Introduction to SLAM

"Building a map and localizing the robot simultaneously"

★ Defination of the SLAM Problem

Given

① The robot's Controls

$$u_{1:T} = \{u_1, u_2, \ldots, u_T\}$$

② Observations

$$z_{1:T} = \{z_1, z_2, \ldots, z_T\}$$

Wanted

① Map of the environment

$$m$$

② Path of the robot

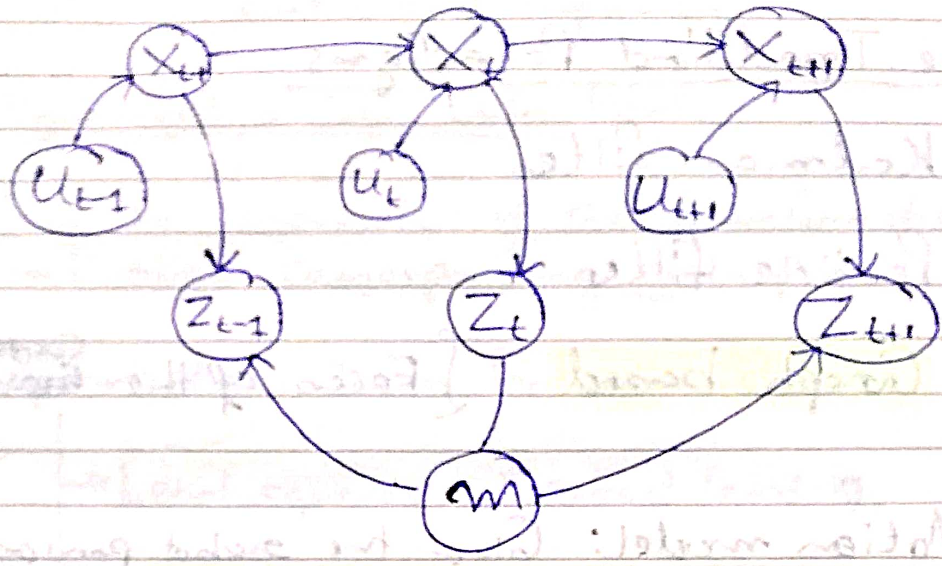
$$x_{0:T} = \{x_0, x_1, \ldots, x_T\}$$

★ In the Probabilistic World

⇒ Estimate the robot's path and the map

$$P(x_{0:T}, m \mid z_{1:T}, u_{1:T})$$

→ {Joint pdf of random vectors $x_0, x_1, \ldots, x_T$ & m}



⇒ This illustrates dependencies between probability distributions

Full slam ⇒ Estimating map and full path the robot took.

$$P(X_{0:T}, m \mid Z_{1:T}, U_{1:T})$$

Online Slam ⇒ Estimating the map and the most recent pose.

$$P(X_t, m \mid Z_{1:t}, U_{1:t})$$

So, $p(x_t, m \mid Z_{1:t}, U_{1:t}) = \int \cdots \int P(x_{0:t}, m \mid Z_{1:t}, U_{1:t}) \, dx_{t-1} \cdots dx_0$

⇒ Online Slam means marginalizing out the previous poses.

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★ Three Traditional Paradigms

1. Kalman filter
2. Particle filter
3. Graph based {Focus of the Course}

Motion model:
Given the robot previous pose & control, what will be the PDF of robot present pose

$$P(X_t | X_{t-1}, u_t)$$

Observation model:
Given the robot pose and map, what will be the PDF of observation.

$$P(Z_t | X_t, m)$$

★ Virtual Observation

⇒ Relate pair of poses from which observations have been recorded.