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1. What are the differences between **exteroceptive sensors** and **proprioceptive sensors**? (Select all that apply) **1 / 1 point**

- [x] Proprioceptive sensors do not interact with the environment, whereas exteroceptive sensors do.

  Correct
  Exteroceptive sensors contain active sensors such as Lidar or Sonar, which interact with the environment by emitting light or sound and waiting for response.

- [x] Exteroceptive sensors can determine obstacle size and distance away, whereas proprioceptive sensors cannot.

  Correct
  Proprioceptive sensors do not observe nor measure environment surroundings.

- [ ] Proprioceptive sensors are used to determine vehicle position, whereas exteroceptive sensors are used for sensing the environment.
- [ ] Exteroceptive sensors can determine distance traveled by the vehicle, whereas proprioceptive sensors cannot.
- [ ] Proprioceptive sensors can determine distance traveled by the vehicle, whereas exteroceptive sensors cannot.

2. Which of the following exteroceptive sensors would you use in **harsh sunlight**? **1 / 1 point**

- [x] Radar

  Correct
  Radar is unaffected by harsh sunlight.

- [x] Sonar

  Correct
  Sonar is unaffected by harsh sunlight.

- [ ] Cameras
- [ ] Lidar

3. Why is synchronization and timing accuracy important in the self driving system? **Choose the primary reason.** **1 / 1 point**

- ( ) Synchronization is important to ensure organized computation.
- ( ) Synchronization is important to ensure that sensors measure the environment at the same time.
- (•) Synchronization is important to ensure correct sensor fusion.
- ( ) Synchronization is important to check sensor failure.

Correct
Correct!

4. Your autonomous vehicle is driving on the German autobahn at 150 km/h and you wish to maintain safe following distances with other vehicles. Assuming a safe following distance of 2s, **what is the distance (in m) required between vehicles**? Round your answer to **2 decimal places**. **1 / 1 point**

83.34

Correct
150*2/3.6

5. Using the same speed of 150 km/h, **what is the braking distance (in m) required for emergency stops**? Assume an aggressive deceleration of 5 m/s^2. Round your answer to **2 decimal places**. **1 / 1 point**

173.69

Correct
(150/3.6)^2/(2*5)

6. Suppose your vehicle was using long range cameras for sensing forward distance, but it is now nighttime and the images captured are too dark. **Which of the following sensors can be used to compensate**? **1 / 1 point**

- [x] Lidar

Correct

Correct
Lidar can be configured for long range detection and can also operate in darkness.

- [ ] Sonar
- [ ] IMU
- [x] Radar

Correct
Radar can be configured for long range detection and can also operate in darkness.

7. What are the differences between an **occupancy grid** and a **localization map**? (Select all that apply) **1 / 1 point**

- [x] The localization map is primarily used to estimate the vehicle position, whereas the occupancy grid is primarily used to plan collision free paths.

Correct
Correct. The vehicle position is a critical measurement to estimate how the ego vehicle is moving through the environment, and relies on matching sensor measurements at the current time to the localization map. The occupancy grid map stores live collision avoidance data in the form of occupied and unoccupied cells around the vehicle.

- [x] An occupancy grid uses a dense representation of the environment, whereas a localization map does not need to be dense.

Correct
Since localization mapping is only concerned with identifying the vehicle pose in the environment, it can use point features or object locations and does not need to densely cover the entire environment, whereas occupancy grid mapping must capture the locations of all obstacles to be avoided and must therefore be dense.

- [ ] The occupancy grid only contains static objects, while the localization map contains only dynamic objects.
- [ ] The localization map uses only lidar data, whereas the occupancy grid can use both lidar and camera data.

8. The vehicle steps through the software architecture and arrives at the controller stage. What information is required for the **controller** to output its commands to the vehicle? **1 / 1 point**

- [ ] Locations of obstacles and other vehicles
- [x] Planned paths

Correct
The controller commands the vehicle to follow the planned paths.

- [ ] Environment maps
- [x] Vehicle state

Correct
The controller requires the vehicle position and velocity to determine the appropriate amount of steering, throttle, and brake.

9. What is (are) the role(s) of the **system supervisor**? (Select all that apply) **1 / 1 point**

- [x] To ensure that the maps update at the correct frequencies

Correct
The system software is responsible for monitoring software and ensuring operation at correct frequencies.

- [x] To ensure that the sensors are working correctly

Correct
The system supervisor is responsible for monitoring hardware and ensuring that the sensors are not broken.

- [ ] To ensure that the planned paths are collision free
- [ ] To ensure that the controller outputs are within operating range

10. Which of the following tasks should be assigned to the **local planner**? **1 / 1 point**

- ( ) Planning a route to a destination
- (•) Planning to avoid a parked car in the ego vehicle's lane
- ( ) Planning a merge onto the highway
- ( ) Planning a lane change to turn left

Correct
This is a reactive planning task, so it should be designated to the local planner.

11. What common objects in the environment appear in the **occupancy grid**? **1 / 1 point**

- ( ) Other moving vehicles
- (•) Parked vehicles
- ( ) Lane boundaries

- Lane boundaries
- Traffic lights

Correct
The occupancy grid contains static obstacles which block vehicle movement.

12. Which of the following maps contain **roadway speed limits**?

1 / 1 point

- Occupancy grid
- Localization map
- Detailed roadmap

Correct
The detailed roadmap contains traffic regulations.