Smart Deployment of Nodes in a Network

Tech ID: 34190 / UC Case 2020-278-0

BACKGROUND

Outdoor wireless sensor and camera networks are important for environmental monitoring and public-safety surveillance, yet their real-world deployment still relies heavily on expert intuition and exhaustive simulations that fail to scale in many landscapes. Traditional coverage-maximization techniques evaluate every candidate position for every node while factoring in every other node, the task complexity becomes intractable as node count or terrain granularity grows. The challenge is sharper in three-dimensional topographies where ridges, valleys, and plateaus block line-of-sight and invalidate two-dimensional heuristics. Moreover, once nodes are in the field, relocating them is slow and costly if new blind spots emerge or missions evolve.

TECHNOLOGY DESCRIPTION

To help these challenges, researchers at UC Santa Cruz (UCSC) have developed a computational framework that modernizes how mobile sensor networks automatically optimize their positioning across complex three-dimensional terrain through intelligent proxy-location sampling and range-limited visibility algorithms. UCSC's terrain-aware approach significantly reducing computational complexity to near-linear scaling by having each node evaluate only a handful of strategically selected proxy locations rather than exhaustively testing every possible position, while also using a wonderful-life utility or WLU (known algorithm that determines a contribution that a surveillance node individually provides to the overall fitness of the surveillance network) metric that enables distributed decision-making without requiring centralized coordination. This approach fundamentally addresses a stubborn challenge of deploying wireless sensor and camera networks in diverse environments by incorporating line-of-sight ray-tracing with hard sensing-range limits, ensuring nodes position themselves to maximize actual useful coverage rather than simply achieving high elevation. Distributed architecture allows networks to scale from a few nodes to hundreds while maintaining real-time optimization capabilities, with each mobile platform equipped with GPS, mobility components, and edge computing power to execute the relocation algorithm locally. The resulting system delivers superior coverage performance, energy efficiency, and cost savings compared to historical deployment methods.

APPLICATIONS

- city/urban safety monitoring
- environmental monitoring
- defense/battlefield surveillance
- border surveillance

ADVANTAGES

- By sampling proxy locations and ignoring distant nodes in WLU calculations, the algorithm slashes evaluation load >90%, letting commodity, low-power processors onboard each node run real-time optimization without cloud help.
- Easily scalable using only terrain data and messages from neighbors within a single communication radius for network growth and distribution.
- Unlike typical flat-ground heuristics, the relocation logic inherently accounts for hills, ridges, and depressions, preventing costly misplacements atop high plateaus that often reduce visibility because of sloped occlusions.

RELATED MATERIALS

- Outdoor 2.5D-Terrain IoT Deployment Algorithms - 10/19/2022
- Deployment Algorithms for Outdoor IoT Networks over 2.5D Terrain - 06/01/2022

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OTHER INFORMATION

KEYWORDS

IoT, camera nodes, nodes, wireless sensor, sensor, position, positioning, terrain, 2.5D, sensor network, deployment, terrain-aware, remote sensing, line-of-sight, viewshed

CATEGORIZED AS

- **Communications**
  - Networking
  - Other
- **Environment**
  - Other
  - Sensing
- **Security and Defense**
  - Other
- **Sensors & Instrumentation**
  - Environmental Sensors
  - Other
  - Position sensors
- **Engineering**
  - Other

RELATED CASES

2020-278-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- A Novel Iot Protocol Architecture; Efficiency Through Data And Functionality Sharing Across Layers
- Cross-Layer Device Fingerprinting System and Methods

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