Design Proposal

1. Background research

The following terms were used during the background research, usually in conjunction with each other:

Research terms	Critical information sought
Autonomous cars	The features of driverless cars
RADAR, LIDAR, sensors, traffic sign recognition	The most effective methods to detect objects around the car and recognize the traffic signs
V2V, V2I	Latest trends and technologies in V2V and V2I

2. Selection of operations

As per the assignment instructions and considering the fundamental features (Yoganandhan, et al., 2020) and key technologies (Reddy, 2019) of driverless cars, three operations were chosen to be supported in the system.

a. Detecting the obstacles on the road:

Due to its high efficiency and accuracy (Hecht, 2018), LiDAR is projected to be used in the autonomous car. In this context of this project, the term “obstacle” refers to anything on the way of the car that impedes the car from moving forward. In this sense, pedestrians, traffic cones or any kind of objects on the road are considered an obstacle.

b. Detecting and interpreting the traffic signs:

As demonstrated by Aghdam et al. (2016), it is possible to detect traffic signs using a high-resolution camera and Convolutional Neural Network (Convnet) with a precision up to 99.89% when tested against German Traffic Sign Benchmark (INI, 2019) dataset. To simulate this idea in this project, the Traffic Sign Recognition System (TSRS) that will communicate with Traffic Management Authority (TMA) database is created.

c. Vehicle to Vehicle (V2V) communication:

V2V communication module is usually comprised of ambient sensors and backscatter sensor tags (Jameel, et al., 2019) and it listens the environment and gathers information about other vehicles and it also broadcasts its own trip information. In this project, V2V Comms module will store the information gathered from other cars in a list and share it with the control unit.

3. UML models

a. Methodology:

The design of UML models started with a description of the system which helped to identify the use cases and classes in the system. Then, use case diagram is designed first, followed by the activity diagrams, state machine diagram, sequence diagrams and the class diagram. The reason behind follow this order was to start from the design-related aspects of the system and get deeper towards the implementation details.

b. Use case diagram:

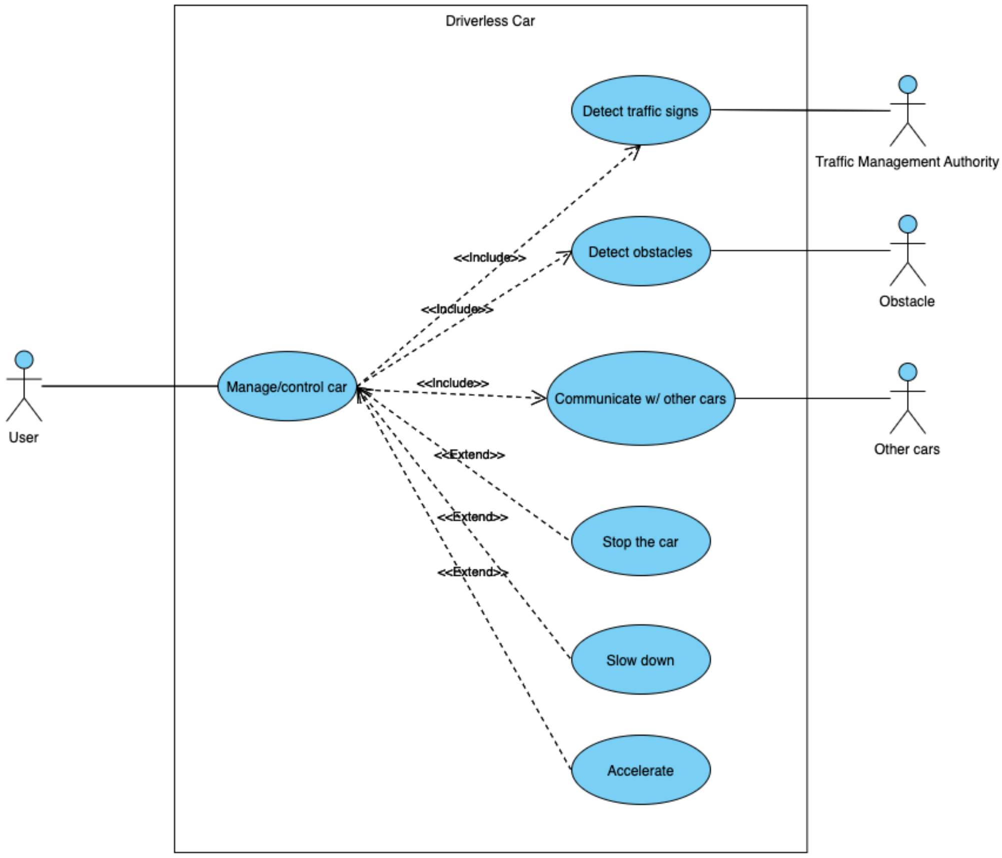

Figure 1: Use case diagram of a driverless car

c. Activity diagrams:

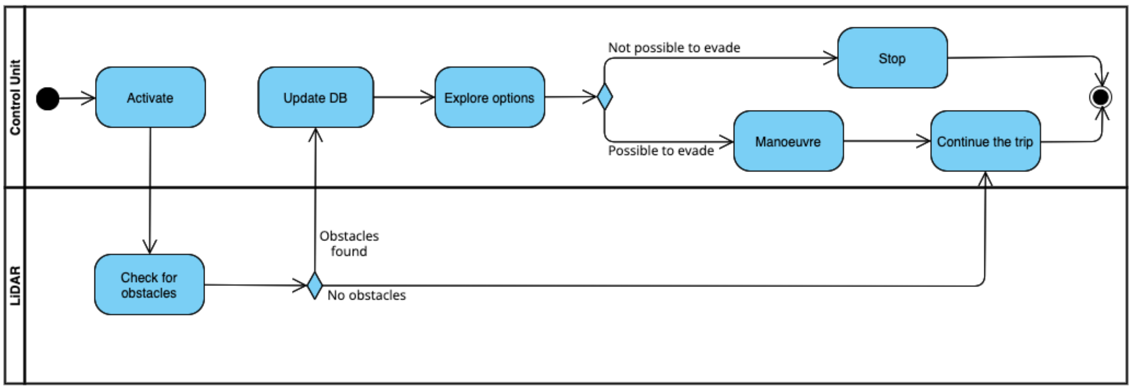

Figure 2: Activity diagram for "detect obstacles" use case

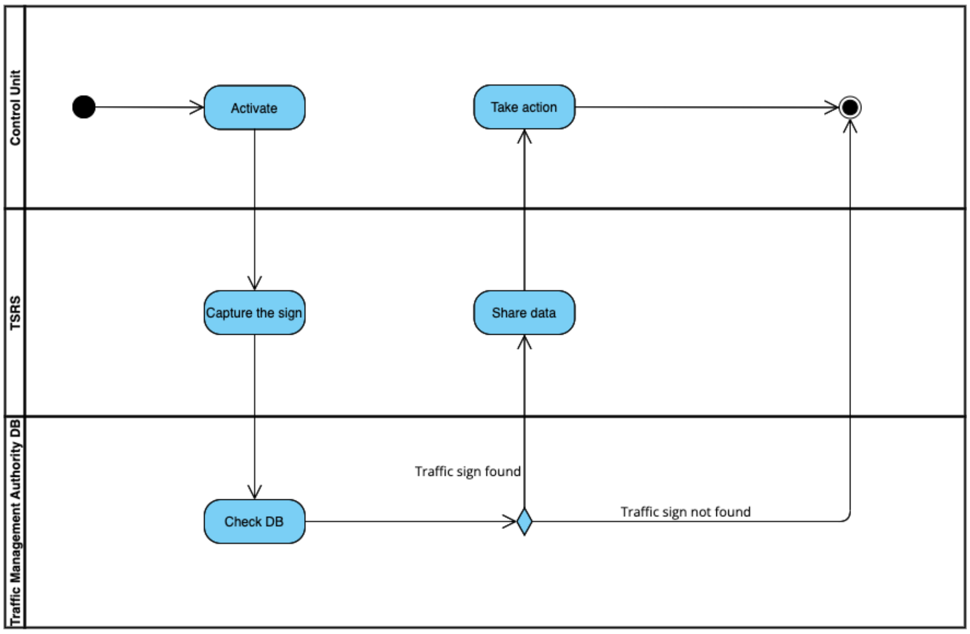

Figure 3: Activity diagram for "detect traffic signs" use case

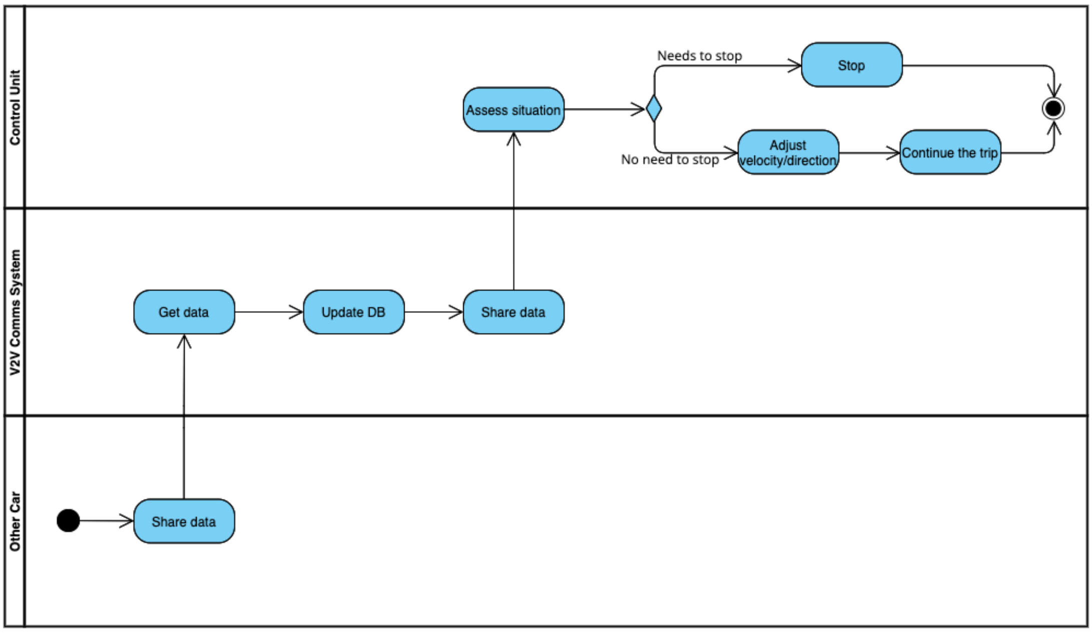

Figure 4: Activity diagram for "V2V communications" use case

d. State machine diagram:

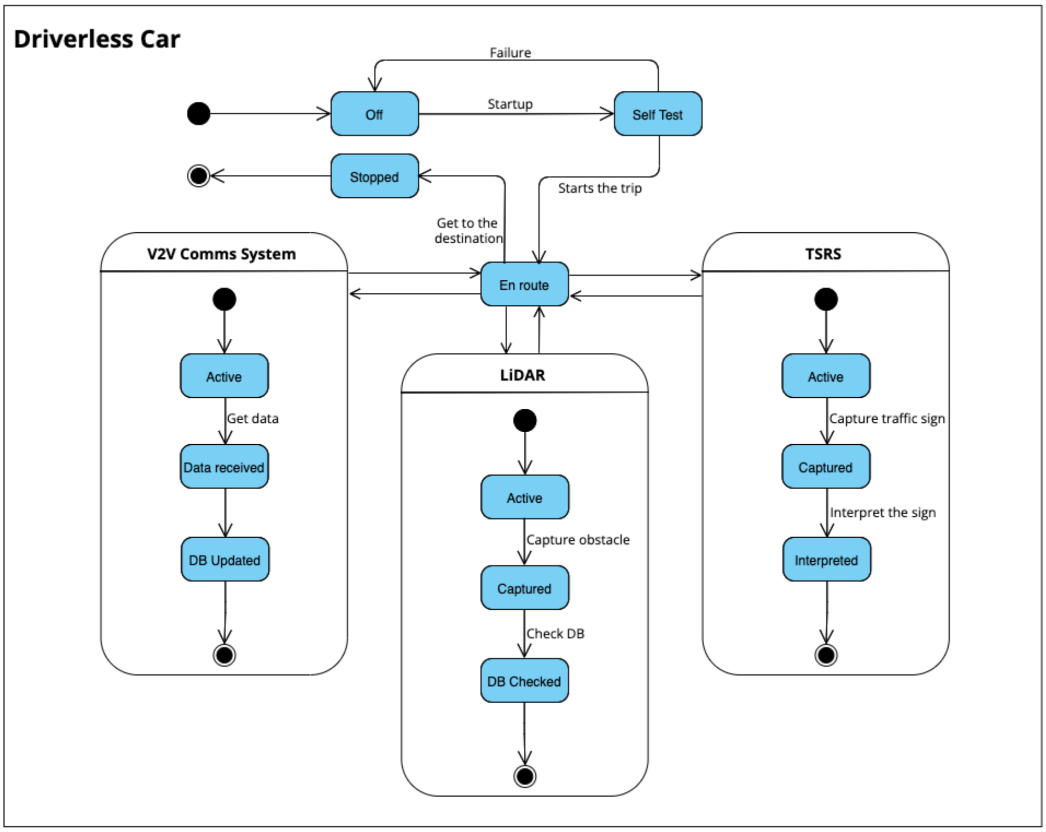

Figure 5: State machine diagram of the driverless car

e. Sequence diagrams:

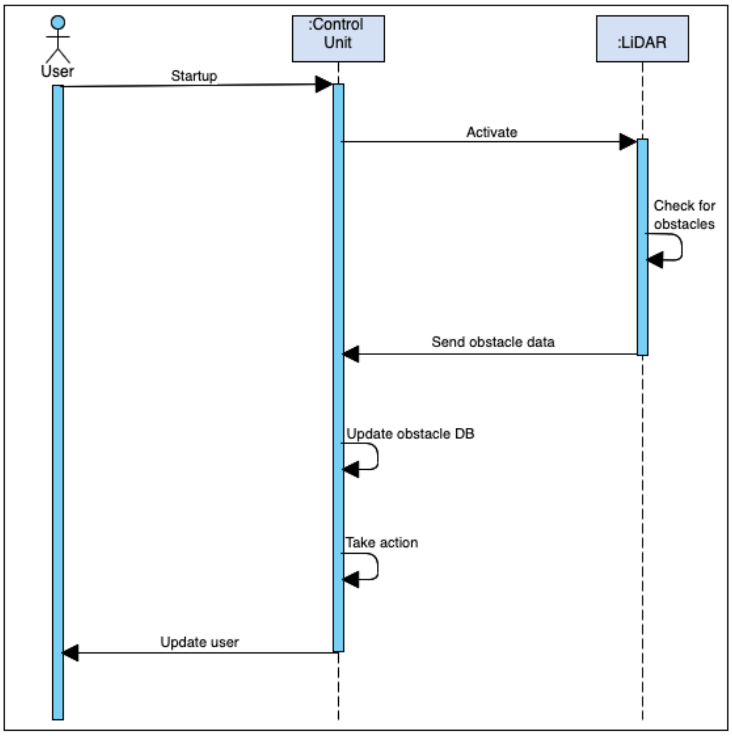

Figure 6: Sequence diagram for detecting obstacles

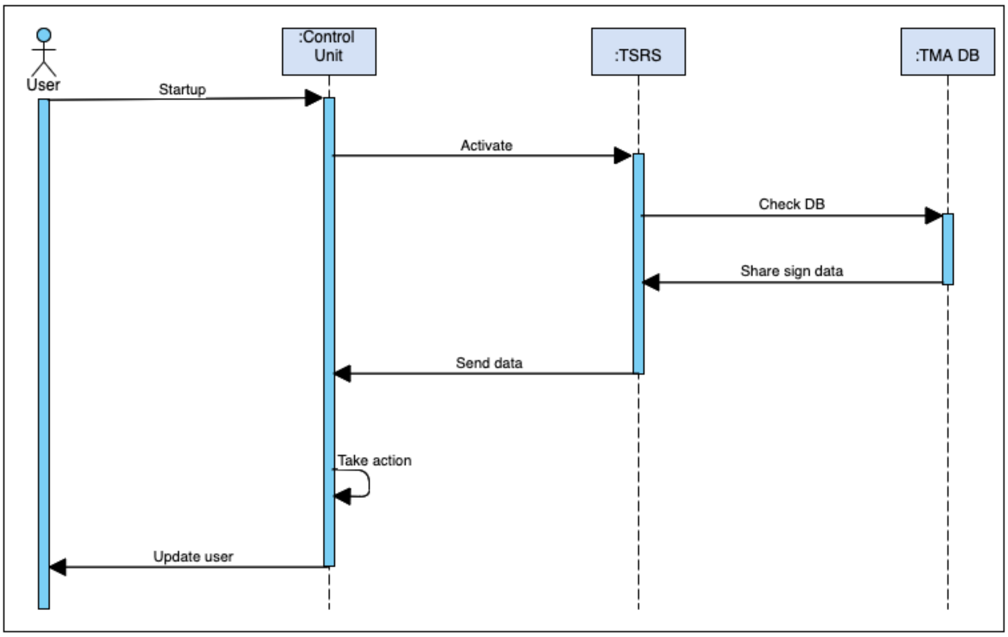

Figure 7: Sequence diagram for detecting traffic signs

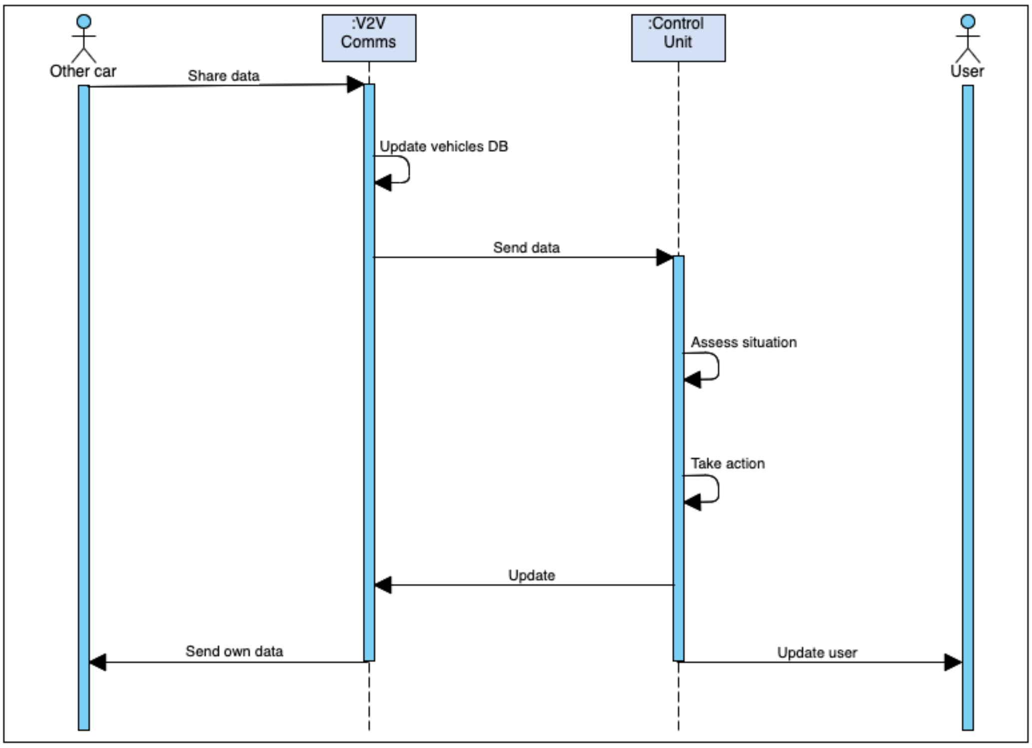

Figure 8: Sequence diagram for V2V communications

f. Class diagram:

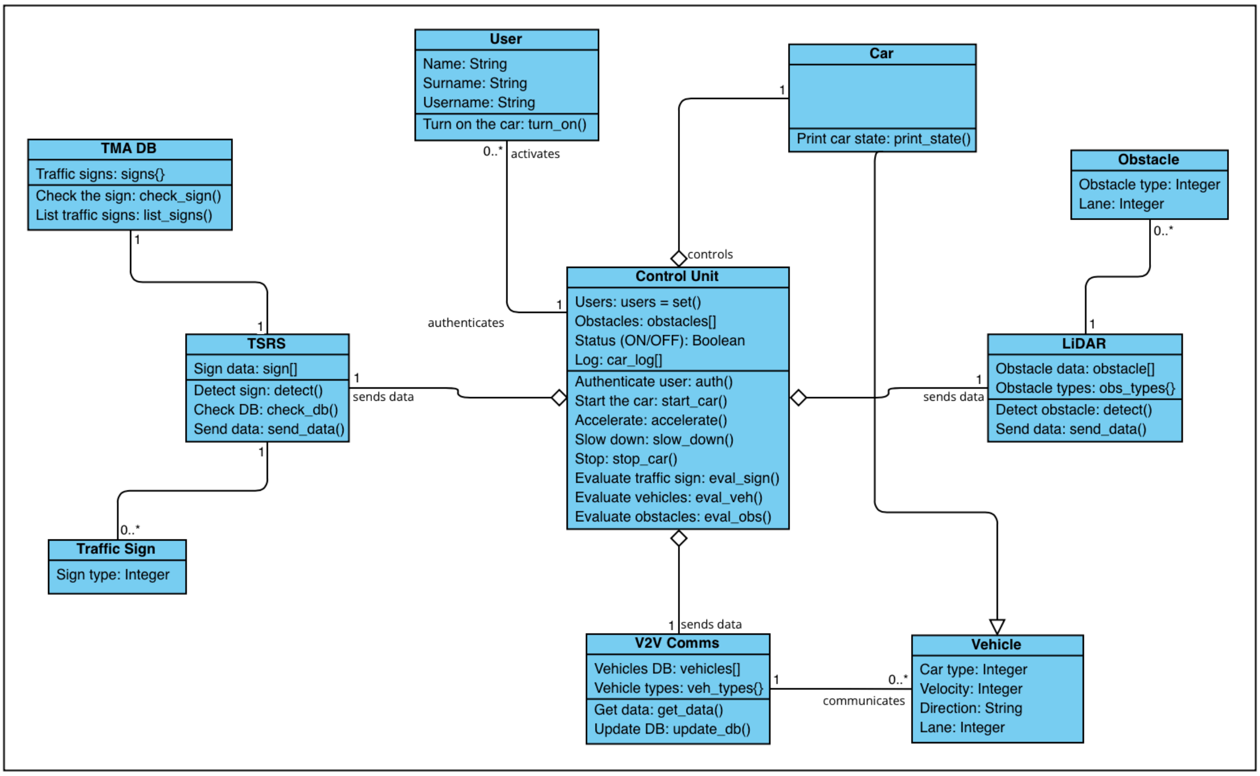

Figure 9: Class diagram of a driverless car

4. Data structures used in the system

a. Lists:

Lists are mainly used to simulate databases in the project (i.e. vehicles[], sign[], obstacles[]).

b. Dictionaries:

Traffic Signs and Obstacle Types are stored in dictionaries as key:value pairs.

c. Sets:

Usernames are stored in a set because the sets do not allow duplicate values, enabling easier membership test (e.g., authenticate the user).

d. Queues:

The only queue implemented in the system is the obstacles[] managed by the control unit. Each obstacle detected by the LiDAR unit will be appended to the obstacles[] queue. Because the first detected obstacle will also be the first one to be evaded, it will be dequeued first.

e. Stacks:

The car log, which stores the messages/warnings sent to user by the control unit is implemented as a stack. The user reads the latest message first and then the message is deleted from the log.

References

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