Real–Time Detection and Tracking using Wireless Sensor Networks

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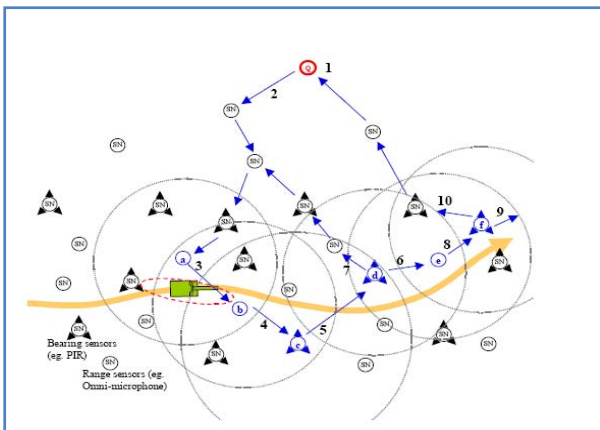
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Project Aims

To develop and deploy a detection and tracking system based on wireless sensor networks. Real-Time detection and tracking is achieved using Wireless Sensor Networks Hardware. The system is envisioned to be able to effectively handle multiple arbitrarily moving targets.

Tracking in Wireless Sensor Networks

A generic tracking scenario: A network comprised of low-power, resource constrained nodes, detects an object of interest and initiates tracking based on sensor readings obtained be the nodes. A base station node is used to for report and display purposes.

A generic tracking scenario. Adapted from [1]

In order to estimate an objects position, a certain sensing modality which associates the distance of the object from the sensor node should be made available. Classification of targets can be made possible by using more than one different sensors to gather measurements. Some of the modalities considered for tracking are summarized below.
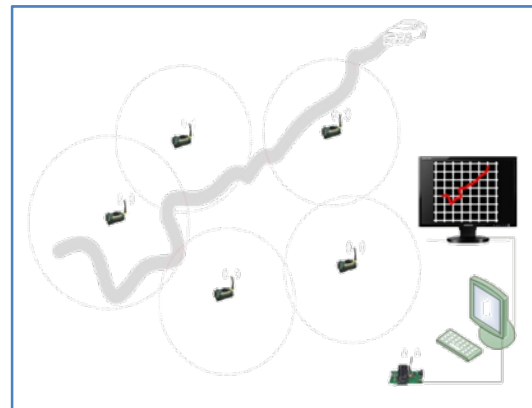
1. Time of Flight
2. Direction of Arrival
3. Acoustic Sensors
4. Passive Infrared Sensors
5. Magnetic Sensors

Most of these modalities have been investigated and sub-meter accuracy can be achieved using range only measurements.

Network Topology - Structure

A detection/tracking system requires the implementation of a tracking algorithm which uses the measurements provided by sensors to estimate the object's position. Other kinematic attributes that can be estimated through this procedure are, velocity and acceleration.

The tracking algorithm is based on Particle Filters. Particle Filters are sequential Monte Carlo algorithms based on sample (particle) representation of probabilities densities. These can be applied to a state-space model and recursively estimate the state vector of the system.

A vehicle tracking scenario

This algorithm is scheduled to be implemented in Wireless Sensor Network hardware, and experiments will be conducted to evaluate the system performance.

Application Domains

The above system can be used in a number of different domains which require tracking of moving objects. Examples include:

1. Vehicle Navigation
2. Wildlife Monitoring
3. Military battlefield surveillance
4. Industrial asset monitoring
5. Security Systems

References

1. Feng Zhao, Jie Liu, Juan Liu, L. Guibas, and J. Reich. Collaborative signal and information processing: an information-directed approach. Proceedings of the IEEE, 91(8):1199–1209, Aug. 2003.