1. What is odometry?

Odometry is generally related to mobile robots or ground vehicles wherein it is a method by which we obtain of the robot- pose and heading. Different external – e.g visual cameras (visual odometry) and internal sensors (wheel encoders) are used for odometry.

2. What are the main problems related with odometry?

Wheel encoders which are primarily used in odometry have some degree of measurement noise, which makes it extremely difficult to give an accurate position of the robot. Further, they are prone to slippage and it has no means of correcting reference since it is internal to the robot. This makes odometry a challenging problem.

3. Can odometry can be used as the only mean of localization? Why?

Odometry can only be used when the robot does not cover vast areas. Odometry provides position estimate by adding the differential value (angular velocity in the case of wheel encoders) along with the noise. With time, this value diverges due to the addition of noise, causing a large difference in actual and estimated position.

4. What is dead reckoning?

Dead-reckoning is a means of estimating the position of the mobile robot with reference to a known inertial frame of reference by integrating the differential estimates from different sensors. It incorporates data from odometry, imu etc. to give an accurate estimate of the position of the robot at any given instance of time, when the initial position of the robot is known.

5. What are the main challenges when applying an Extended Kalman filter?

Extended Kalman filter is an addition to the linear Kalman filter. It linearizes the non-linear system to a linear system by approximation, such that Kalman Filter can be used. This poses certain challenges like the higher order dynamics have to be included in the process noise, critical evaluation of the sensors to find the measurement noise, etc. Further, fine-tuning of the parameters for the optimal estimate is a time taking process and no definite guideline is available.

6. Define the SLAM problem with your own words.

SLAM stands for simultaneous localization and mapping, wherein the robot localizes itself with respect to its surroundings. It not only has to estimate the position of the robot but also know the estimate position of the surroundings. In SLAM, the position estimate improves over time.

SLAM presents a challenging problem as both the robot path and map are unknown. Further, error in map and position estimate are correlated.

7. How do occupancy grids work?

Occupancy grid works by dividing the robot workspace as a discrete grid. It is a method to convert a continuous time to discrete time for motion planning. Occupancy grid can store the information about the surroundings as well as obstacles from laser range finders, sensors and camera.

8. What are the main pros and cons of a Particle Filter for navigation?

Particle Filter is better for non-linear systems by discretizing the system into multiple particles. In particle filter, the non-linearity of the system is retained, unlike Extended Kalman filter, guaranteeing better performance. However, if the system has higher order states, the particle filter gets exponentially worse.

9. What are the main challenges in robotics navigation? [Don't worry with the openness of the question. Just give your opinion]

The complexity of robot navigation increases in a dynamic environment. It heavily depends on how accurate the SLAM system works. For accurate SLAM system, a fusion of multiple sensors has to be done and the measurement noise has to be accounted for as the erroneous sensor measurement would lead to an erroneous map. Next challenge comes in the path planning in a map which is approximate wherein one has to account for error in the position of the obstacles and feasible paths to derive an optimal path for navigation. Further, once an initial estimate of the map is known, simultaneous planning and improving the map also presents a unique challenge.

10. What is a holonomic robot ? Give examples.

A holonomic robot is capable of moving in N dimension independently without any constraints if the robot has N degrees of freedom. E.g –

Omni-directional drive, Quadcopters etc.