4.1 SQA activity: State-Based Defect Detection Scenarios

4.1.1 Path Planning

Equivalence Class Partitioning (ECP):

- **Valid Classes**:
  - The destination is selected from the provided options.
  - The destination is entered manually and is valid (x is integer, y is integer).
- **Invalid Classes**:
  - The destination is selected but is not available (e.g., out of service area).
  - The destination coordinates are entered manually but are invalid (e.g., incorrect format, non-existent location).

Scenarios and Test Case:

Table 4.1: State-Based TC1

Scenario	Input Value	ECP	Expected Output
Out of service area coordinates	x = 80.000000 y = 170.000000	Invalid	**Error**: Vehicle tries to go to the entered Coordinates, even if they are in any building

4.1.2 Path Following

Equivalence Class Partitioning (ECP):

- **Valid Classes**:
  - The vehicle's velocity and acceleration parameters are within normal operational ranges. i.e. <120 km/h
- **Invalid Classes**:
  - The vehicle's velocity or acceleration parameters are abnormal or invalid. i.e. = 120km/h

Scenarios and Test Cases:

Table 4.2: State-Based TC2

Test Case	Input Value	ECP	Expected Output
Abnormal Velocity Parameters	Velocity = 200 km/h	Invalid	Unexpected Error
Negative Velocity Parameters	Velocity = -20 km/h	Invalid	Unexpected Error

4.1.3 Vehicle Control

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - The vehicle's speed is within the normal operational range (i.e. 0 km/h to maximum speed limit).
  - The throttle position is within the normal operational range (i.e. 0% to 100%).
- **Invalid Classes:**
  - The vehicle's speed parameters are abnormal or invalid (i.e. speed exceeding maximum permissible limit).
  - The throttle position is abnormal or invalid (i.e. throttle position exceeding 100%).

Scenarios and Test Cases:

Table 4.3: State-Based TC3

Test Case	Input Value	ECP	Expected Output
Negative Speed	Speed = -10 km/h	Invalid	Unexpected Error
Negative Throttle Position	Throttle = -20%	Invalid	Unexpected Error

4.1.4 Vehicle Control

Equivalence Class Partitioning (ECP):

- **Valid Classes:**

Normal Steering: Steering angle within operational range

  - -90° to 90° latitude, -180° to 180° longitude

- **Invalid Classes:**

Abnormal Steering: Steering angle outside operational range (< -30° or > +30°)

Scenarios and Test Cases:

Table 4.4: State-Based TC4

Test Case	Input Value	ECP	Expected Output
Abnormal Orientation	Roll = -220° Pitch = of 120°	Invalid	Unexpected Error
Abnormal Steering Angle	Range = -45°, 40°	Invalid	Unexpected Error

4.1.5 Vehicle Control

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - Speed: 0 km/h ≤ Speed ≤ 120 km/h
  - Distance: 2 meters ≤ Distance ≤100 meters
  - Throttle Adjustment: 0 % ≤ Throttle ≤ 80 %
  - Brake Application: 0 % ≤ Braking Force ≤ 100 %
- **Invalid Classes:**
  - Speed: > 120 km/h
  - Distance: Distance >100 meters
  - Throttle Adjustment: < 0 % or Throttle > 80 %
  - Brake Application: < 0 % or Braking Force > 100 %

Scenarios and Test Cases:

Table 4.5: State-Based TC5

Test Case	Input Value	ECP	Expected Output
Abnormal Steering Angle	Range = -45°, 40°	Invalid	Unexpected Error
Unsafe distance	Distance = 0	Invalid	Unexpected Error
Braking force	Force = 152%	Invalid	Unexpected Error
Abnormal Speed	Speed = -15.2	Invalid	Unexpected Error

4.1.6 Vehicle Control

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - Lateral Position: -1.0 meters ≤ Lateral Position ≤ 1.0 meters
  - Steering Adjustment: -30° ≤ Steering Angle ≤30°
- **Invalid Classes:**
  - Lateral Position: Lateral Position > 1.0 meters
  - Steering Adjustment: Steering Angle > 30°

Scenarios and Test Cases:

Table 4.6: State-Based TC6

Test Case	Input Value	ECP	Expected Output

Abnormal Lateral Position	Lateral Position = -2.0 meters	Invalid	Unexpected Error
Excessive Steering Adjustment	Angle = -45.23°	Invalid	Unexpected Error

4.1.7 Localization Module Test Cases

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - Sensor data (GPS, IMU, LIDAR) within acceptable ranges.
  - GPS accuracy ≤ 5 meters.
  - IMU data drift ≤ 2 degrees.
  - LIDAR scan range ≥ 50 meters.
- **Invalid Classes:**
  - Sensor data outside acceptable ranges.
  - GPS accuracy > 5 meters.
  - IMU data drift > 2 degrees.
  - LIDAR scan range < 50 meters.

Scenarios and Test Cases:

Table 4.7: State-Based TC7

Scenario	Input Value	ECP	Expected Output
GPS Signal Loss	GPS Accuracy = 15 meters	Invalid	Transition to Error State: "Localization

			Error"
GPS Signal Loss	GPS Status = No signal	Invalid	Unexpected Error
IMU Drift	IMU Drift = 1.5 degrees	Valid	Transition to Update Location
LIDAR Scan Range Too Short	LIDAR Range = 30 meters	Invalid	Transition to Error State: "LIDAR Range Error"
Accurate Localization	GPS Accuracy = 3 meters IMU Drift = 1 degree	Valid	Transition to VerifyLocation

4.1.8 Obstacle Detection and Avoidance Module Test Cases

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - Obstacle detected within sensor range.
  - LIDAR detection distance ≤ 100 meters.
  - Obstacle size ≥ 0.5 meters.
  - Obstacle-free zone.
  - No objects detected within 100 meters.
- **Invalid Classes:**
  - Sensor fails to detect within expected range.
  - LIDAR detection distance > 100 meters for a detected obstacle.
  - Obstacle size < 0.5 meters considered noise.

Scenarios and Test Cases:

Table 4.8: State-Based TC8

Scenario	Input Value	ECP	Expected Output
No Obstacle Detected	LIDAR Detection	Invalid	Transition to No

	Distance = 150 meters		Obstacle state
LIDAR Sensor Failure	LIDAR Status = No data received	Invalid	Unexpected Error
Valid Obstacle Detected	LIDAR Detection Distance = 50 meters	Valid	Transition to Classify Obstacle
Dynamic Obstacle Within Range	LIDAR Detection Distance = 80 meters	Valid	Transition to Compute Avoidance

4.1.9 Traffic Light Detection Module Test Cases

Equivalence Class Partitioning (ECP):

- **Valid Classes:**
  - Traffic light detected and state correctly identified.
  - Distance to traffic light ≤ 50 meters.
  - Recognition confidence ≥ 80%.
- **Invalid Classes:**
  - Traffic light detection errors or low recognition confidence.
  - Distance to traffic light > 50 meters.
  - Recognition confidence < 80%.

Scenarios and Test Cases:

Table 4.9: State-Based TC9

Scenario	Input Value	ECP	Expected Output
Traffic Light Not Detected	Detection Distance = 60 meters	Invalid	Continue scanning in ScanForTrafficLight state

Traffic Light Detected, High Confidence	Recognition Confidence = 90%	Valid	Transition to Recognize State
Camera Failure	Camera Status = No data received	Invalid	Unexpected Error
Low Confidence in Recognition	Recognition Confidence = 70%	Invalid	Re-scan for traffic light state
Traffic Light at Threshold	Detection Distance = 50 meters	Valid	Proceed with state recognition (Red/Yellow/Green)