Imm algorithm implementation for tracking

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Introduction

The porpouse of this document is the analysis and performance evaluation of an IMM algorithm's implementation in a sensor grid tracking an object. The object can move with two different model, random walk and unicycle, governed by a Markov chain. The goal is evaluate the best trade-off between error on estimated position and real position and number of messagesses involved in tracking

Backgound

Tracking a object with a changing dynamic require propers algorithms and filters. Retriving physical data with observations it's not enough, models achiving the best-fit to our data is needed in order to make a prediction and estimate with reduced uncertainty. Here comes to play a major role the IMM algorithm (Interacting Multiple Models): The data from sensor are combined with different dynamical models through the algorithm...

Simulation Model

The target can move with random movement described by a Markov chain and accordingly two different models of movement The tracking are performed with grid of sensors. In order to perform a proper simulation the sensor has assumed to have a limited range for the tracking and we cannot retrive any information if target is out. It also took in consideration the power consumption for a possible physical system: to model a more enegy efficient system the sensor can switch to 3 different working condition: On,Off,Idle. To achive this goal the sensor is working as a state machine as showned in the figure below:

Sensors can communicate with the sensors in their neighboorhoods and exchange signal named CanSense and CantSense that regulate the transition between differents state.

How the sensors works

The measurment acquired by eachs sensors are then combined through the theory of linear consensus The filter choosed are the WSL

Sensors in the simulations are Radar and the H matrix that reprent the measurment:

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Simulation model implementation

Introduction

Filter

Sensor

The sensor grid are is composed by a set of sensor that can communicate with each others creating a fully connected graphic The single sensor works as a state machine, and change its state accordingly with the signal exchanged with the neighboors.

Random walk and Unycicle model

The target in this simulation can move accordingly to two model: random walk and Unycicle. The genaral expression of the two process it

$$X^{+} = \mathbf{A}X(k) + \mathbf{B}u(k) + \mathbf{G}w(k) \tag{1}$$

State,state and noise matrix associate to the random walk has showned below:

$$X = \begin{bmatrix} x \\ y \\ \dot{x} \\ \dot{y} \end{bmatrix} A = \begin{bmatrix} 1 & 0 & \delta & 0 \\ 0 & 1 & 0 & \delta \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} G = \begin{bmatrix} \delta^2/2 & 0 \\ 0 & \delta^2/2 \\ \delta & 0 \\ 0 & \delta \end{bmatrix}$$

The **B** input matrix change accordingly with the acceleration input

$$B = \begin{bmatrix} \delta^2/2 & 0 \\ 0 & 0 \\ \delta & 0 \\ 0 & 0 \end{bmatrix} B = \begin{bmatrix} 0 & 0 \\ 0 & \delta^2/2 \\ 0 & 0 \\ 0 & \delta \end{bmatrix}$$

The unycicle model state representation employed has showned below

Result

The performance evaluation of the system are evaluted by computing the RMS of the predicted trajectory eith the respect to the actual one choosing different rate of performind the WSL. The final result are listed in the table below

1 step	2 step	3 step	4 step
1	6	87837	787
2	7	78	5415
3	545	778	7507
4	545	18744	7560
5	88	788	6344