

Localization in Non-GPS reachable area in mobile sensor networks

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Goal: make a product that can be used to take trace of visitors and locate them in areas like mountains, caves, oceans and so on.

Development environment: Android system.

Device: smart phones

Description: When visitors travel to an area that is hardly accessible by GPS and not available for them to communicate them through phone calls or messages, it is more risky for some members who may get lost. This application is designed for localization of the members. The application provides two functions. One is prevention of loss of members. Members may get alert when they are going to get lost from the troop. The other is to provide searching method that tries to locate the lost members in an intelligent way.

Application background: Explorer assistance, robot-assisted exploration.

Inspiration: The concept of localizability in wireless networks. But in this application, the concept is a little different.

Prevention of loss: Based on localizability of a specific node and the network, we model this network as a graph, and for any node, we need check the localizability periodically.

Relocation of lost members: Once a node is lost, the application should provide an intelligent approach to search this node with maintaining the localizability of the network.

Challenges:

- (1) Measurement of the distances between two nodes.
- (2) Definition of the localizability of the node and network.
- (3) Compared with wireless sensor networks, this network is more dynamic, which means the topology always changes with time.

Details:

Communication methods options:

- (1) Wi-Fi direct
- (2) Bluetooth

Problems and solutions:

(1) Measurement of the distances between two nodes

Solutions:

Use Wi-Fi Direct or Bluetooth to measure the distance between two nodes, if all distances are measured, the network graph can be achieved.

(2) Absolute location or relative location?

This can be decided by the user. If choosing absolute solution, anchor nodes need to know their locations. If choosing relative locations, several leaders should be chosen as anchor nodes that are used to locate the network.

(3) How to define anchor nodes in the graph?

Solutions:

a. Static: Experts play the role as anchor nodes. The experts are familiar with specific area and can define their concrete locations.

b. Dynamic: members who can locate themselves play the roles as anchor nodes. Locating themselves means they know the specific positions where they are. The role as anchor node may change to normal node if one lost his position.

(4) What information should maintained in one node?

a. Centralized: One node need to get all the information of the networks, each node maintain a network graph.

Shortcomings: high cost, multi-hop delays may lead to inconsistency.

b. Distributed: One node only maintain the information needed to localize itself and the information needed by others who need this specific node's location information.

c. Hybrid: anchor nodes (leaders) may maintain all the information of the network, even though the network may not be up to date all the time or have inconsistency, still can provide information to monitor the network topology.

(5) How do nodes deliver packets with each other?

Through Wi-Fi Direct or Bluetooth, realize P2P communication between two nodes.

(6) Instructions in the network.

The instructions can be sent out by the leaders and should be propagated to the whole network to decide the strategy whether exploiting first or strong connection first.

Exploiting first will encourage nodes to exploit the unfamiliar area as much as possible.

Strong connection or easy localization first encourage nodes make more conservative decision to maintain the specific node and network localizability.

(7) How does a node decide the next movement?

One node makes its decision according to the instructions and its maintained topology changing trend.

(8) How can a node lose localizability and lead to part of the network not localizable.

Movement of a specific node may make this node not localized and also probably lead to the relative nodes which depend on this node's localization losing localizability.

(9) Once a node loses its localizability, what should be done?

a. For the lost node, it should make its decision to join back to the network according to the topology changing trend.

- b. For the other lost nodes, they will probably make decisions to get back to network to gain localizability.
- c. For the rest of the network, they need to adjust strategy to maintain the network localizability first and try to get the lost nodes back.