Object Tracking in Wireless Sensor Networks

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Outline

- Introduction
- Proposed object tracking methods
- Discussion
- references

Introduction

- What are the attractive characteristics of sensor nodes?
  - Small size
  - Low cost
  - Can distribute to wide area
  - Etc.

Introduction

- Due to these attractive characteristics, sensor networks become adopted to many military and civil applications.
  - Target tracking
  - Surveillance
  - Environmental
  - Etc.

Introduction

- What's the importance of the object tracking applications?
  - Tracking enemy vehicles
  - Detecting illegal border crossings
  - Tracking the movement if wild animals
  - Traffic load of the city
  - Etc.

Proposed object tracking methods

- We can classify the design issues into some categories.
  - Tree construction [1]
  - Cluster-based [2-7]
  - Prediction-based
  - Target classification[4,5]

Tree construction

- DAB: Drain-And-Balance method for constructing message-pruning tree.[1]

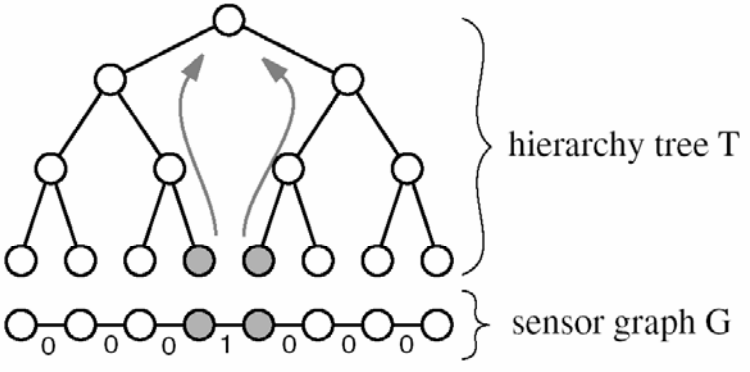


Figure 3: In this example, detection events occur only between the middle two sensors, at a unit rate. Since the detection messages travel to the root, the communication cost of six messages per unit time is incurred at the links indicated by the arrows

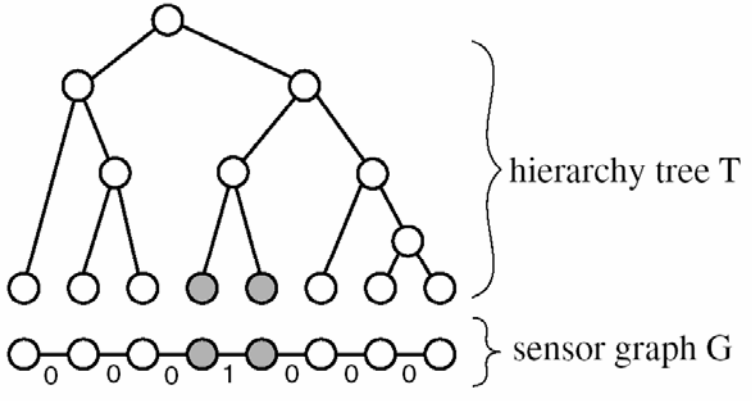


Figure 4: This example shows a hierarchy with a minimal communication cost. The detection messages from the shaded sensors are pruned by their immediate ancestor

Tree construction

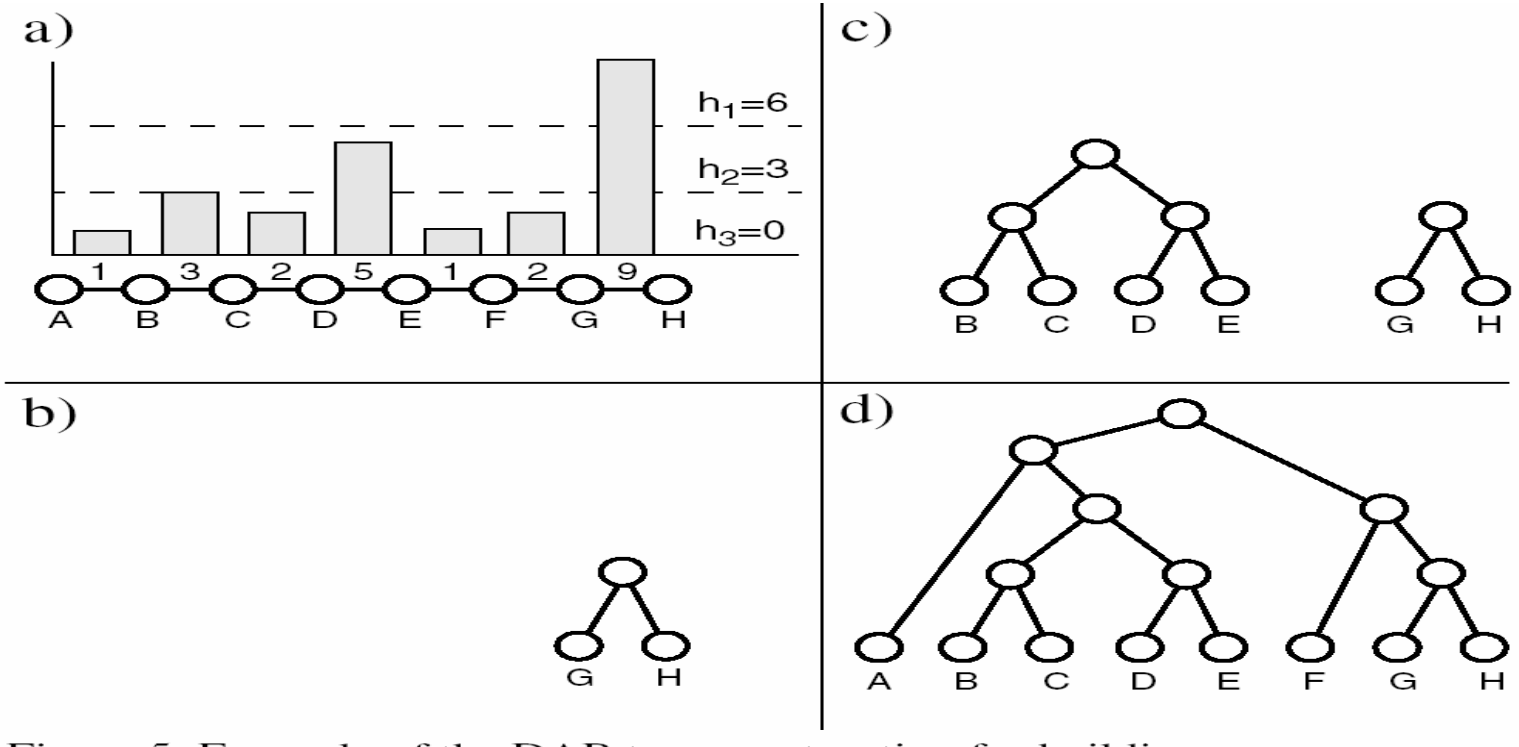


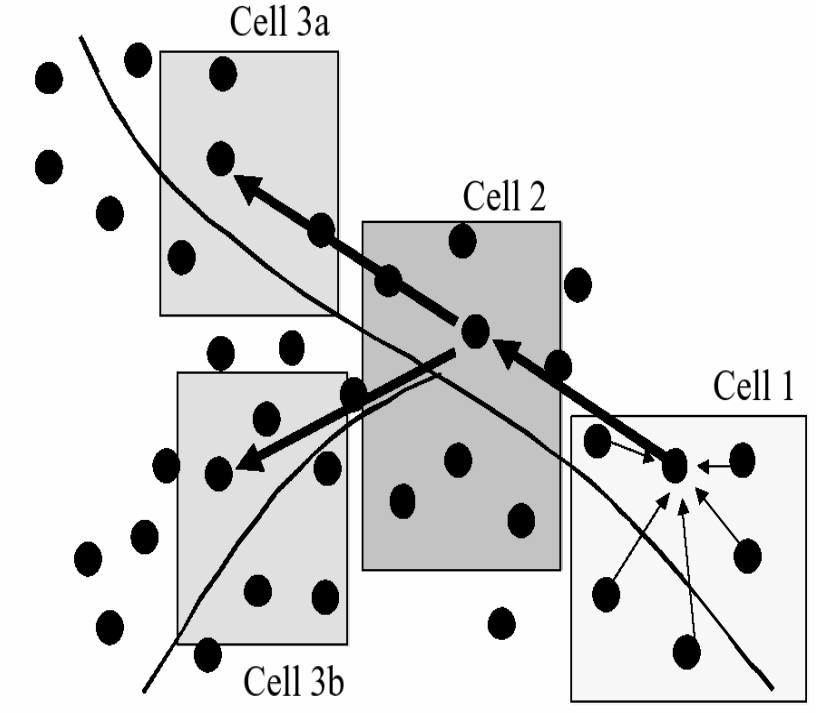
Figure 5: Example of the DAB tree construction for building a message-pruning hierarchy. Part a) shows the 1D input sensor graph G, with the weights depicted using vertical bars, and three indicated thresholds. Parts b, c, d) show the tree after the first, second and last DAB step, respectively. The final tree constructed appears in part d)

Cluster and Prediction based

- In order to design the object tracking applications into distributed manner, many researchers used cluster-based strategies.
- Using multiple nodes to track the objects may get more precise information then using only one node.
- Often combine with prediction-based methods

Cluster and Prediction based

- In general, we can summarize these methods into some steps:
  - Initialization
  - Tracking
  - prediction
  - update



Cluster and Prediction based

- Need to predict the possible location of the moving object.
- With prediction, it can minimize the number of nodes participating in the tracking activities.
- Different prediction models, wake up mechanisms and recovery mechanisms will affect the system performance.

Cluster and Prediction based

- Prediction models
  - Heuristics INSTANT
    - Assumes object will stay in the current speed and direction
  - Heuristics AVERAGE
    - Using the average of the object's moving history to derives the future speed and direction
  - Heuristics EXP_AVG
    - Assigns different weights to the different stages of history

Cluster and Prediction based

- Wake up mechanisms
  - Heuristics DESTINATION
  - Heuristics ROUTE
  - Heuristics ALL_NBR
- Recovery mechanisms
  - ALL_NBR
  - Flooding recovery

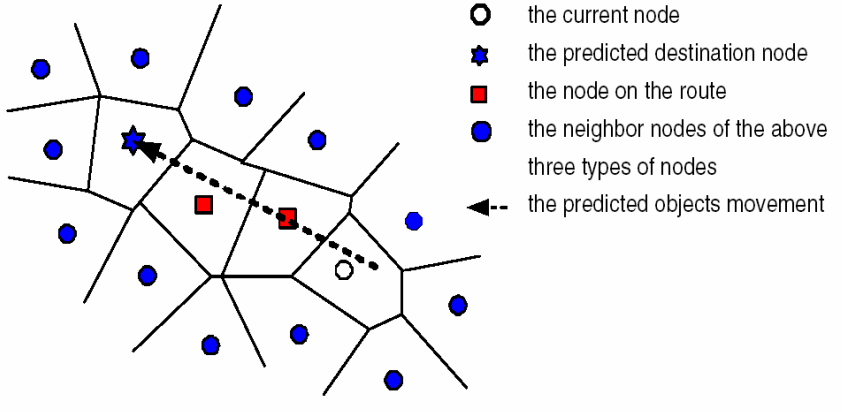
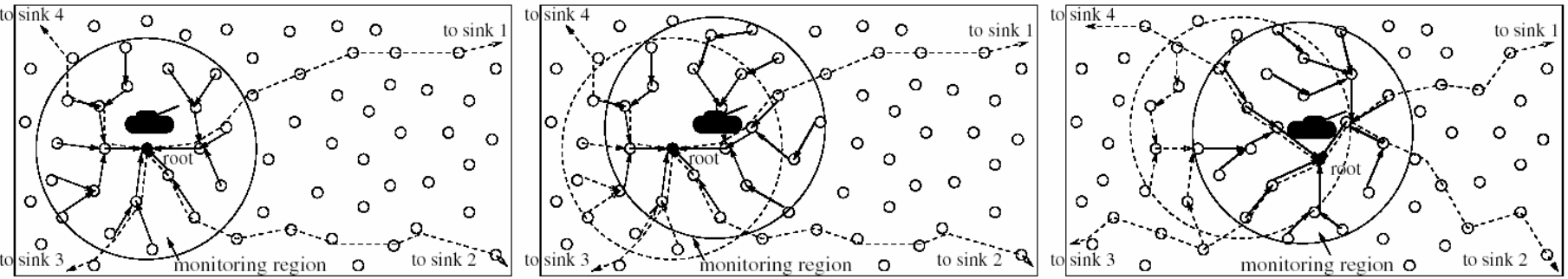


Figure 3. Heuristics for wake up mechanisms

Cluster and Prediction based

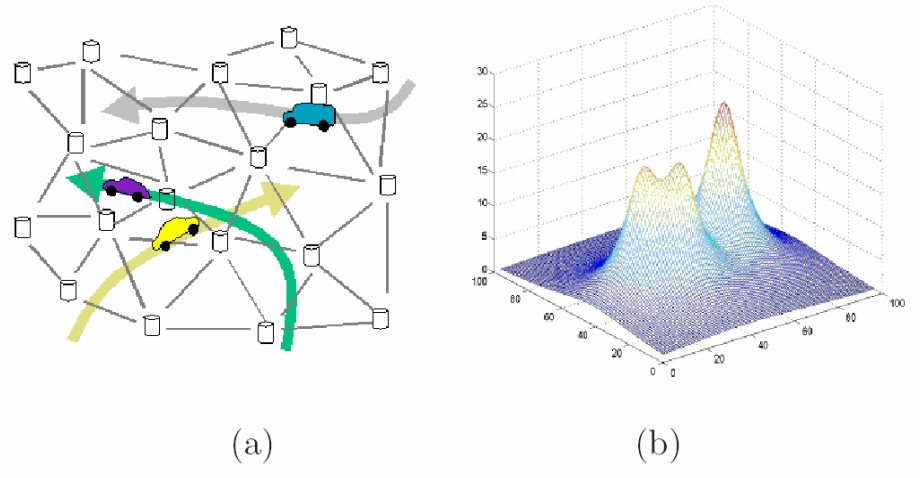
- Other cluster-like methods for object tracking
  - Convoy tree[6,7]
  - Location-centric approach[5]
  - Etc.



Target classification

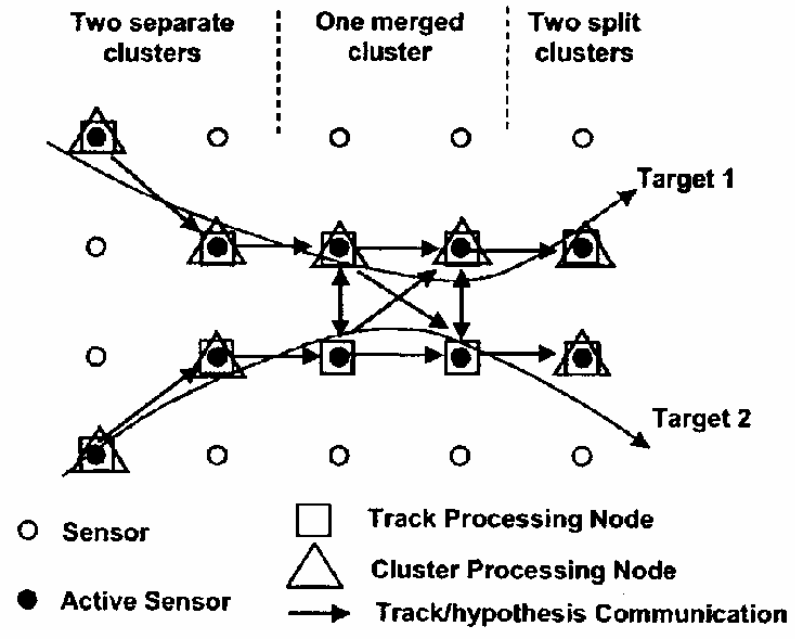
- Classification algorithms are needed in general for tracking multiple targets.
  - Different modalities
  - Different measurements
  - Make sure whether the target is your desired tracking type or not.
  - Classification algorithms
    - K-Nearest Neighbor classifier
    - Maximum Likelihood classifier
    - Support vector machine classifier
    - Etc.

Target classification



(a) (b)

Fig. 6. Target counting scenario, showing three targets in a sensor field (a). The goal is to count and report the number of distinct targets. With the signal field plotted in (b), the target counting becomes a peak counting problem.



Discussion

- The practicability of the message punning tree is a big question.
  - Intermediate nodes are not real nodes.
  - How to define weights on every edges?
  - Centralize model

Discussion

- Distributed vs. Centralized
- Need to design a good prediction method to reduce the loss rate in cluster-based object tracking algorithm.
- Object tracking with mobile sinks scenario in sensor networks

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