SLAM and MOT

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1 Notation

$$Robotstate: X_r = \begin{bmatrix} x_r \\ y_r \\ \alpha_r \end{bmatrix}$$

$$Landmarkstate: X_{lm} = \begin{bmatrix} x_{lm} \\ y_{lm} \end{bmatrix} \text{ (To simplify equation, just use one landmark)}$$

$$Movingobjectstate: X_{mot} = \begin{bmatrix} x_{mot} \\ y_{mot} \\ \alpha_{mot} \\ v_{mot} \end{bmatrix}$$

2 Processing model

Motion model is $X(k+1) = F(X(k), u(k))$

$$\begin{bmatrix} x_r \\ y_r \\ \alpha_r \\ x_{lm} \\ y_{lm} \\ x_{mot} \\ y_{mot} \\ \alpha_{mot} \\ v_{mot} \end{bmatrix} (k+1) = \begin{bmatrix} x_r \\ y_r \\ \alpha_r \\ x_{lm} \\ y_{lm} \\ x_{mot} \\ y_{mot} \\ \alpha_{mot} \\ v_{mot} \end{bmatrix} (k) + dt * \begin{bmatrix} v_r(k) * cos(\alpha_r(k) + g(k)) \\ v_r(k) * sin(\alpha_r(k) + g(k)) \\ v_r(k) * sin(g(k))/WB \\ 0 \\ 0 \\ v_{mot}(k) * cos(\alpha_{mot}(k)) \\ v_{mot}(k) * sin(\alpha_{mot}(k)) \\ 0 \\ 0 \end{bmatrix}$$

g is steering angle, v_r is robot speed, WB is the vehicle wheel-base. Constant velocity and orientation assumption is made for moving objects.

Jacobian of states in process model is as following.

$$J = \begin{bmatrix} 1 & 0 & -v_r(k)*dt*sin(\alpha_r(k)+g(k)) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & v_r(k)*dt*cos(\alpha_r(k)+g(k)) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & -v_{mot}(k)*dt*sin(\alpha_{mot}(k)) & dt*cos(\alpha_{mot}(k)) \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & v_{mot}(k)*dt*cos(\alpha_{mot}(k)) & dt*sin(\alpha_{mot}(k)) \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Jacobian of inputs in process model is as following.

$$J_u = \begin{bmatrix} dt*cos(\alpha_r(k)+g(k)) & -v_r(k)*dt*sin(\alpha_r(k)+g(k)) \\ dt*sin(\alpha_r(k)+g(k)) & v_r(k)*dt*cos(\alpha_r(k)+g(k)) \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Prediction step:

$\hat{X}(k+1) = F(\hat{X}(k), u(k))$

$P(k+1|k) = J*P(K|K)*J^T + J_u*Q_u*J_u^T$

3 Observation Model