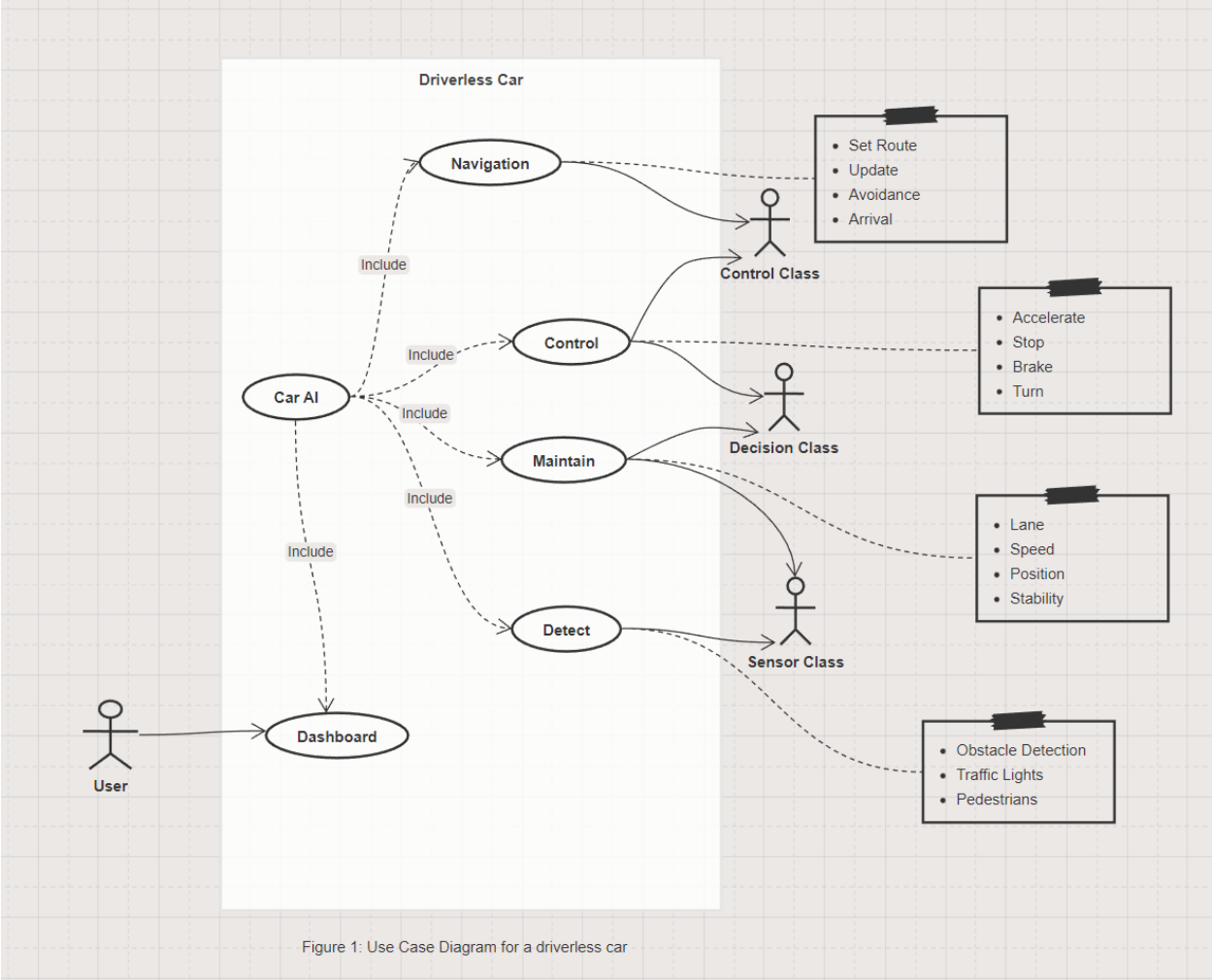
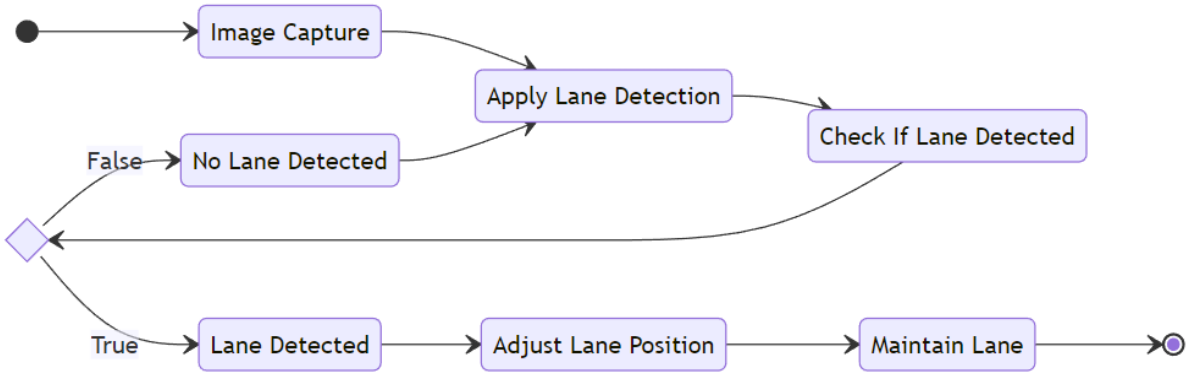


Figure 1: Use Case Diagram for a driverless car

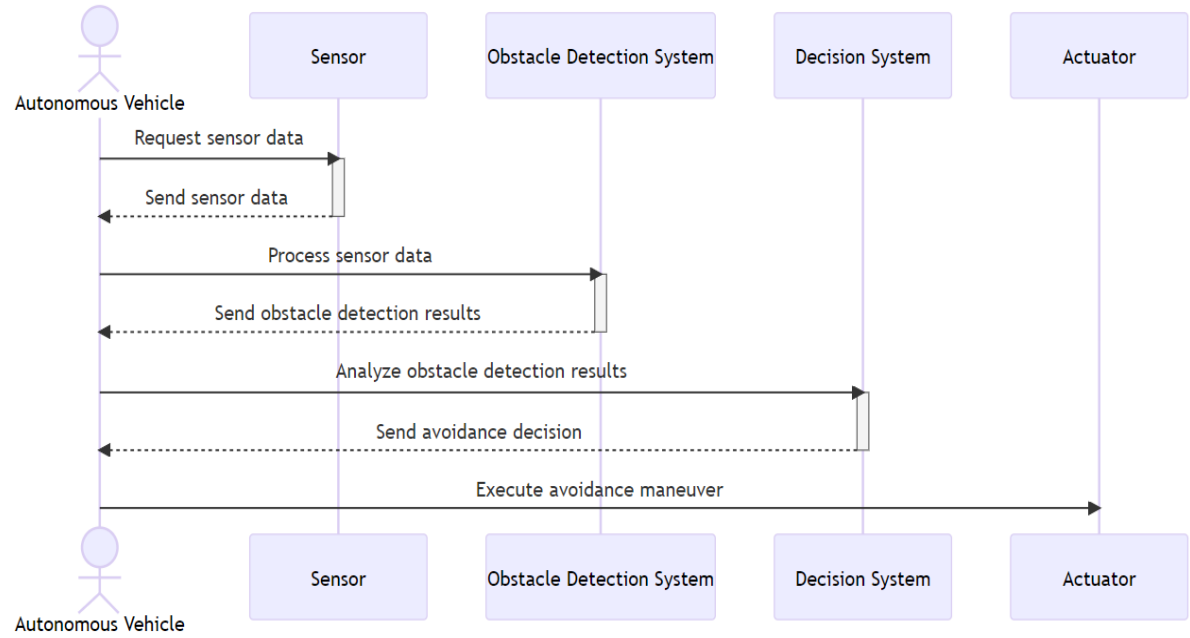
Activity Diagram:

Figure 2: Activity diagram for driverless car in the lane detection operation



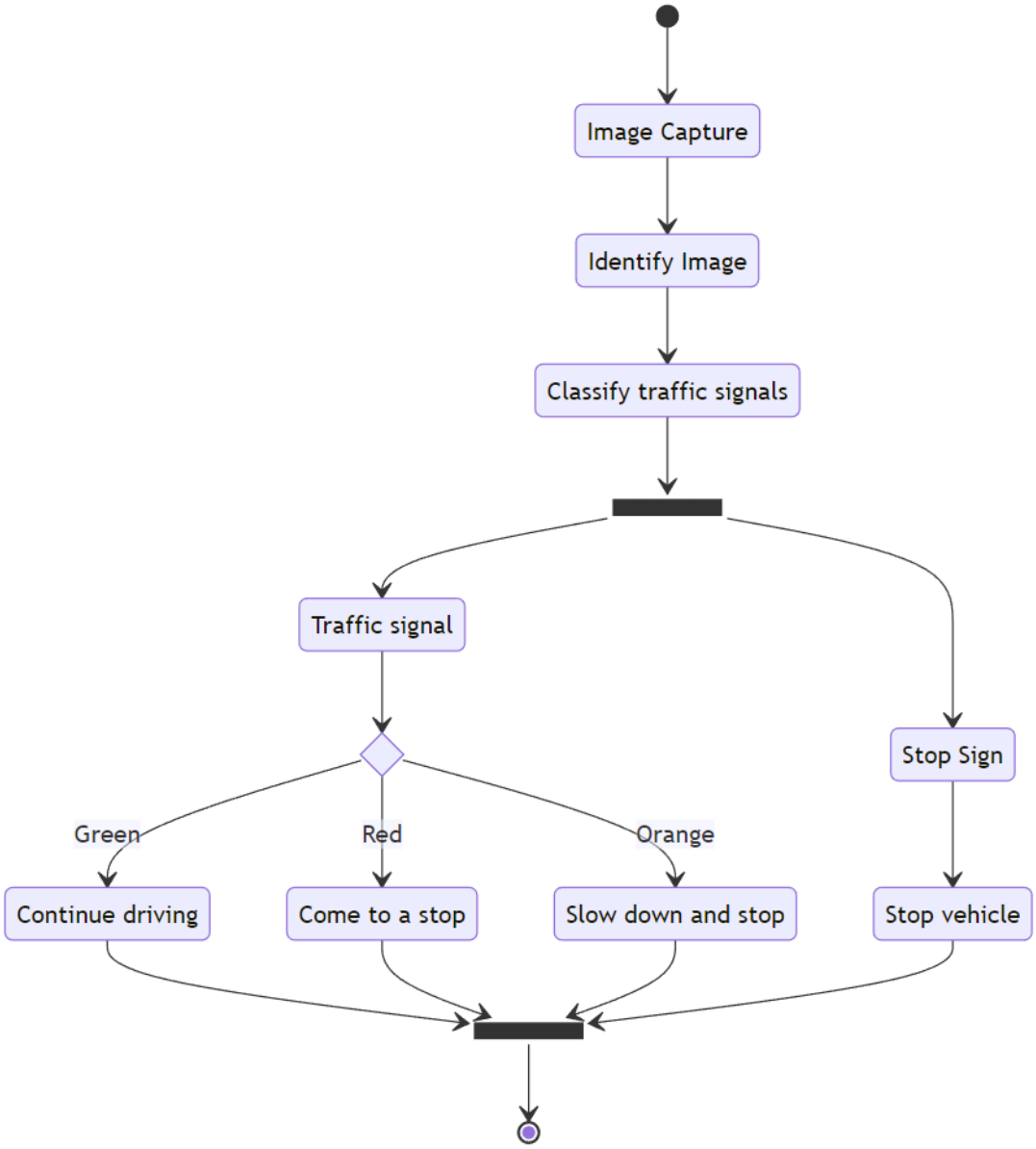
Sequence Diagram:

Figure 3: Sequence Diagram for driverless car in the object avoidence operation



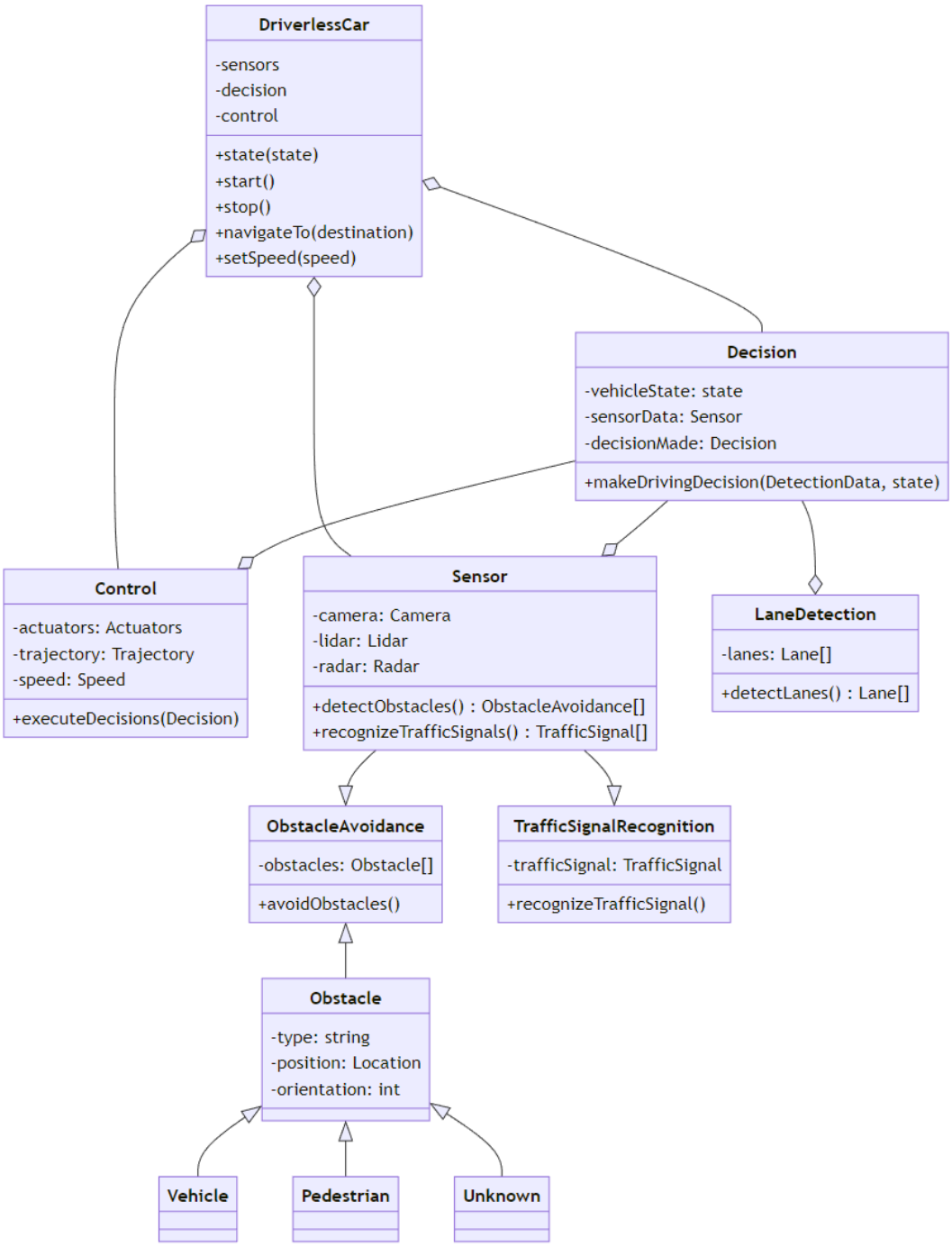
State Machine Diagram:

Figure 4: State machine diagram for driverless car in the traffic signal recognition scenario



Class Diagram

Figure 5: Class Diagram for driverless car



Data Structures:

- **List:** stores a collection of sensor data and can be used to pass data to the perception system.

- **Stack:** can be used to implement a navigation system by adding available paths at decision points and popping off the chosen path.
- **Dictionary:** stores information about the car's surroundings, such as the location of other vehicles or traffic signals, with keys representing object type and values containing object information.
- **Queue:** can be used to schedule tasks or actions for the car to perform, such as slowing down or changing lanes.

References:

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