Accurate Range-Only Tracking in Wireless Sensor Networks

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Introduction

Wireless Sensor Networks (WSNs) provide novel means of interacting with the physical world through the information they collect and disseminate. WSNs can be deployed in large numbers in order to monitor a specific area. The spatial resolution and flexibility they offer, makes them suitable for tracking applications.

The Tracking System

We propose a tracking system which operates solely on range estimates provided from a number of anchor nodes positioned in known locations. Figure 1 depicts an overview of the proposed tracking system where four anchor nodes are deployed to collect ranging data. A Particle Filter (PF) inspired tracking algorithm is designed to utilize the data and online infer the target's position and two-axis velocity .

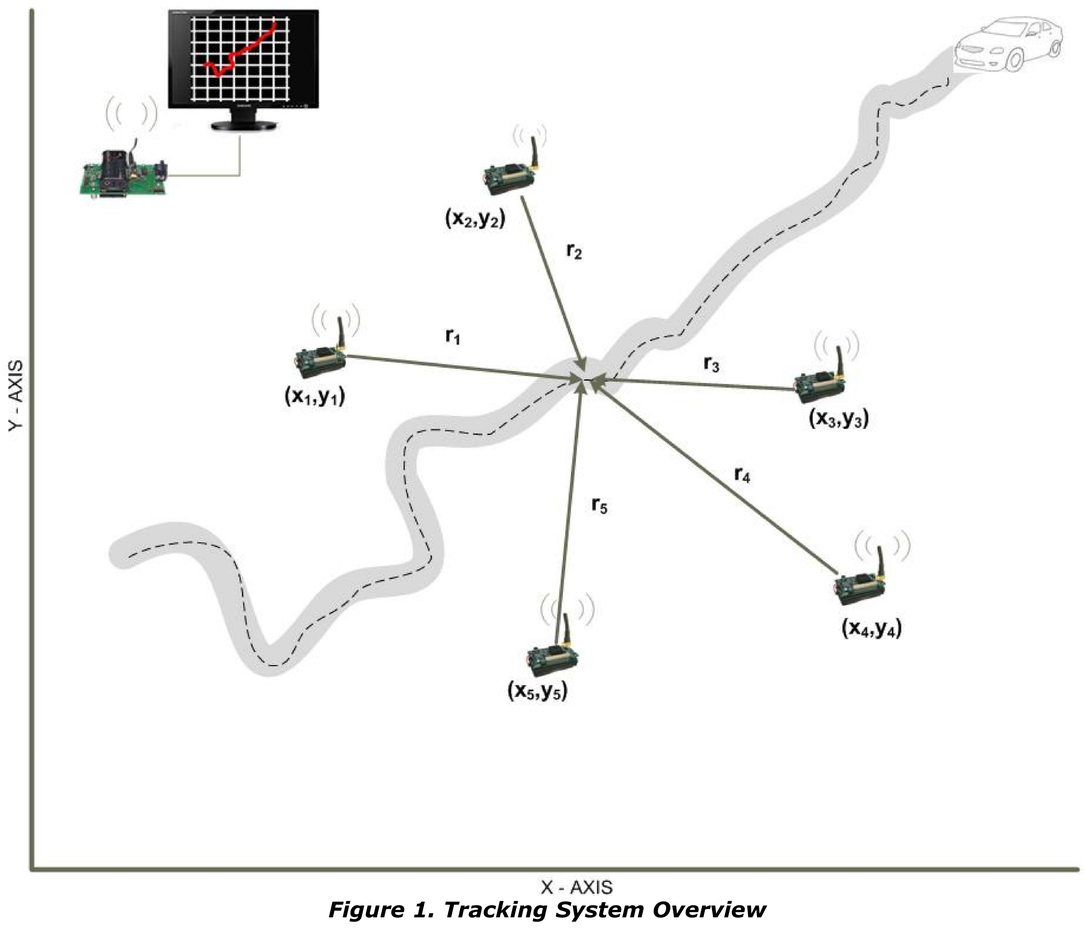

Figure 1. Tracking System Overview

To successfully track manoeuvring targets, a multiple model state-space representation is employed. We opt to employ switching multiple models to capture the development of the system's state when a manoeuvring target is the object of interest.

The state vector comprises of the object's position and two-axis velocity. Thus,

$$\mathbf{x}_k = [x \; y \; v_x \; v_y]$$

At every time step "*k*" a number of "N_s" anchor nodes provide range estimates. Hence the measurements vector is contains the "N_s" range estimates, provided by the anchor nodes.

$$\mathbf{z}_{k,N_s} = \left[\sqrt{(y_{k,t} - y_{k,N_s})^2 + (x_{k,t} - x_{k,N_s})^2} \right]$$

Simulation - Results

The performance of the proposed tracking system is evaluated through simulations. In the simulation environment considered, a mobile node is the target and four anchor nodes collect ranging data. Figure 2 illustrates results from an exemplar run of our system.

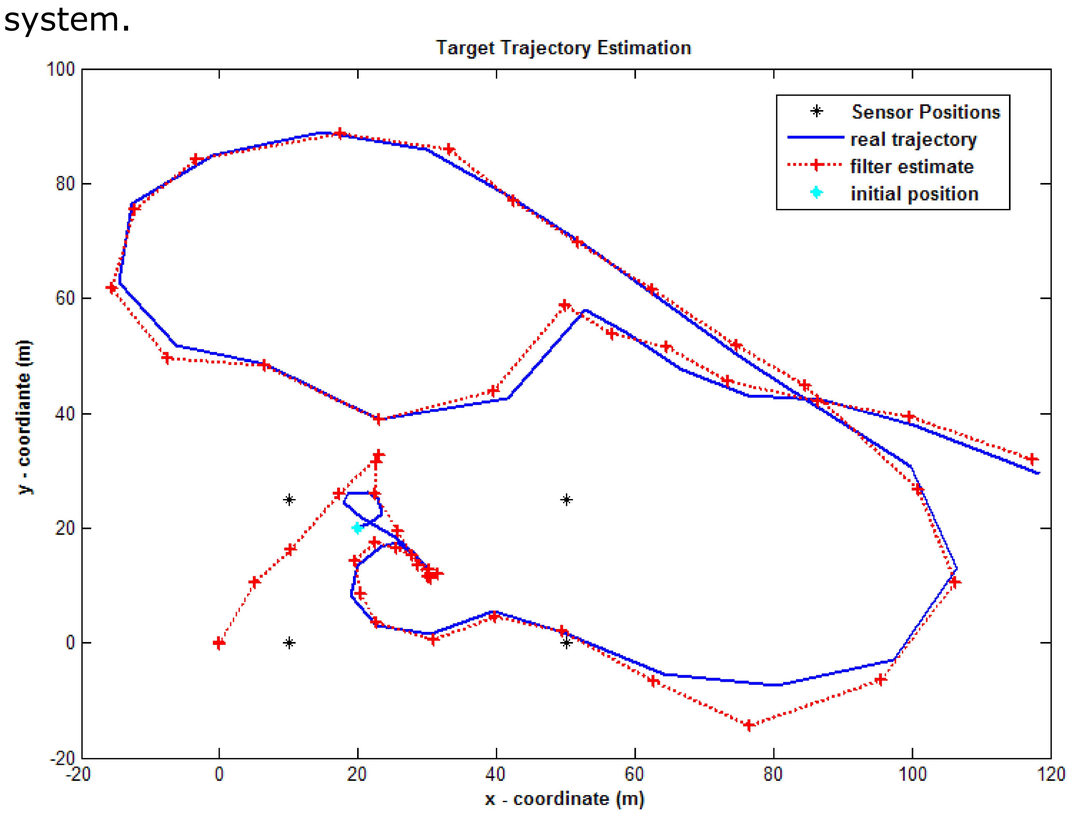

Figure 2. Trajectory Estimation

Figure 3 depicts a bar chart of the Root Mean Square Error of a heavy cluttered scenario which was executed for 100 times. In 87% of the executions the RMSE remains lower than 20m.

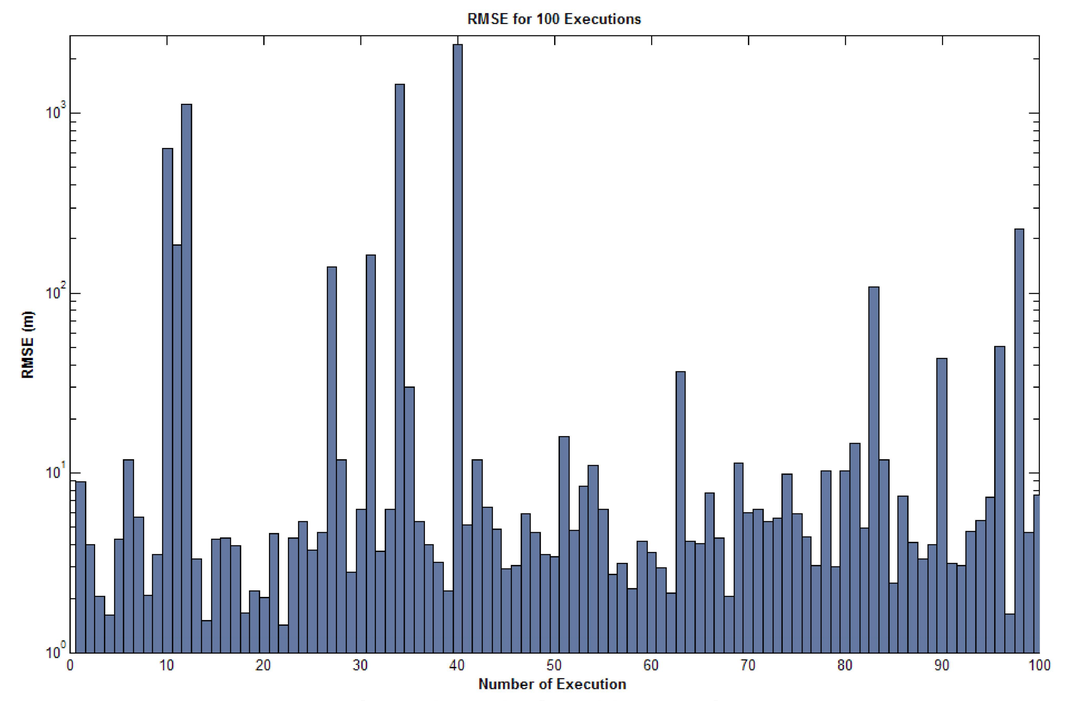

Figure 3. RMSE for 100 executions

Conclusions – Future Work

- Range Only Tracking System
- Simulations demonstrate prominent results
- Ability to handle manoeuvring targets
- Small number of particles employed (≤500)
- Future Direction - Implementation on hardware

References

[1] Arulampalam, M.S., Maskell, S. , Gordon, N. and Clapp, T., "A tutorial on particle filters for online nonlinear/non-Gaussian Bayesian tracking". *IEEE Trans on Signal Processing.vol 50*, (Feb. 2002), pp. 174 -188.

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