

# Requirements for Self Driving Car

## Functional

### Autonomous Steering

1. No single failure of any madoule shall result in an 'out of control' vehicle.
2. An audible alert to the driver shall occur upon a failure in any module in the system where the driver needs to resume control without the support of the electrical power steering system.
3. The driver shall have within reaching distance on the steering wheel a discreet override switch that will disable the autonomous steering and return to normal control.
4. Autonomous steering control shall ramp down and be terminated in the event that the driver applies rotational force on the steering wheel.
5. The steering module shall change from autonomous control torque to normal control torque within 500 milliseconds.
6. The steering module shall interact with other modules in the system to ensure no operation jeopardizes another.
7. The circuits that could result in single point failure shall be monitored for identified faults every 200 milliseconds.
8. The system shall run mandatory safety checks upon vehicle start up, to ensure the safety of the electrical power steering system.

### Controls

9. Normal control shall operate using the data from the torque sensor(s) on the steering column.
10. Normal Control must be read the torque sensor and calculate the power assist every 500 microseconds
11. The power steering system will shut down fully if one of the torque sensors fail.
12. The control system should be able to stop if there is no parking at the destination and circle around the area for parking.
13. The system shall not stop within 0.5 mile of the No parking sign received from the camera sensor.
14. The control module shall turn on the parking lights when the car comes to a complete stop during a parking action.
15. The system shall wake up and do startup checks if the antenna's detect the keyfob within 0.5 meters of the car.
16. The system shall turn off power consuming features(like phone charging, music over 10 in volume measure) when detect 30% power remaining.
17. The headlight module shall turn adjust the turn off/on of the headlights depending on the data from the photoelectric sensors in the headlight.

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## Navigation Module

18. On receiving user input the navigation module shall show the user list of possible routes available to reach the input destination, in 0.04s.
19. On selecting the route with tolls , driver shall be informed of the total cost of the trip including tolls within 0.1s of route selection
20. The navigation module shall allow the user to select route from the displayed list and set it in car's gps within 0.5s of selection.
21. The navigation module shall provide the user with the option to check current gps location.
22. On receiving the display current gps option the navigation module shall show the exact current location within 0.2s
23. On receiving the selected route from user the navigation module shall show the ETA within 5s
24. On receiving the input selected route the navigation module shall display the road conditions within 1s.
25. On receiving the date input from user, the system shall correctly display the routes for that date within 0.08s.
26. The navigation module shall allow user to have an option to schedule future rides by taking as input date, time and route from user
27. They system shall be able to read the input date, time and route of scheduled rides correctly.
28. The navigation module shall alert the user when the destination is 5 minutes away according to the ETA calculated.
29. The navigation module shall alert the user about the current road condition, current position of construction sites in the route selected for a trip.
30. The navigation module Shall alert driver about road speed limits when the speed sensor reads the current speed as 10 miles/hour above the speed limit.
31. The navigation module shall download the current map within 200 miles of the location of the car and refresh it every 2 hours.
32. The GPS module should correctly identify one way road from the sensor data.
33. The GPS module shall update traffic information every 30 seconds.
34. The GPS module shall enable the user to share live location tracking.
35. The GPS module shall use linked accounts and favourite contacts list to suggest user when instructed by the driver to share live location.
36. The Navigation module shall follow the lane discipline predicted by the lane discipline prediction from the prediction module

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## Trip Planner

- 37. The trip planner module shall not allow the driver to schedule future trips if the inputted date and time have already been used for another trip in the future date.
- 38. The trip planner module shall have the ability to provide authorized driver with their ride history for 30 days.
- 39. On receiving input to view ride history the navigation module shall display the ride history in no more than 0.6s.
- 40. The trip planner module shall allow the user to reuse past route and destination from the ride history list for the current trip.

## Collision Detection

- 41. The collision detection module should act on upcoming collisions using object priority policies within 0.0001 seconds.
- 42. The collision detection module shall detect potential collision with another vehicle, bicycle or pedestrian within a distance of 525 feet and alert the driver within 0.001s
- 43. The collision detection module shall be able to read the data from the forward collision warning sensor every 30s.
- 44. In event of upcoming detected collision the module shall apply emergency brakes automatically within 0.001s
- 45. The collision detection module shall inform emergency services within 1s of a collision if the impact force is more than 40KN.
- 46. The collision detection module should inform other nearby self driving vehicles to be more cautious when a collision has happened.
- 47. Upon a collision the system shall stop all modules of driving functionalities and start upon the prompt by the driver.
- 48. If an upcoming collision is detected, the collision detection module shall reduce full acceleration within 0.001s in order to prevent driver from accidentally accelerating
- 49. The module shall be able to deploy airbags within 100 microseconds of the collision.

## User Interface

- 50. The system shall have a user face recognition turned on within 0.001s when key fob is detected within the car and all doors are closed.
- 51. The system shall display the option to set the temperature inside the car.
- 52. The system shall correctly read data from sensors and set the input temperature within 8s if the option of 'auto temperature set' is selected by the user in the air conditioning panel.
- 53. The system shall display an option to select and input songs playlist specific to the authorized user.

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- 54. The system shall correctly interpret the selected playlist and start playing within 0.02s.
- 55. The system shall display an option to adjust driver seat which will take height and distance from wheel as input. The system shall correctly align the driver's seat as per the input by user within 8s. Shall save all the driver seat/song playlist changes done by the user and display a save confirmation message within 5s"
- 56. Shall save all the driver seat/song playlist changes done by the user and display a save confirmation message within 5s
- 57. Shall correctly set the previously set car temperature when the user unlocks the car
- 58. Shall be able to save user preferences of different users and retrieve correct user preferences within 0.5s of car being unlocked
- 59. Shall not allow inter-user settings accessibility and will display a prompt of unauthorized user within 2s.
- 60. Shall display an option to select different languages for the interaction with the system.
- 61. Shall display an option to switch to speech command mode.
- 62. Shall display an option to select the language of speech command from English/Spanish languages with an accuracy of 99.9%.
- 63. Shall correctly set the input language for interpreting the verbal commands within 0.0003s.
- 64. Shall be able to interpret verbal commands of user with an accuracy of 99.999%.
- 65. On not being able to interpret the verbal command the system shall notify the user to speak again or try different command within 0.5s.
- 66. Shall display an option to sync smart devices with car
- 67. Shall correctly start scanning for smart devices within 2s
- 68. Shall correctly display list of available smart devices in car.
- 69. Shall correctly display the pin to connect the smart device within 0.5s
- 70. Shall display connection successful message within 0.5s of connecting the device
- 71. Shall start playing the song from connected device's recent playlist
- 72. Shall display a connection error within 0.5s if unable to read the connection request

## Image Classification Module

- 73. The Image Classification module should keep track of road markings (Ex. Zebra crossings, stop signs on the road, etc., the red zone at parking) and inform the Navigation module.
- 74. The Image Classification module shall detect and understand any signals (indicators, overtake requests) being given by other vehicles/humans and inform the Navigation module.
- 75. The Image Classification module shall read the lane markings and inform the Navigation module when car gets close to a lane marking without indication.
- 76. The Image Classification module shall detect cycle lanes and inform Navigation module to not get into cycle lane.

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## Manual Override Module

- 77. The Passenger Safety module should allow manual override of opening the door when the car is in motion when passengers presses emergency button.
- 78. When the user requests for a manual override the system shall ensure entire controls are handed over to the user and no module is in auto mode.
- 79. When the car is being driven in manual mode, the Driver Monitoring module shall track the driver's eye movement and head position.
- 80. When the car is being driven in manual mode, the Driver Monitoring module shall inform the Notification module when it predicts the driver is not paying attention.
- 81. When the car is being driven in manual mode, the Notification module shall send out voice and text alert messages to the driver requesting to pay attention to driving

## Smart Summon Module

- 82. The module shall provide an option in car application running on user's phone to summon the car from parking space
- 83. The module shall be able to detect the exact location of user within 0.01s of receiving the summon command from user
- 84. The module shall be able to calculate the turn angles of the car with an accuracy of 99.999% to navigate properly through tight perpendicular parking space
- 85. On receiving stop car command from user's cell phone the module shall safely stop the car within 0.01s
- 86. On receiving summon command from user, the module shall interpret images of surrounding from cameras within 0.5s to verify that the surrounding is a parking space before starting the car
- 87. The module shall notify the user via a notification on smart device/text message about the ETA to user's location.
- 88. When a module fails in the car, the smart summon should not operate the car and notify the user about the failure.

## Security and Convenience Module

- 89. The module will provide an option to record and store videos captured by the forward-facing camera (Dash Cam) when the car is in use
- 90. The module will store all the video clips taken during Sentry Mode to a separate secured folder on USB drive every night
- 91. The module will provide an option to set a pin to secure the stored video clips folder
- 92. The module will run memory check every night and delete older clips to make storage space available for next day

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- 93. Data transfers of program and calibration data require encryption in the transfer.
- 94. The security module shall detect passive entry in the car if option is disabled by the user, unless turned off by the user itself.
- 95. The signal from the key fob should be higher than 112 bit encryption.
- 96. The system shall perform sanity check of all the modules when an upgrade is performed or the system is calibrated.

## Full 360 View Module

- 97. The view module will perform blindspot monitoring every 1s in the ongoing trip
- 98. The navigation module will display a red lane within 0.0001s if the view module detects a vehicle in blindspot during an upcoming turn
- 99. The module will display an option to view all the adjacent cars.

## Data Storage

- 100. The data storage module shall store local traffic guidelines(speed limits, actions on scene of incident, post crash guidelines) upon reading the current location from the GPS module.
- 101. The data flow between different modules should encrypt the CAN data of the internal modules of the car.
- 102. The system shall be store user's settings data in a remote server, to retrieve it when local data is unavailable.

## Non Functional

### Availability

- 1. When the car is parked, system will run check and verify and charge battery to ensure availability
- 2. The system shall have a back-up process for every module - communication, navigation, sensory modules in case of failure along with notification to the driver.
- 3. Due to a random event the obstacle detection module fails, the car shall notify the user and switch to manual controls with no downtime
- 4. When the communication of navigation module with the GPS server fails, the car shall be able to navigate with notification to the driver

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5. The system shall notify the driver upon analyzing the weather conditions not suitable for auto-pilot driving and switch to manual control with no downtime.
6. In case of failure of vehicle's localization information, the system shall compute localization from LiDAR data in 100 microseconds.

## Performance

7. The car should maintain a distance of n cars configured by the user.
8. The system shall be able to sense the specifics of the weather conditions in terms of temperature, terrain and visibility and drive under any kind of weather condition
9. The system shall be able to detect a change in terrain within 5kms of entering the terrain and change gears to adapt accordingly
10. The system shall be able to drive car upto driver's location upon summon order from the driver through an electronic device(mobile, desktop)
11. The car should have a top speed of at least 170 miles per hour.
12. The car should go from 0 to 100 miles per hour in less than 2.9 seconds.
13. The system shall continuously capture and interpret complete data concerning the surrounding environment to an accuracy of three 9's
14. The system shall process at least 1GB of data per second for a reliable self driving experience

## Security

15. The system shall be able to verify the user's identity when key fob is detected upon the instruction of start from the user
16. When an unverified stimulus tries to enter system's data bus, the system shall function normally and notify the user with no downtime or hampering in functionality
17. Not all users shall have access to every user's car settings. A single user can access only his/her account
18. The car shall start only in the presence of an authorized driver in car
19. The system shall be able to lock the car when it detects the position as parked and no activity for 15 minutes of clock time with the system or any sensors of the either of the doors as well as the system interaction of the user
20. The system shall use multi-factor authentication to identify the driver

## Reliability

21. The system shall be able to detect the stop sign with an accuracy of five 9's and make a complete stop at least 10 meters before it.
22. The system shall be able to calculate the longitude and latitude of the destination entered and confirm with the remote server with an accuracy of ~50m.

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23. This data from the self driving sensors needs to be continuously interpreted

## Safety

24. The system shall comply with 5-star NHTSA policies for road safety

25. The system shall switch to manual mode within 300milliseconds upon detecting skid conditions from the data received from the wheel sensors

26. The car should maintain an average speed given by the user and should default to the road speed limits

27. The car should avoid small objects which may be present but not affect the car. For example, the car shouldn't stop when there is a random plastic bag in front of it. (Don't use LIDAR)