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| **SWE.1 SW Requirement Analysis** | |
| **Software Requirement** | ID  🡺 1  Name  🡺 Lane Detection  Description (Outcomes of analysis)  [1-step]  1. Parse the CSV file based on the ego vehicle’s y-axis initially.  2. Extract the driving way using a lane fitting algorithm with filtering noise.  [ k-step (k >1) ]  3. Split the CSV by driving way from the *k-1 step*(previous step)  4. Extract the driving way using lane fitting algorithm with filtering the noise and considering the number of lanes.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 1  Name  🡺 Lane Detection  Description  🡺 Extract Driving way by fitting the Lane after filtering the noise considering the number of lanes. |
| ID  🡺 2  Name  🡺 SCC (Smart Cruise Control)  Description (Outcomes of analysis)  1. Identify the lead vehicle based on the driving lane from the candidate vehicles.  2. Calculate the distance between the ego vehicle and the selected lead vehicle.  3. Design a PID controller to maintain a constant time gap.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 2  Name  🡺 SCC (Smart Cruise Control)  Description  🡺 Adjust the velocity of ego to follow the lead vehicles without collision. |
| ID  🡺 3  Name  🡺 Merge  Description (Outcomes of analysis)  1. Track the object to obtain obstacle state.  2. Generate the obstacle’s predicted path to check for collision.  3. Generate lattice planner using ego’s driving way to merge.  4. Calculate the collision cost function to identify drivable lanes.  5. Update the ego’s driving way.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 3  Name  🡺 Merge  Description  🡺 Check if ego should change the lanes. |
| ID  🡺 4  Name  🡺 Road Condition  Description (Outcomes of analysis)  1. Subscribe to the mission topic to retrieve the road condition.  2. Adjust the reference velocity based on the road condition.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 4  Name  🡺 Road Condition  Description  🡺 Adjust the reference velocity while considering the road condition. |
| ID  🡺 5  Name  🡺 Road slope  Description (Outcomes of analysis)  1. Subscribe to the mission topic to retrieve the road slope.  2. Adjust the reference velocity proportionally to the road slope grade.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 5  Name  🡺 Road Slope  Description  🡺 Adjust the reference velocity proportionally to road slope grade. |
| ID  🡺 6  Name  🡺 Parking  Description (Outcomes of analysis)  1. Generate the guiding line while considering the pose of the parking lot.  2. Interpolate the path from the edge point of guiding line to the ego’s position.  Source user requirement (ID, Name, Descriptions, etc.)  ID  🡺 6  Name  🡺 Parking  Description  🡺 Control the vehicle to reach goal pose of a parking lot. |
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| **SWE.6 SW Verification** | |
| **Software Verification** | ID  🡺 1  Name  🡺 Drivinng way Verification  Description (Outcomes of analysis)  1. Lane fitting analysis : Plot the lane points that are classified into left and right lanes and the driving path extracted by lane fitting algorithms. Verify that the driving way is robust in noisy environments and whether it is divergent.  2. Collision Prediction analysis : Plot the predicted path of the ego vehicle along with dynamic obstacles to avoid collisions while changing would be avoided.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 1, 3, 6  Name  🡺 Lane Detection & Merge & Parking  🡺 Extract the driving way of ego vehicle and predict the collision.  Description  🡺 Analyze the driving path and lane classification for robustness in noisy environmetns and evaluate collision avoidance during lane changes using predicted paths of the ego vehicle and dynamic obstacles. |
| ID  🡺 2  Name  🡺 Longitudinal and Lateral Controller Verification  Description (Outcomes of analysis)  1. Throttle and Brake Response Analysis: Plot both throttle and brake input trends over time to assess stability and minimize fluctuations in longitudinal control. Verify that throttle and brake commands are smooth and respond predictably to changes in road conditions and slopes, ensuring stable acceleration and deceleration behavior.  2. Cross Track Error Monitoring: Record and plot CTE to evaluate lateral stability, focusing on sections with high curvature. Verify that deviations from the desired path remain within acceptable limits, especially in challenging road curvature scenarios under varying road conditions and slopes.  3. Target Distance Tracking: Plot the distance between the ego vehicle and the lead vehicle over time to confirm adherence to the target following distance. Validate that ACC maintains a consistent and safe gap in response to lead vehicle speed changes.  Source requirement (ID, Name, Descriptions, etc.)  ID  🡺 2, 3, 4, 5  Name  🡺 SCC(Smart Cruise Control & Merge & Road Condition & Road Slope  🡺 Control the vehicle with adequate throttle, brake and steering angle.  Description  🡺 Evaluate the longitudinal and lateral control performance by analyzing throttle, brake, and steering responses, monitoring CTE, and verifying safe target distance tracking under varying road conditions and slopes. |
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| **SWE.2: Software Architecture Design** | | | | |
| **Visual Materials** | | | | Draw visual materials of software architecture.  Connect related components and interfaces.  🡺 |
| **Architecture**  **Description** | | **Component** | | ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Source requirement (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Source requirement (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Source requirement (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Source requirement (ID, Name, Descriptions, etc.)  🡺 |
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| **Interface** | | ID  🡺  Name  🡺  Objective (Describe detailed objectives and means of interface)  🡺  Relation (Describe the related components)  🡺  Data (Describe the form and characteristics of data.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and means of interface)  🡺  Relation (Describe the related components)  🡺  Data (Describe the form and characteristics of data.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and means of interface)  🡺  Relation (Describe the related components)  🡺  Data (Describe the form and characteristics of data.)  🡺 |
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| **SWE.5: Software Component & Integration Verification** | | | | |
| **Software**  **Verification** | **Component** | | ID  🡺 Name  🡺  Description (Elements to be verified)  🡺  Verification (How to verify? What criteria to use? etc.)  🡺  Source component (ID, Name, Descriptions, etc.)  🡺 | |
| ID  🡺 Name  🡺  Description (Elements to be verified)  🡺  Verification (How to verify? What criteria to use? etc.)  🡺  Source component (ID, Name, Descriptions, etc.)  🡺 | |
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| **Interface** | | ID  🡺 Name  🡺  Description (Elements to be verified)  🡺  Verification (How to verify? What criteria to use? etc.)  🡺  Source interface (ID, Name, Descriptions, etc.)  🡺 | |
| ID  🡺 Name  🡺  Description (Elements to be verified)  🡺  Verification (How to verify? What criteria to use? etc.)  🡺  Source interface (ID, Name, Descriptions, etc.)  🡺 | |
| ID  🡺 Name  🡺  Description (Elements to be verified)  🡺  Verification (How to verify? What criteria to use? etc.)  🡺  Source interface (ID, Name, Descriptions, etc.)  🡺 | |
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| **SWE.3: Software Detailed Design & Unit Construction** | |
| **Software Unit**  **Function** | ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Constraints  🡺  Source component (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Constraints  🡺  Source component (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Name  🡺  Objective (Describe detailed objectives and roles of components)  🡺  Input (Describe the form and characteristics of the input data.)  🡺  Output (Describe the form and characteristics of the output data.)  🡺  Constraints  🡺  Source component (ID, Name, Descriptions, etc.)  🡺 |
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| **SWE.4: Software Unit Verification** | |
| **Software Unit**  **Verification &**  **Elements Description** | ID  🡺  Description (Objective, specific requirements, etc.)  🡺  Functional verification  🡺  Non-functional verification  🡺  Source unit (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Description (Objective, specific requirements, etc.)  🡺  Functional verification  🡺  Non-functional verification  🡺  Source unit (ID, Name, Descriptions, etc.)  🡺 |
| ID  🡺  Description (Objective, specific requirements, etc.)  🡺  Functional verification  🡺  Non-functional verification  🡺  Source unit (ID, Name, Descriptions, etc.)  🡺 |
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