Applied estimation

Lab2

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1 PART I - Preparatory Questions

Particle Filters:

1 - What are the particles of the particle filter?

Particles are also called samples. They are used to represent the posterior distribution of some random process of a given noise. Each particle represents a possible state.

2 - What are importance weights, target distribution, and proposal distribution and what is the relation between them?

Importance wights is the probability of a measurement regarding a particle. Target distribution represents the belief bel(xt).Proposal distribution represents the bel(xt) based on the prior belief over state xt−1 and the control ut.

The importance weights are ratio between target distribution and proposal distribution evaluated at the particles state.

3 - What is the cause of particle deprivation and what is the danger

The reason for particle deprivation is the lack of good particles, which leads to convergence to an incorrect position. This may be caused by re-sampling to eliminate good particles, resulting in particle reduction. The danger of particle deprivation is that there will be no particles around the real state of the system. After the algorithm discards all particles that are close to the correct state during re-sampling, it cannot recover the lost particles for the real posture.

4 - Why do we resample instead of simply maintaining a weight for each particle always.

The simplest particle filter algorithm faces degradation problems. As time goes by, there are fewer and fewer particles available (very low weight). Therefore, re-sampling is required to replace low-weight particles with copies of high-weight particles.

5 - Give some examples of the situations which the average of the particle set is not a good representation of the particle set.

Consider some extreme cases, such as multiple peaks with the same density at a symmetrical center of gravity, then their average value will appear at the geometric center, but this does not represent their current position.

6 - How can we make inferences about states that lie between particles.

We can use Gaussian kernels method or create bins and calculate it from histogram.

7 - How can sample variance cause problems and what are two remedies?

The sampling steps create more randomness to the particle filter which cause the noise problem. Remedies is

1)Reducing the re-sampling frequency

2)Using a sequential stochastic process instead

8 - For robot localization for a given quality of posterior approximation, how are the pose uncertainty (spread of the true posteriori) and number of particles we chose to use related.

Higher pose uncertainty would result in larger spread of the posteriori, so larger number of particles are required.