Efficient Greedy Face Probe Routing for Wireless Sensor Networks

UMBC
AN HONORS UNIVERSITY IN MARYLAND

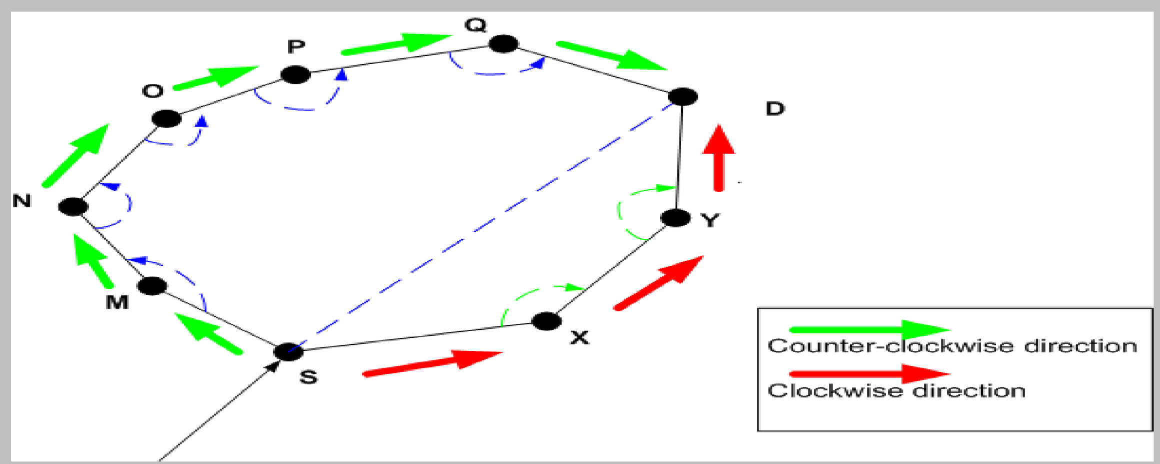
Zhong Ren

1. Introduction

- Project Objective:
  To design an efficient, scalable geographic routing protocol in wireless sensor network which can significantly shorten the hop-to-hop routing path and be scalable under different network topologies and node densities.

2. Motivation

- EGFP is motivated by GPSR (Greedy Perimeter Stateless Routing)
- GPSR exploits the duality between greedy routing and face routing.
- In face routing, GPSR exclusively takes counter-clockwise direction in selecting next hops, which is not always a good choice.



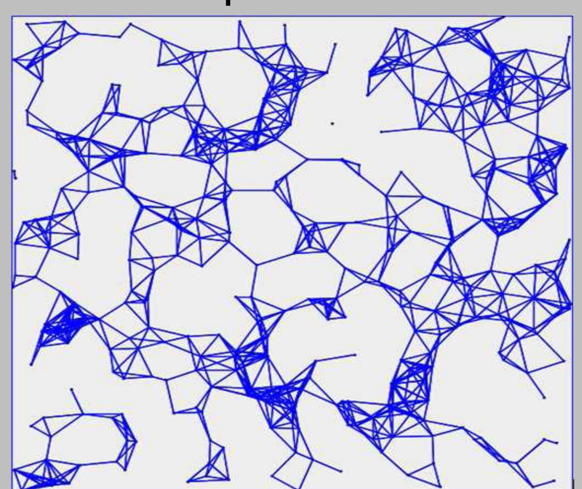
Face routing under different directions

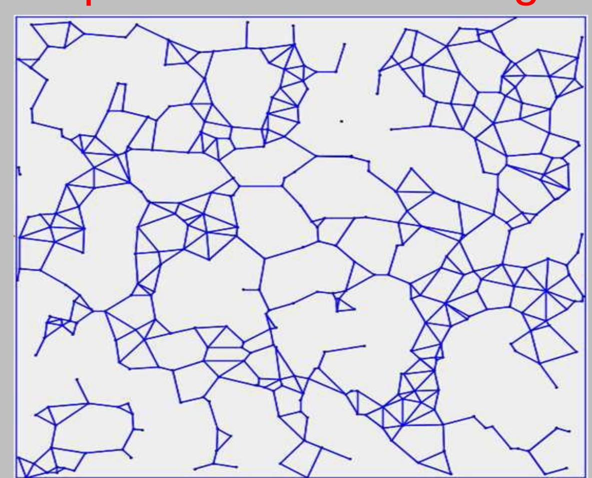
In the above figure, under the assumption that data packet are forwarded purely in face routing, counterclockwise edge selection results in packet traversing S->M->NO->P->Q->D to destination while clockwise edge selection will guide the packet through S->X->Y->D, which is 3 hops less.

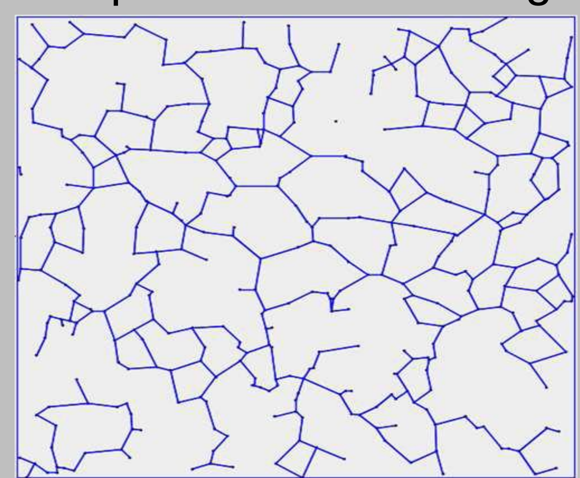
3. Related work and underlying Architectures

Almost every geographic routing algorithm operates on planarization. Without planarization, face routing will fail even in the most simple topologies.

- Common planarization strategies are Unit Disk Graph (UDG) , Gabriel Graph (GG) and Relative Neighbor Graph (RNG)
- EGFP implements both Gabriel Graph and Relative Neighbor Graph as planarization strategies.

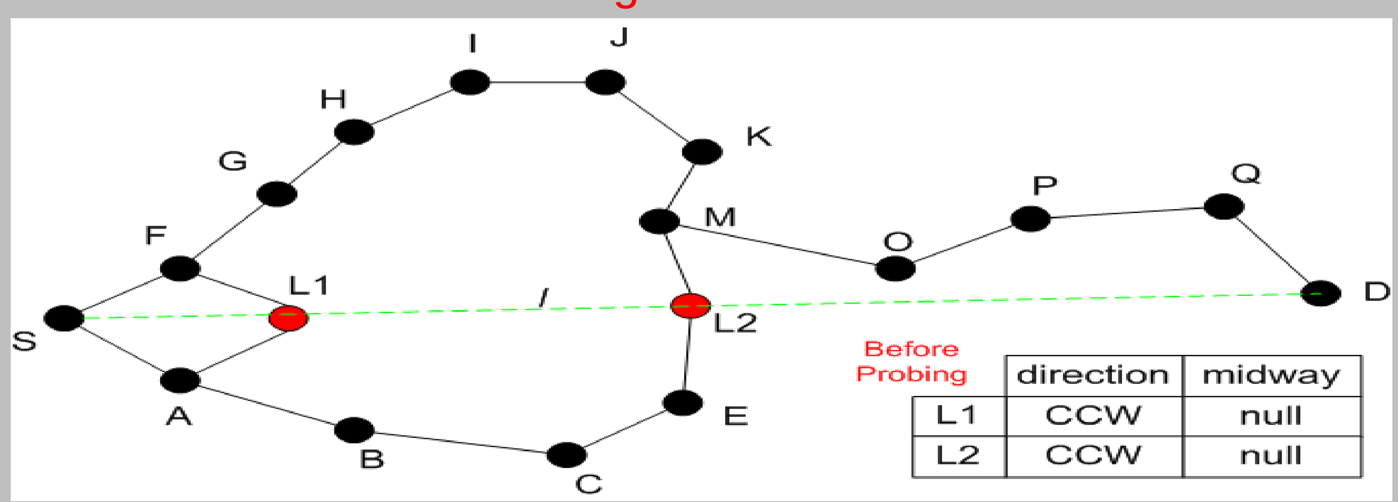

UDG


GG


RNG

4. Algorithms

- Part One: Face Probing



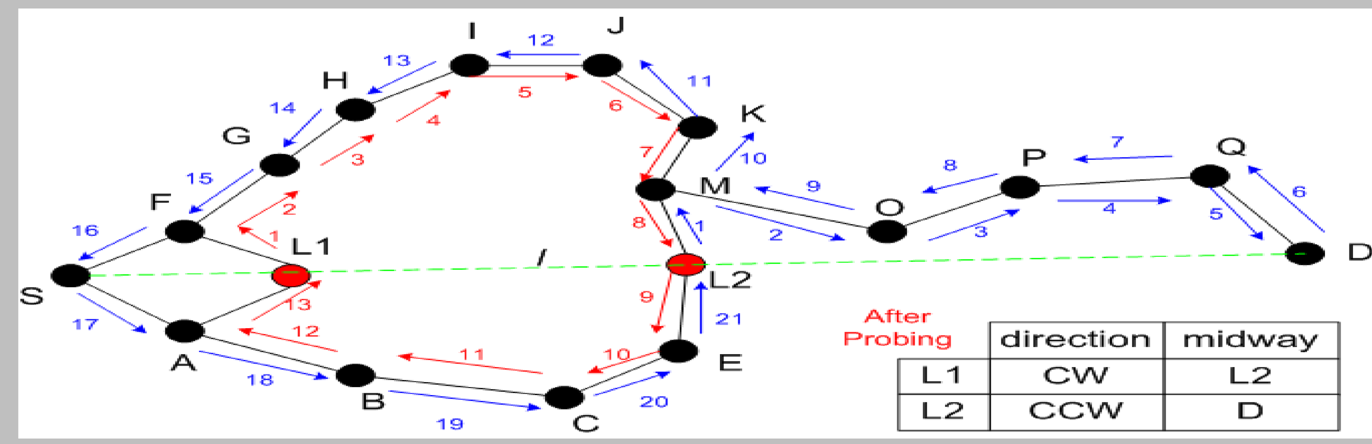
Before probing

After initialization, every nodes has default direction as CCW and midway as null.

Only local minimal needs to send probe packets, because Greedy forwarding only fails at local minimal nodes and alternative routing strategies has to be used.

Field	Function
curr_hop	Hop count so far
exitpt	The closest node to destination
ccw_hop	Counterclockwise hop count to exitpt

Probing package header



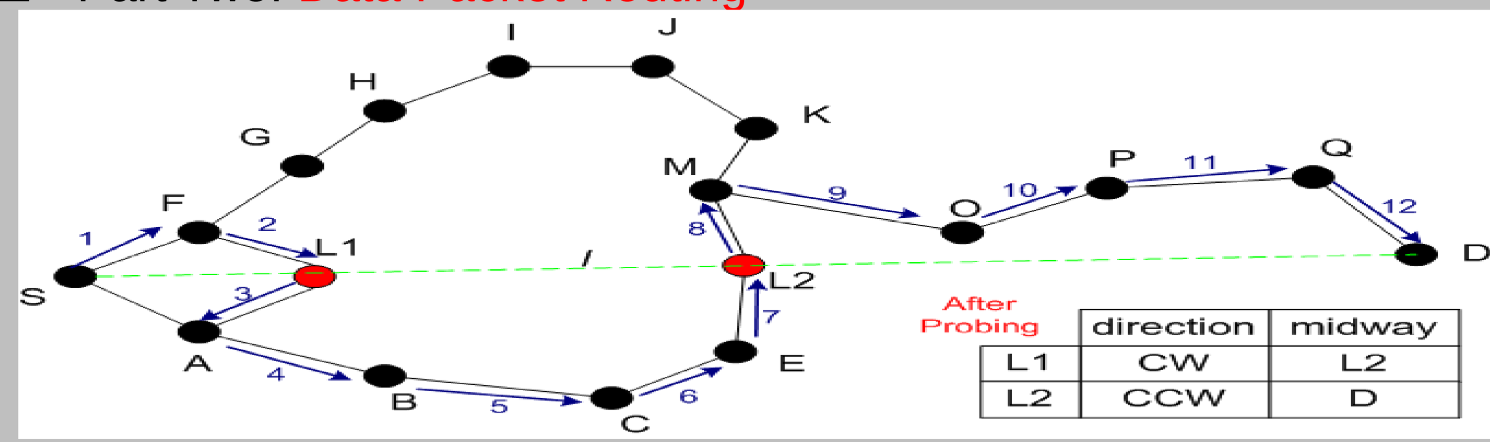
After probing

- exitpt is found along the probing path, which the node closest to destination
- A local minimal is said to has
  counter-clockwise direction
  if *ccw hop =< curr hop − ccw hop*.
  clockwise direction
  if *ccw hop > curr hop − ccw hop*.

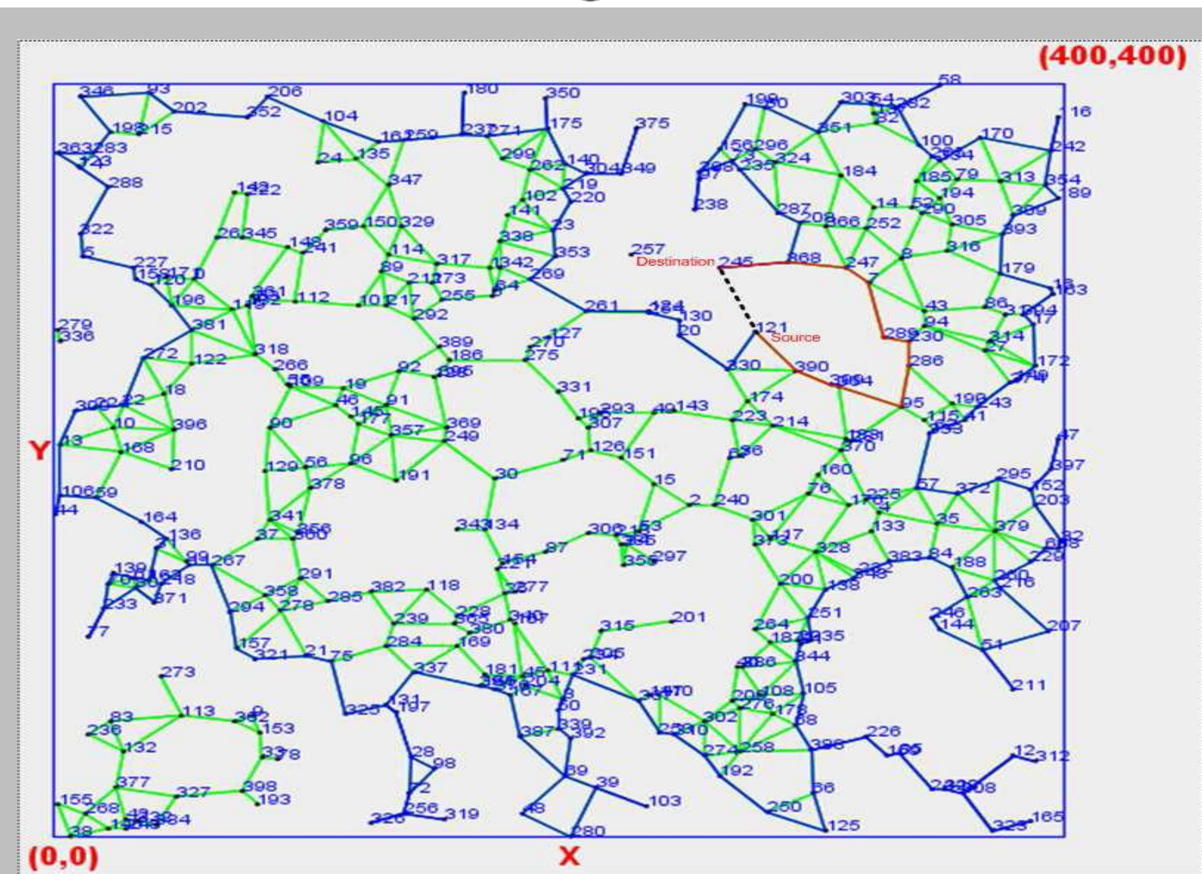
Field	Function
mode	Packet mode
direction	The direction data packet follows in Directional mode
midway	The point data packet changes direction

Data packet header

- Part Two: Data Packet Routing



- Under Directional mode, data packet is forwarded using GPSR face routing rules, edge selection direction is determined by direction field in data packet unless forwarding node is midway node or data packet exits Directional mode
- When data packet reached midway node, midway node writes data packet's direction field with its own direction and update packet's midway node



The figure on the left is an example of different routing paths taken by GPSR and EGFP.

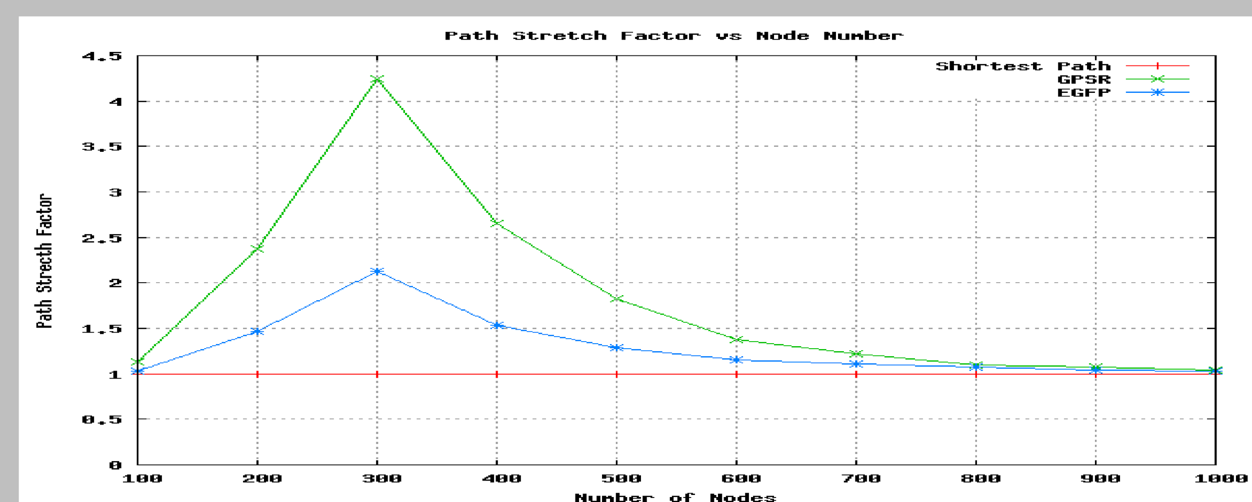
GPSR path is marked in blue , EGFP path is marked in red

By taking counterclockwise direction, GPSR traverses the whole outer face; EGFP chooses the right direction and reaches destination in considerable shorter path.

Routing paths taken by GPSR and EGFP

5. Performance Evaluation and Future work

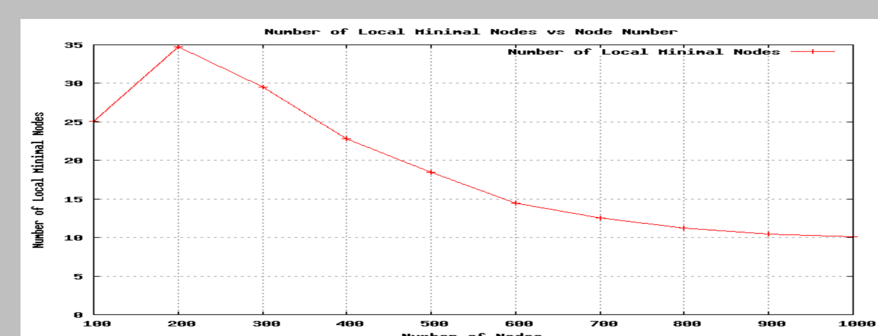
Performance is evaluated in terms of Path Stretch Factor, Number of local minimal and Total overhead

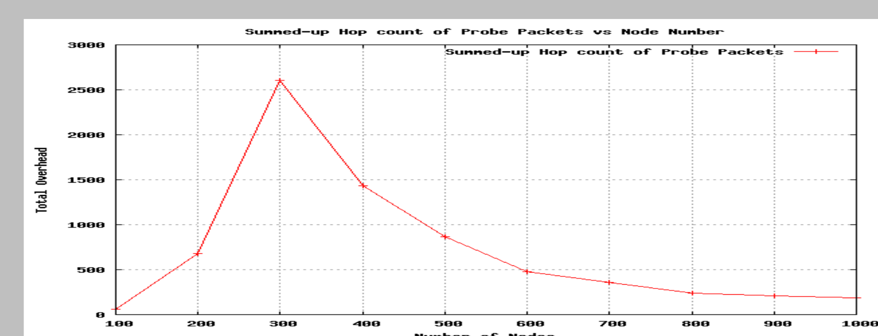


Path Stretch Factor

Path Stretch Factor is the ratio of routing path length to shortest path length.

As observed figure on the left, EGFP has smaller path stretch factor than GPSR at all times, which means EGFP is significantly more efficient than GPSR in term of hop-to-hop routing path length in any node densities.


Number of local minimal


Total Overhead

EGFP is also proven to be a scalable geographic routing protocol. As we can observe in the above two figures , both number of local minimal nodes and total overhead do not increase accordingly when the total number of nodes in the network increases.