A Design Proposal of Software to Support Operation of a Driverless Car

In the process of designing software to support the operation of a driverless car, extensive research was conducted on various aspects of autonomous vehicles, driverless car technology, and related software engineering principles. The following key terms were included in the research:

Operations:

In addition to the core system components and modules, our driverless car software incorporates three essential operations to enhance user interaction and simulate real-world driving scenarios.

Route Planning and Navigation:
Purpose: Allows users to input their destination and calculates the best route for the car.
Integration: Utilizes GPS and real-time camera data to plan routes and interfaces with control systems.
User Interaction: Users input destinations and receive route guidance through the front-end interface.

Real-Time Sensor Data Display:
Purpose: Provides real-time sensor data from cameras, GPS, radar, and more.
Integration: Aggregates data from various sensors for a comprehensive view of the car's surroundings.
User Interaction: Users monitor the car's surroundings via user-friendly visualizations on the front-end.

Emergency Handling:
Purpose: Ensures the car can respond to emergencies during autonomous driving.
Integration: Collaborates with control systems to execute emergency actions when needed.
User Interaction: Allows users to trigger emergency actions through the front-end interface.

Scope of the Development Project:

The project's primary goal is to tackle the longstanding problem of road safety and self-driving, which leads to over 1.3 million preventable global road accident-related deaths annually. Additionally, the increasing traffic congestion results in longer commute times, impacting productivity and the environment.
Recent advancements in machine learning and AI, along with improved computer performance, enable the development of self-driving cars. These vehicles offer several key benefits:

Accessibility: Self-driving cars have the potential to enhance transportation accessibility for individuals with disabilities, the elderly, and those who cannot operate traditional vehicles.

Enhanced Road Safety: Self-driving cars are immune to human errors and distractions, enabling swift and precise responses to real-time road conditions.

Lower Expenditure: Fewer accidents translate to reduced expenses associated with damages and repairs.

Data Collection: These vehicles can collect vast amounts of data on road conditions, traffic patterns, and weather, which can be invaluable for urban planning and infrastructure improvement.

Reduced Commute Times: Through communication and advanced GPS systems, self-driving cars significantly shorten commute durations, reducing traffic congestion.

Environmentally Friendly: Self-driving cars employ efficient driving techniques, resulting in lower emissions and a greener transportation system.

Reduced Need for Parking Space: As self-driving cars can drop off passengers and park themselves efficiently, they can reduce the need for extensive parking infrastructure in urban areas.

Enhanced Public Transportation: Self-driving technology can complement public transportation systems, providing efficient first- and last-mile connectivity to transit hubs.

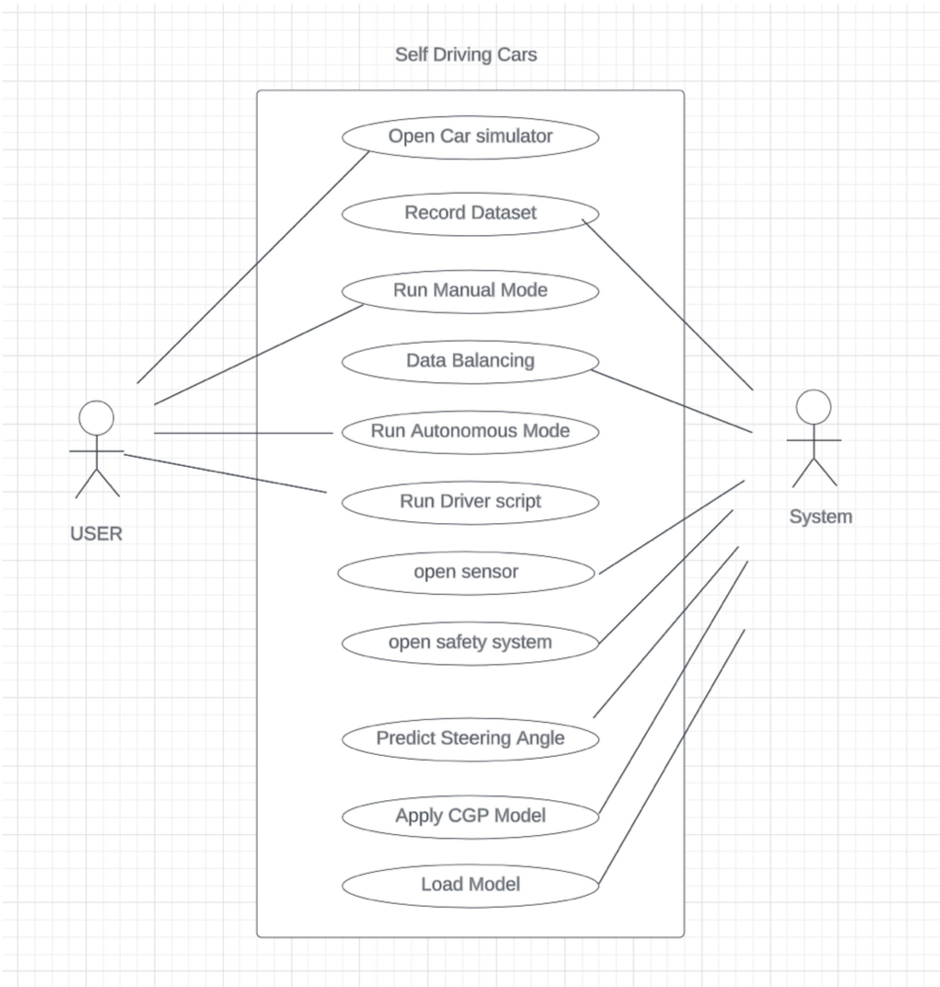
Enhanced Traffic Discipline: Effective law enforcement and traffic management can be achieved by implementing speed caps in various regions.

Overview of Modules and Components:

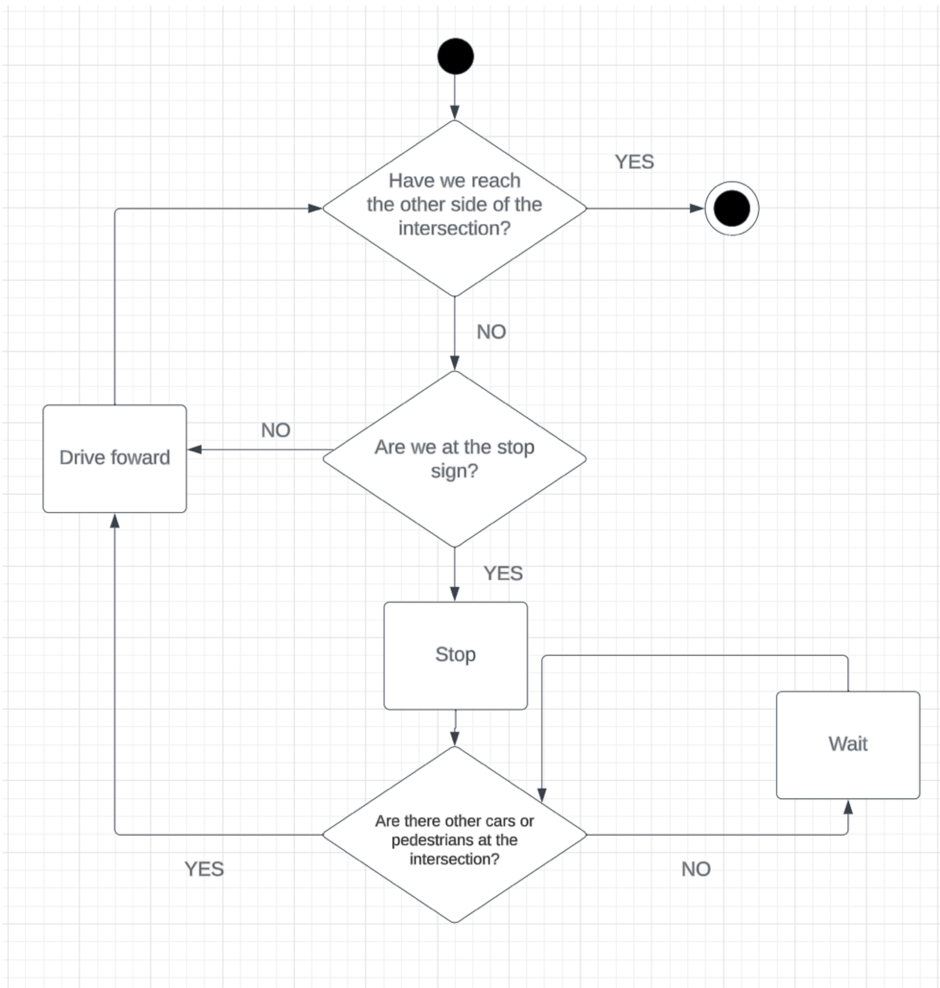
1. Android Devices
   - **Camera Module:** Captures real-time visuals from the car's perspective and processes the data using machine learning for environment assessment.
   - **GPS Module:** Determines the car's precise location and aids in navigation using Google Places API data.
   - **Compass Module:** Provides the car's current heading direction for accurate motion control.
2. Driver
   - **Software Driver:** Controls the car's motors, manages speed, directs movement, and handles turning angle and direction.
3. Control Systems
   - **Control Systems**: Regulate speed, steering, and braking for safe and efficient car operation.
4. Cloud Platform
   - **Machine Learning Algorithm:** Processes camera data to assess the car's environment and informs the car's motion.
   - **Storage:** Hosts the machine learning algorithm and stores training/testing data, as well as location and heading information.
5. Sensor
   - **Sensor Fusion:** Combines data from various sensors like lidar, radar, cameras, and GPS to create a comprehensive view of the vehicle's surroundings.

This system's core purpose is to enable autonomous driving by integrating and processing real-time data from these components to ensure safe and efficient navigation.

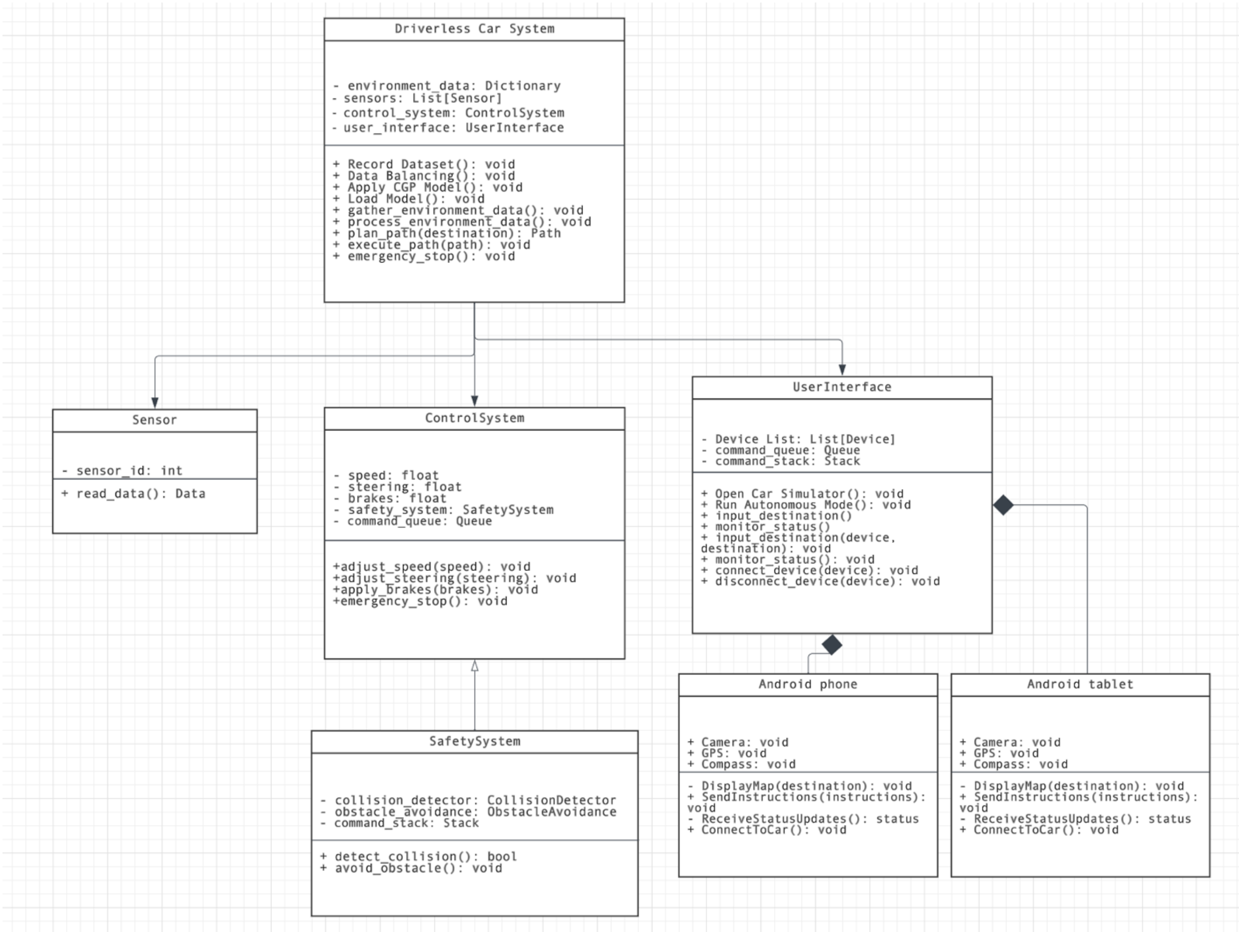
UML Models:



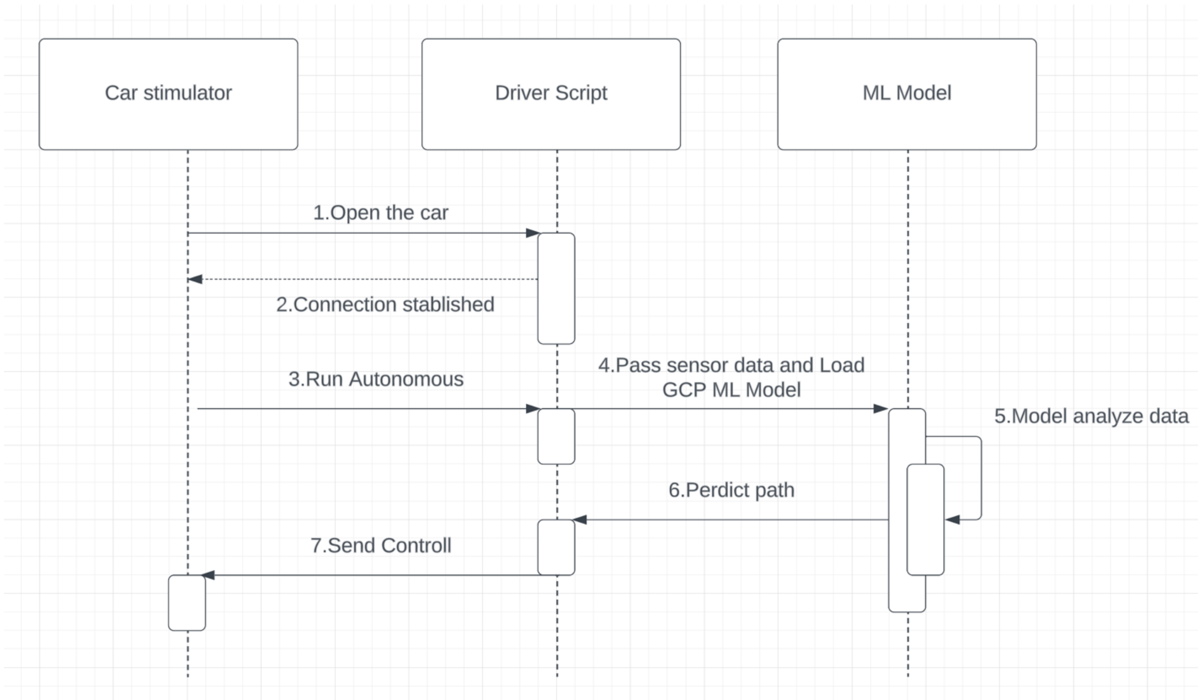
Use Case Diagram: This diagram illustrates the use cases of self-driving between user and system.



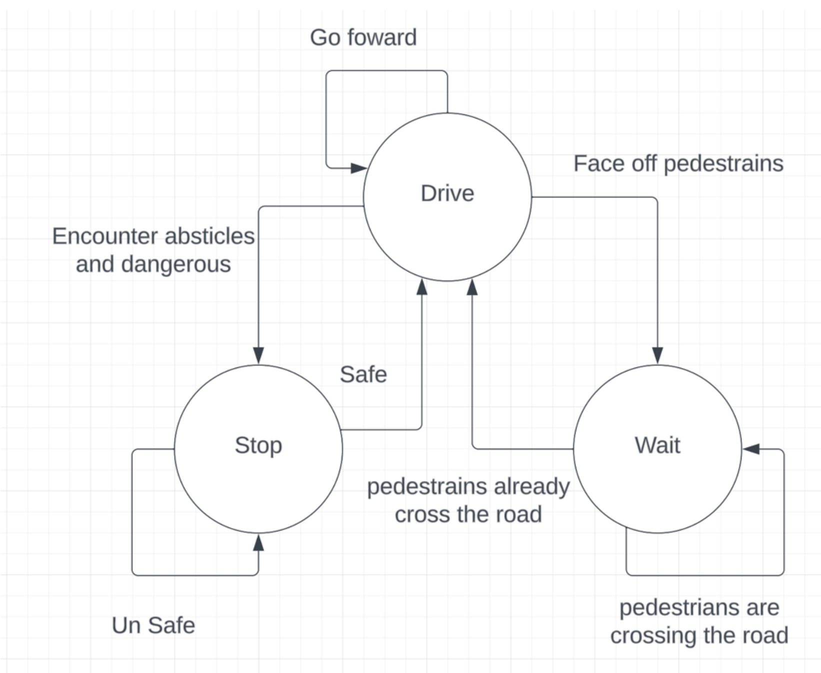
Activity Diagram for autonomous mode at intersection: Activity diagrams depict the flow of cross intersection activities within the self-driving system.



Class Diagram: Class diagrams represent the classes and their relationships within the system, including classes for sensors, control systems, and user interfaces.



Sequence Diagram: Sequence diagrams show the interactions and message exchanges between objects and components during route planning scenarios.



State Transition Diagram: State transition diagrams model the different states and transitions of the autonomous car, including waiting, driving, and emergency stop states.

Data Structures for Efficient Data Retention Usage:

Queue-Based Task Management (FIFO) :
Navigation Commands: Follow commands like turns and straight paths in the order they're received.

Continuous Route Planning: Add planned route segments to the queue for sequential execution.

User Requests: Handle user actions like stopping, dropping off passengers, or changing destinations in the order they're requested.

Stack-Based Priority Handling (LIFO) :
Emergency Commands: Prioritize urgent actions like "Emergency Stop" to be executed immediately, overriding other commands.

Interrupted Actions: Pause complex maneuvers and prioritize "Abort" commands when users need to interrupt the current action.

Last-Minute Changes: Handle late route changes or user instructions by executing the most recent ones first.

In short, queues maintain order and prioritize tasks based on when they were received, while stacks give priority to the most recent tasks, making them useful for urgent or interrupted actions in the self-driving car system.

Dynamic Data Storage with List:
Sensor: Lists are used to store dynamic data, such as historical sensor readings and navigation waypoints.

Efficient Data Organization with Dictionary:
environmental data: Dictionaries excel in their capacity to effectively organize various attribute data types, such as environmental data. By utilizing key-value pairs, dictionaries provide an efficient means for objects to link and access their specific data, ensuring a streamlined and structured approach that aligns objects with their pertinent information.

In conclusion, the proposed software for supporting the operation of a driverless car is designed to encompass a comprehensive understanding of autonomous vehicle technology and software engineering principles. It employs an object-oriented approach, integrates machine learning, provides a user-friendly interface, and includes various UML diagrams and data structures to create a robust and efficient system. This design aims to address the challenges and complexities of autonomous driving while ensuring safety and reliability.

Reference:

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