Indoor Positioning using IMU and Radio Reciever

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- Our approach: use the cellular network and the hardware avaliable in a phones for positioning.

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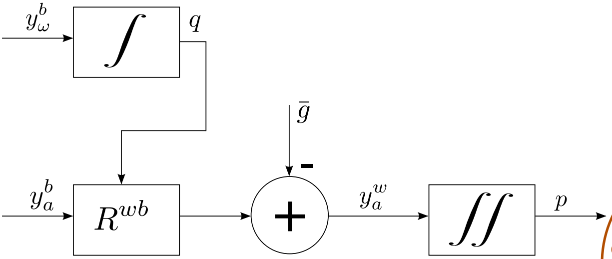
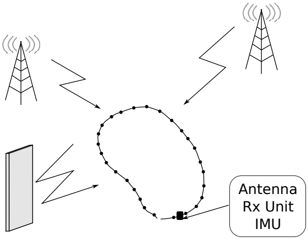


Background - Synthetic Arrays

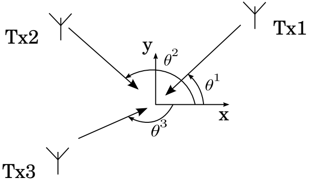
A synthetic antenna array is formed by moving a single reciever antenna and simultanusly tracking the local position with the IMU.



Modeling - Measurements

The phase of the recieved radio signal is dependent on the local position where the signal was sampled and angle of arrival of the radio signal. Measurements from radio reciever:

$$y_k = \sum_{n=1}^{N} \alpha_k^n e^{i[cos(\theta_k^n)p_k^x + sin(\theta_k^n)p_k^y + \nu_k]} + e_k \quad e \sim \mathcal{CN}(0, \sigma_r^2)$$



Modeling - Sensor Fusion

The unknown states that we want to estimate are

$$\{p_k, v_k, q_k, \alpha_k^{1,\ldots,N}, \theta_k^{1,\ldots,N}, \nu_k\}^T \in \mathbb{R}^{12+2N}$$

where N denotes the number of radio sources to be tracked.

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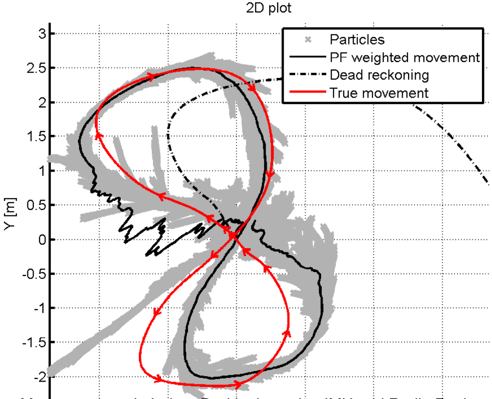
- The unscented Kalman filter
- The particle filter
- Marginalized particle filter

Results from simulations

A marginalized particle filter has been implmented in Matlab and IMU and RF signals are generated. The filter is initialized without any knowledge abot the radio channel but the AOA are known to $\pm 20°$.



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- Synchronized signals from the receiver antenna and the IMU were recorded with a software defined radio from National Instruments.

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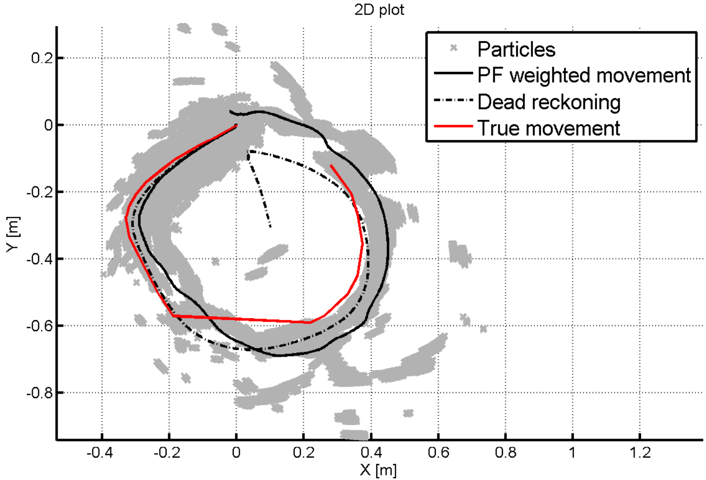
Result from Experiment



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- Glue the filter together with initializing algorithms fro AOA estimation.
- Study the influence of phase drift in the reciever.
- Do experiments indoors and in other radio environments.