Autonomous Car System Design

Summative Assessment: System Design

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Autonomous Car Features

A driverless car features several systems that are capable of perceiving the environment with minimal human input. Complex algorithms including car navigation, environment perception, car control and path planning are required with numerous sensors and computers (Jo, et al. 2014).

There are several key terms that are used for conducting background research on self-driving cars:

a. **Driverless Cars Environmental Mapping**
b. **Traffic Recognition**
c. **V2V Communication**

Moreover, there are 3 fundamental operations that features a driverless car:

1. **Environment interpretation and obstacle detection.**

   Sensor generated information as well as improved image recognition technologies from devices such as LIDAR, SONAR, and GPS, robotic cars are able to better identify surrounding objects and run it against the TSRS (Erso & Waqar 2020). This includes other vehicles information, traffic lights, and traffic signs (Zhou & Liqun 2019). In this case, recorded information is classified into categories and stored (Resmi & Shruthi, 2019). However, detected objects that do not exist in any database will be classified as obstacles.

2. **Vehicle to vehicle Communication.**

   Utilizing wi-fi technology for short range communication, vehicles exchange detailed positioning, velocity and direction (Yogha 2021). The purpose of this is to provide collision warning system and cooperative driving. This insures traffic fluidity and collision free circulation (Hasan, et al., 2020). Broadcasted information from nearby vehicles will appear on the user's dashboard.

3. **On-board control unit**

   Based on processed data from recorded sensor information such as surrounding objects and nearby vehicles (V2V), the on-board unit will send control commands that determines the route and speed of the self-driving car (Reddy 2019). This data will be stored in the control unit.

UML Model Design

1. **Use Case Diagram**

   Autonomous car use-case model illustrates the implementation of features in relation with actors and conditions such as the user, the control unit, and the obstacle.

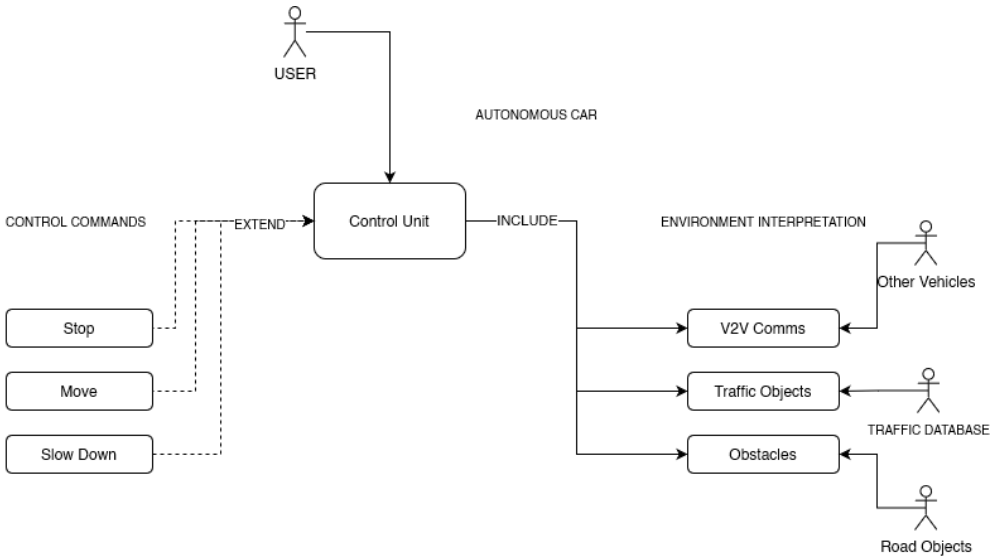
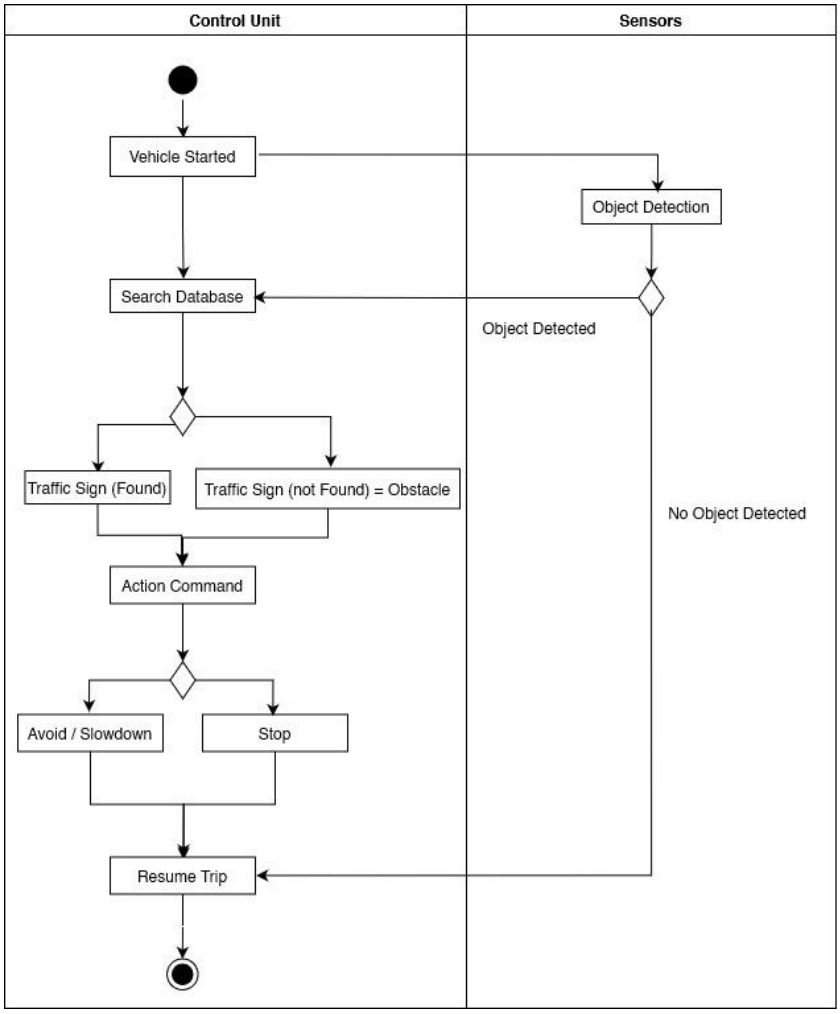


Figure 1: Autonomous car Use-case Diagram

2. Activity Diagram

The activity diagrams showcase the interaction between sensor generated information, environment interpretation database and control commands.


Control Unit
Sensors
Vehicle Started
Object Detection
Search Database
Object Detected
Traffic Sign (Found)
Traffic Sign (not Found) = Obstacle
No Object Detected
Action Command
Avoid / Slowdown
Stop
Resume Trip

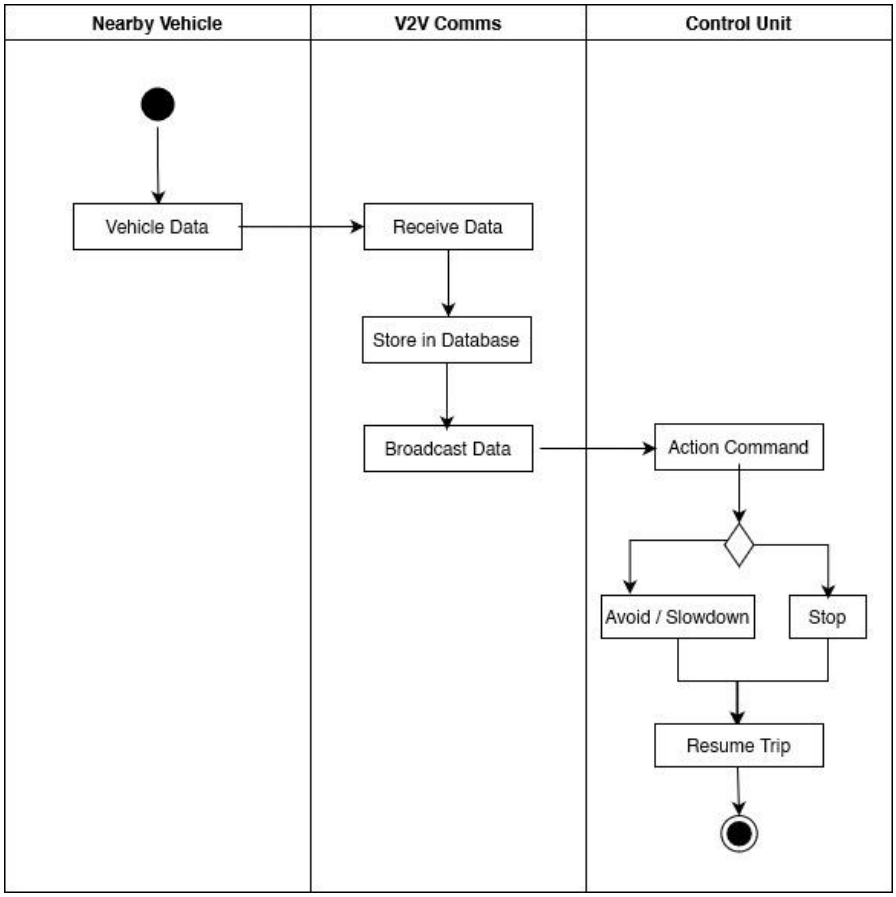


Figure 2: Object Detection and vehicle communications.

3. Class Diagram

The class model previews the design implementation of the driverless car.

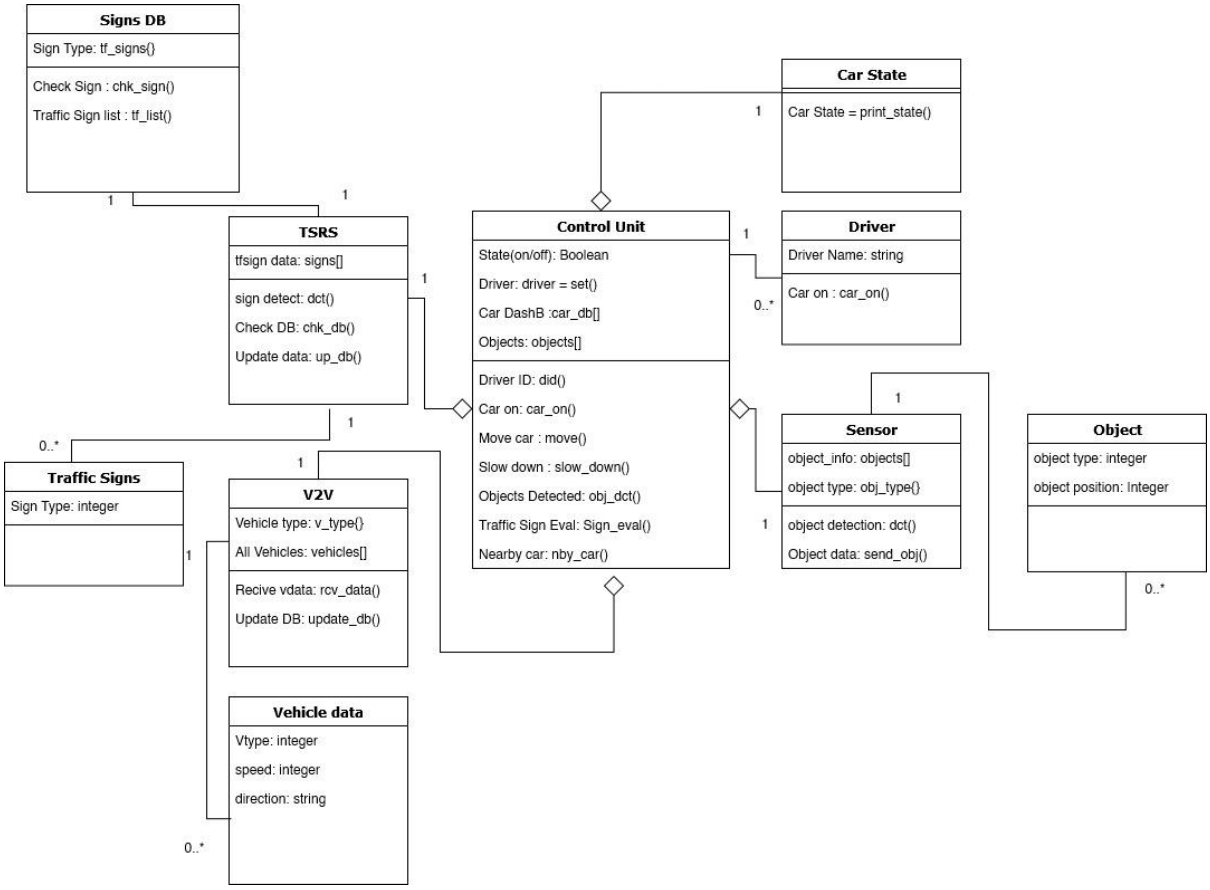


Figure 3: Class Diagram, Autonomous Car

4. Sequence Diagram

The sequence model showcases the series of actions between control units and car systems. Each system will initiate a sequence based on the system type.

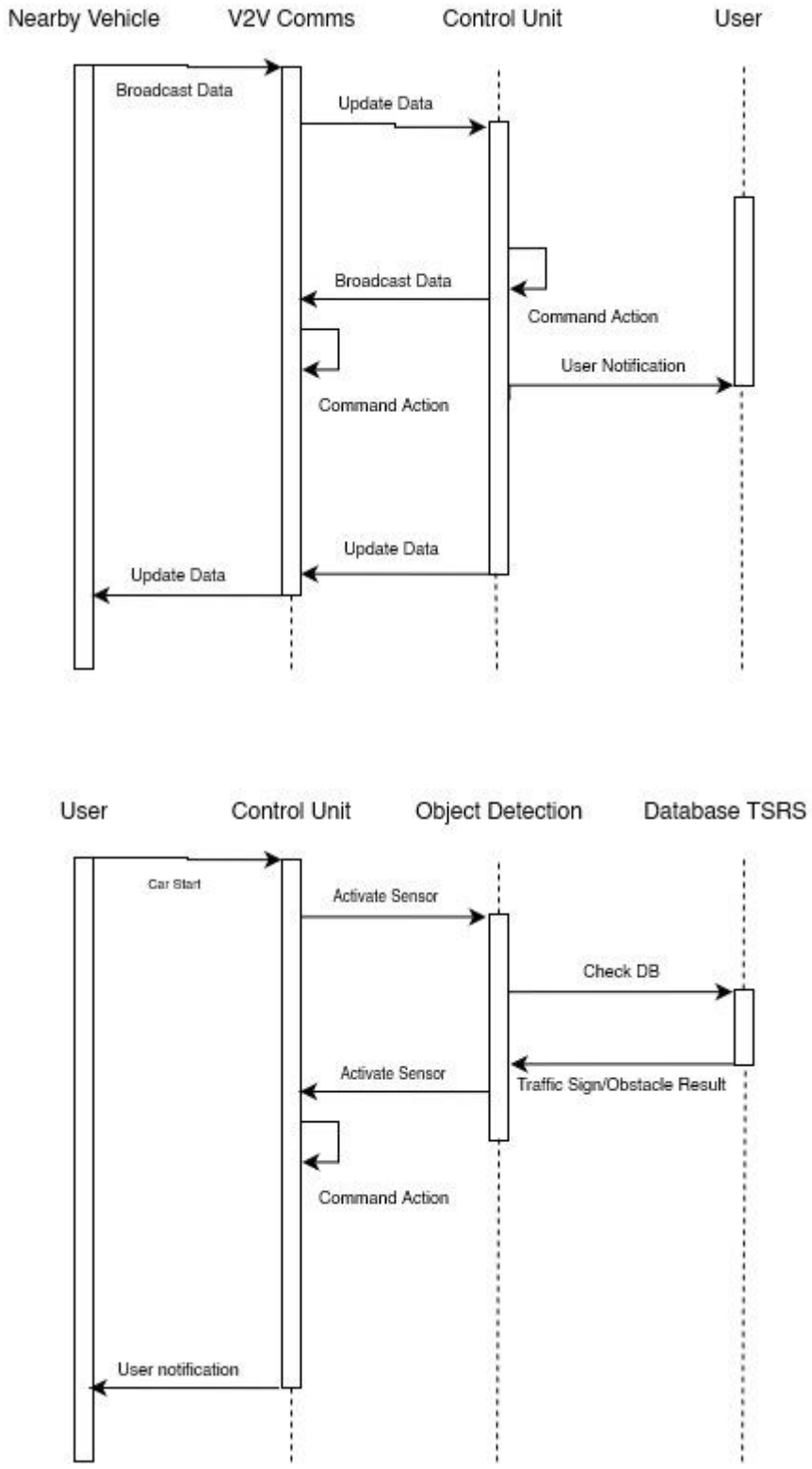


Figure 4: Sequence Diagrams, V2V and object detection

5. State Transition Diagram

Autonomous car systems will transition depending on the current state. Events such as surrounding obstacles, nearby vehicle information will perform an action on the system's current state.

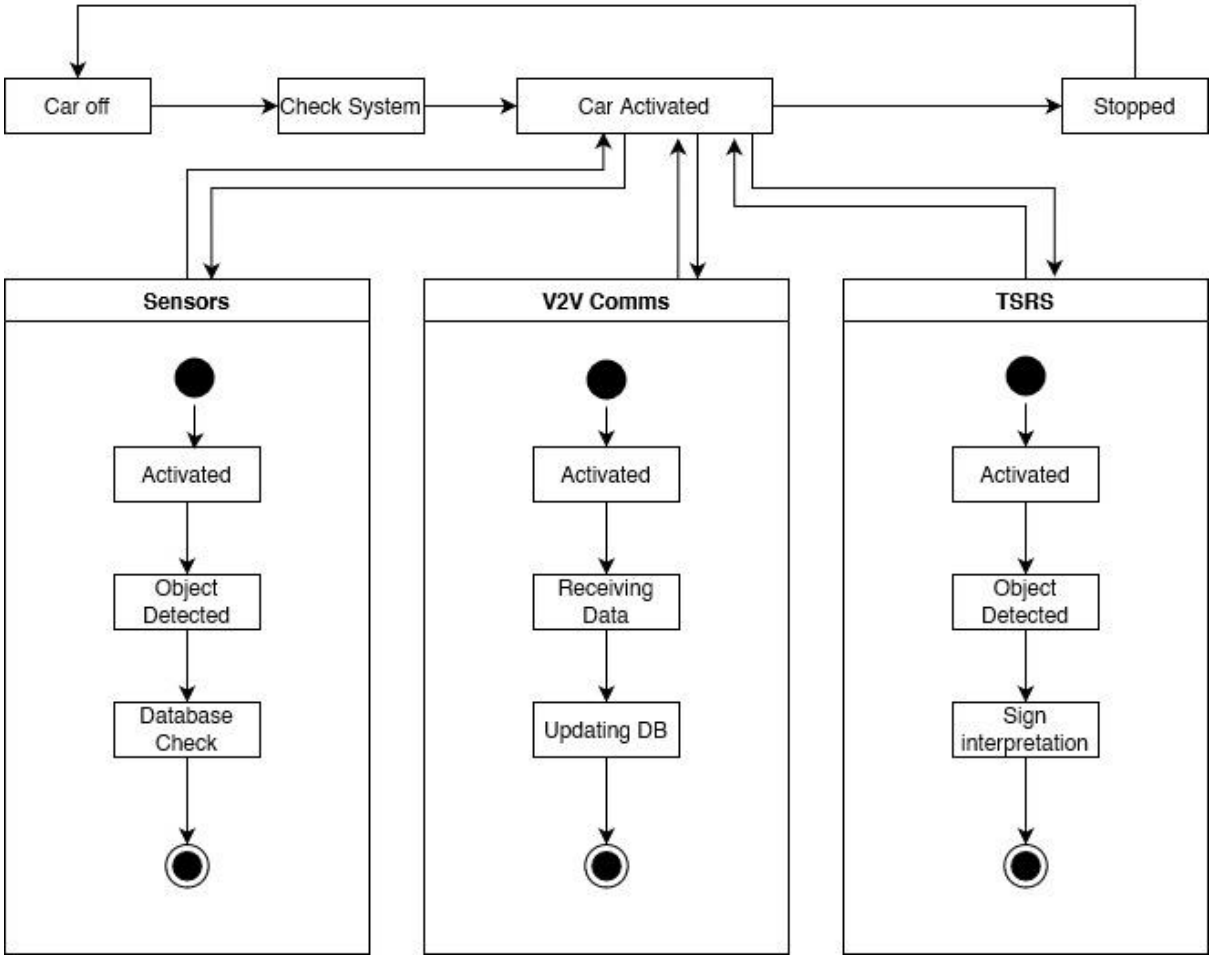


Figure 5: State transition diagram between car systems

Data Structures

1. **List**

   The **environmental interpretation** feature will contain a database consisting of environment objects such as vehicles[] and signs[].

2. **Stack**

   Since stack is a linear data structure, **The On-board control unit** feature will display updated vehicle interactions with road objects as a notification.

   Car_db = []

3. **Queues**

   The Obstacle Detection feature will detect environmental objects in which will be stored then evaded, thus the queue data structure will be applied on objects [].

4. **Dictionary**

   Within the environmental interpretation database, are datatypes that differentiate between surrounding objects, vehicles and its behavior. Obj_type = {vehicle: ‘car’, traffic_sign : ‘1’, traffic_light : ‘1’, object_motion : ‘true’)

References

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Hasan, N., Jahan, N. & Anzum, T., 2020. *Traffic Sign Recognition System (TSRS): SVM and Convolutional Neural Network.* Springer, LNNS.

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