### Detailed Use Case

4.3.2.1 Set Destination

|  |  |
| --- | --- |
| Use Case ID: | UC001 |
| Use Case: | Set Destination |
| Actor: | Passenger |
| Precondition: | The Car is integrated with the system |
| Basic Flow: | 1. Passenger launches the autonomous vehicle system. 2. System presents a GUI interface displaying fixed destination options. 3. Passenger selects a destination from the provided options. 4. System validates the selected destination. 5. System confirms the set destination to the passenger. |
| Alternative Flow: | 4a. If the selected destination is not available or invalid, the system prompts the passenger to select another destination from the provided options or input a custom one. |
| Post Condition: | The destination is successfully set in the system. |

Table 4.1 - Detailed: Use-case Access Map

4.3.2.2 Path Route

|  |  |
| --- | --- |
| Use Case ID: | UC002 |
| Use Case: | Path Route |
| Actor: | Ego Vehicle |
| Precondition: | The destination is set. |
| Basic Flow: | 1. System receives the set destination from the passenger.  2. System retrieves the current location of the autonomous vehicle.  3. System calculates the optimal path from the current location to the destination using path planning algorithms.  4. System verifies the calculated path for feasibility and safety.  5. System generates the finalized path for navigation. |
| Alternative Flow: | None |
| Post Condition: | The system successfully calculates a feasible and safe path from the current location to the destination for the autonomous vehicle to follow. |

Table 4.2 - Detailed: Use-case Plan Route

4.3.2.3 Generate Waypoints

|  |  |
| --- | --- |
| Use Case ID: | UC003 |
| Use Case: | Generate Waypoints |
| Actor: | Ego Vehicle |
| Precondition: | The route is planned. |
| Basic Flow: | 1. System receives the planned route. 2. System divides the planned route into discrete waypoints 3. System assigns coordinates to each generated waypoint to define the navigation path. |
| Alternative Flow: | 2a. If the planned route is obstructed or unavailable, the system recalculates the route using alternative paths and regenerates waypoints accordingly. |
| Post Condition: | Waypoints are successfully generated along the planned route for navigation. |

Table 4.3 - Detailed Use-case: Generate Waypoints

4.3.2.4 Navigate Generated Waypoints

|  |  |
| --- | --- |
| Use Case ID: | UC004 |
| Use Case: | Navigate Generated Waypoints |
| Actor: | Ego Vehicle |
| Precondition: | Waypoints are generated |
| Basic Flow: | 1. System retrieves the planned route and waypoints. 2. System allows the vehicle to follows the planned path by steering, accelerating, and braking as necessary to reach each waypoint. 3. System continuously monitors the vehicle's position and adjusts the guidance commands to keep the vehicle on the planned path. 4. The autonomous vehicle progresses along the planned path until it reaches the final destination. |
| Alternative Flow: | 3a. If an obstacle is detected, it will avoid the obstacle using avoidance algorithm and update the guidance commands, vehicle resumes motion along the alternative route. |
| Post Condition: | The autonomous vehicle successfully follows the planned path, reaching the destination while ensuring safety and efficiency |

Table 4.4 - Detailed Use-case: Navigate Generated Waypoints

4.3.2.5 Control Acceleration

|  |  |
| --- | --- |
| Use Case ID: | UC005 |
| Use Case: | Control Acceleration |
| Actor: | Ego Vehicle |
| Precondition: | The vehicle is operational and in motion. |
| Basic Flow: | 1. System monitors the vehicle's velocity or acceleration parameters. 2. If a change in acceleration is required, the system computes the necessary adjustments based on navigation requirements, traffic conditions, and vehicle dynamics. 3. System sends commands to adjust the vehicle's acceleration accordingly, using throttle control or other propulsion mechanisms. |
| Alternative Flow: | 3a. If an unexpected obstacle is detected requiring sudden deceleration, the system overrides the acceleration command and initiates avoidance maneuvers. |
| Post Condition: | The vehicle's acceleration is controlled as per navigation and operational requirements, ensuring safety and efficiency. |

Table 4.5 – Detailed Use-case: Control Acceleration

4.3.2.6 Control Throttle

|  |  |
| --- | --- |
| Use Case ID: | UC006 |
| Use Case: | Control Throttle |
| Actor: | Ego Vehicle |
| Precondition: | The vehicle is operational and in motion. |
| Basic Flow: | 1. System monitors the vehicle's speed and throttle position. 2. A change in throttle position is required, the system computes the necessary adjustments based on navigation requirements, traffic conditions, and vehicle dynamics. 3. System sends commands to adjust the throttle position accordingly, regulating the engine's power output. |
| Alternative Flow: | None |
| Post Condition: | The vehicle's throttle position is controlled as per navigation and operational requirements, ensuring continued functionality even in case of system failure. |

Table 4.6 - Detailed Use-case: Control Throttle

4.3.2.7 Control Steering

|  |  |
| --- | --- |
| Use Case ID: | UC007 |
| Use Case: | Control Steering |
| Actor: | Ego Vehicle |
| Precondition: | The vehicle is operational and in motion. |
| Basic Flow: | 1. System continuously monitors the vehicle's position, orientation, and intended path. 2. Based on navigation instructions and environmental factors, the system computes the required steering angle adjustments. 3. System sends commands to the vehicle's steering system to adjust the steering angle accordingly. |
| Alternative Flow: | None |
| Post Condition: | The vehicle's steering angle is controlled as per navigation and operational requirements, ensuring stability and safety even in challenging road conditions |

Table 4.7 - Detailed Use-case: Control Steering

4.3.2.8 Braking

|  |  |
| --- | --- |
| Use Case ID: | UC008 |
| Use Case: | Braking |
| Actor: | Ego Vehicle |
| Precondition: | The autonomous vehicle is in motion. |
| Basic Flow: | 1. System detects a need for braking, such as in response to an obstacle or decelerating traffic ahead. 2. System evaluates the urgency and severity of the braking required based on the detected situation. 3. The brake is applied 4. The vehicle comes to a stop |
| Alternative Flow: | None |
| Post Condition: | The autonomous vehicle successfully applies braking maneuvers as necessary to respond to changing traffic conditions, obstacles, or other factors, ensuring safety and smooth operation. |

Table 4.8 - Detailed Use-case: Breaking

4.3.2.9 Stop Emergency

|  |  |
| --- | --- |
| Use Case ID: | UC009 |
| Use Case: | Stop Emergency |
| Actor: | Ego Vehicle |
| Precondition: | The autonomous vehicle is operational |
| Basic Flow: | 1. A critical safety issue or emergency situation is detected 2. System activates emergency braking and/or deceleration mechanisms to stop the vehicle as quickly as possible while minimizing risk to occupants and other road users. |
| Alternative Flow: | None |
| Post Condition: | The autonomous vehicle safely stops in response to a critical safety issue or emergency situation, mitigating potential risks and ensuring the safety of occupants and others on the road. |

Table 4.9 - Detailed Use-case: Emergency Stop

4.3.2.10 Detect Obstacle

|  |  |
| --- | --- |
| Use Case ID: | UC010 |
| Use Case: | Detect Obstacle |
| Actor: | Ego Vehicle |
| Precondition: | The autonomous vehicle is operational and equipped with sensors for obstacle detection |
| Basic Flow: | 1. System continuously monitors the surrounding environment using sensors 2. An obstacle is detected within the vehicle's vicinity  * System identifies the type and location of the obstacle. * System evaluates the size, distance, and velocity of the obstacle to assess potential risks. * System generates an obstacle detection event |
| Alternative Flow: | 1a. If the obstacle is not within the vehicle's vicinity   * It should follow the planned path |
| Post Condition: | The system successfully detects and reacts to obstacles in the vehicle's path, ensuring safe navigation. |

Table 4.10 - Detailed Use-case: Detect Obstacle

4.3.2.11 Analyze Environment

|  |  |
| --- | --- |
| Use Case ID: | UC011 |
| Use Case: | Analyze Environment |
| Actor: | Ego Vehicle |
| Precondition: | The obstacle is detected in planned path |
| Basic Flow: | 1. System detects an obstacle within the vehicle's vicinity. 2. System analyses the surrounding environment to identify safe passage options around the obstacle. 3. System evaluates available paths considering factors such as:  * Distance from obstacle * Traffic conditions * Road conditions * Speed limits * Presence of other vehicles or pedestrians |
| Alternative Flow: | 2a. If there is no safe option it stops immediately |
| Post Condition: | The system successfully analyzes the environment and identifies a safe passage option for the autonomous vehicle to navigate around the obstacle, ensuring safe passage towards the destination. |

Table 4.11 - Detailed Use-case: Analyze Environment

4.3.2.12 Avoidance Maneuver

|  |  |
| --- | --- |
| Use Case ID: | UC012 |
| Use Case: | Avoidance Maneuver |
| Actor: | Ego Vehicle |
| Precondition: | The autonomous vehicle detects an imminent collision or hazardous situation. |
| Basic Flow: | 1. An obstacle is detected in the vehicle's path. 2. System initiates the avoidance maneuver without delay. 3. System executes avoidance maneuver, which may involve actions such as braking and lane change, to steer the vehicle away from the obstacle. 4. Vehicle successfully navigates around the obstacle and continues its intended path. |
| Alternative Flow: | 2a. If the primary avoidance maneuver is not feasible due to any reason it will apply emergency stop |
| Post Condition: | The autonomous vehicle successfully executes an avoidance maneuver to navigate around an obstacle or hazardous situation, ensuring the safety of occupants and others on the road. |

Table 4.12 - Detailed Use-case: Avoidance Maneuver

4.3.2.13 Change Lane

|  |  |
| --- | --- |
| Use Case ID: | UC013 |
| Use Case: | Change Lane |
| Actor: | Ego Vehicle |
| Precondition: | The autonomous vehicle is driving on a multi-lane road. |
| Basic Flow: | 1. System identifies the need for a lane change 2. System evaluates the surrounding traffic conditions 3. System determines the optimal timing and trajectory for the lane change to minimize disruption to traffic flow and ensure safety. 4. System executes the lane change maneuver by steering the vehicle smoothly into the target lane while maintaining safe distance from other vehicles. 5. System verifies successful completion of the lane change and resumes normal driving operations. |
| Alternative Flow: | 2a. If the system detects an obstruction or unsafe condition in the target lane during the lane change maneuver:   * System aborts the lane change maneuver. * System re-evaluates the surrounding traffic conditions. * System selects an alternative lane change strategy |
| Post Condition: | The autonomous vehicle successfully changes lanes while ensuring safety and minimizing disruption to traffic flow. |

Table 4.13 - Detailed Use-case: Lane Change

4.3.2.14 Decelerate

|  |  |
| --- | --- |
| Use Case ID: | UC0014 |
| Use Case: | Decelerate |
| Actor: | Ego Vehicle |
| Precondition: | The vehicle is operational and in motion. |
| Basic Flow: | 1. System detects a need for deceleration, such as in response to navigation instructions, lane change, or obstacles. 2. System calculates the required deceleration rate based on the severity of the situation and safety considerations. 3. System sends commands to apply braking and/or throttle adjustments to achieve the desired deceleration. |
| Alternative Flow: | 3a. If the primary braking system fails to respond, the system activates the emergency braking system to achieve rapid deceleration and bring the vehicle to a stop. |
| Post Condition: | The vehicle successfully decelerates as required, ensuring safe navigation and operation, even in emergency situations. |

Table 4.14 - Detailed Use-case: Decelerate