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Survey of Geographical Routing in Multimedia Wireless Sensor Networks

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Abstract: Multimedia wireless sensor network contains rich information and are capable of enormous data communications. In all kinds of routing protocols, geographic routing has been regarded as one of the most promising routing methods for multimedia wireless sensor networks due to its simplicity and scalability. This study presented an overview of forward mechanism and surveyed the currently available techniques for geographical routing. In this survey, we firstly presented four classic protocols; then we summarized their advantages and disadvantages for multimedia wireless sensor networks; finally we discussed some possible directions of future research.

Key words: Multimedia wireless sensor network, multimedia communication, routing, geographical routing, forward mechanism

INTRODUCTION

With ever increasing advancement in the manufacturing industry and extensive application of sensor network, Multimedia Wireless Sensor Networks (MWSN) have attracted unprecedented attention (Ruifang *et al*., 2009). MWSN has some unique characteristics, such as containing rich information, enormous data communication and equal energy-consumption of each unit (Akyildiz *et al*., 2007). Because of these special characteristics of MWSN, it was very difficult to transplant geographical routing protocols of traditional Scalar Wireless Sensor Networks (SWSN) to MWSN directly (Li *et al*., 2009).

In all kinds of routing, for example AODV (Zhaoxiao *et al*., 2009; Tingrui *et al*., 2009), geographical routing has been regarded as one of the most promising routing methods for multimedia wireless sensor networks due to its low computational complexity and scalability (Bin *et al*., 2009). It requires no routing information exchange nor does it need to maintain a large routing table (Li *et al*., 2009).

Our contribution in this study is to survey the state of the art of geographic routing in multimedia wireless sensor networks. We also compared four classic geographical routing protocols from different perspectives in order to discuss directions of future research on this problem.

FORWARD MECHANISM IN GEOGRAPHICAL ROUTING

Greedy forwarding chose a router's immediate neighbors geographically closest to the destination. Due to its simplicity and scalability, this strategy was used in various geographical routing algorithms.

Besides Greedy Forwarding Scheme (GFS) (Finn, 1987), there are MFR(Most Forward within Radius) (Takagi and Kleinrock, 1984), NFP (Nearest Forward Progress) (Hou and Li, 1986), (Compass Routing) (Kranakis *et al*., 1999), RPF (Random Progress Forward) (Nelson and Kleinrock, 1984) etc. Figure 1 illustrates different forwarding mechanism. Node S is the current location of date packet, R is the communication radius of node S, all nodes in the circular dashed are the neighbor of node S, node D is the destination of data packet.

According to the different location of each node, we can obtain six relations from Fig. 1.

$$\min(|CD|,|GD|,|ND|,|MD|) = |GD| \tag{1}$$

$$\max(|Sc|,|Sf|,|Sm|,|Sn|) = |Sm| \tag{2}$$

$$\min(|Sc|,|Sf|,|Sm|,|Sn|) = |Sn| \tag{3}$$

$$\min(\angle CSD, \angle GSD, \angle MSD, \angle NSD) = \angle CSD \tag{4}$$

$$\min(\angle GSD, \angle NSD) = \angle GSD \tag{5}$$

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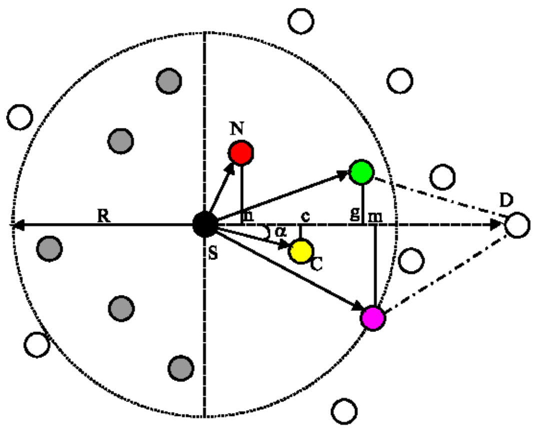

Fig. 1: Different forward mechanism S: Source node; D: Destination node; Node C, G, M and N are the neighbor of S. R is the communication radius of node S

Table 1: Comparison of different forward mechanisms

	Advantages	Disadvantages
GFS	No loop routing Small hops of routing Maximum forward to destination	Poor reliability High transmission power
MFR	Less hops of routing Farthest to current node	Exist loop routing
NFP	High reliability	Minimum forward to destination More hops of routing
CR	Minimum range of transmission directions	Exist loop routing
RCR	Minimum range of transmission directions	Eliminate loop routing
RPF	Low computational complexity	Uncontrollable delay and hops

$$\min(\angle CSD, \angle MSD) = \angle CSD \quad (6)$$

GFS chose node G by Eq. 1 as the next step. MFR chose node M by Eq. 2 as the next step. NFP chose node N by Eq. 3 as the next step. CR chose node C by formula Eq. 4 as the next step. Randomized Compass Routing (RCR) chose node G by Eq. 5 or node C by Eq. 6 as the next step (Kranakis *et al*., 1999). The RPF arbitrarily chose a node from node N, G, M and S as the next step. Different forward mechanisms have different advantages and disadvantages. Table 1 shows their differences.

All these forward mechanisms come from geographical routing for scalar wireless sensor network. Although data communication transmission in multimedia wireless sensor network is much larger than scalar wireless sensor network, they are still suitable for multimedia wireless sensor network.

CLASSIC GEOGRAPHICAL ROUTING

Greedy perimeter stateless routing: Karp's GPSR protocol chose greedy forwarding as basic data

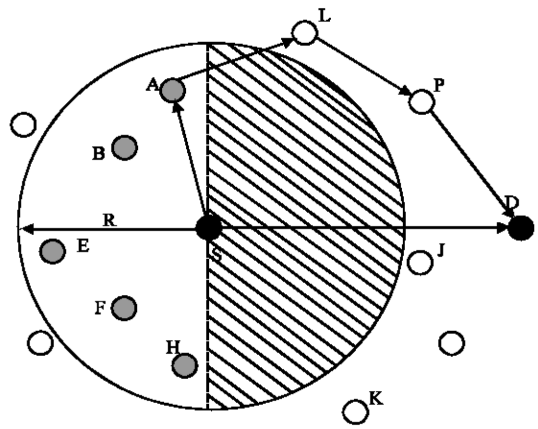

Fig. 2: Greedy forward failure. Node S encounters void. Node D is the destination

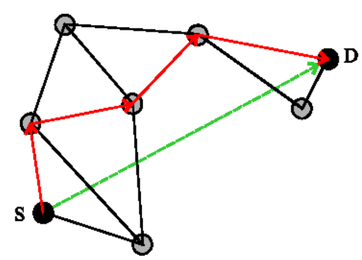

Fig. 3: Right-hand rule and perimeter mode. S: Source node and D: Destination node. Perimeter path (Red solid line)

forwarding strategy (Karp and Kung, 2000). Greedy forwarding behaves well in practice, but it fails to yield a path to the destination when encounter a void area, where no node exists, for example Fig. 2 (Li *et al*., 2009).

GPSR uses the right-hand rule (Fig. 3) to find the route to the destination when greedy strategy fails and this kind of perimeter mode commonly result in excessive hops.

Advantages:

- Low computational complexity
- It doesn't exist loop routing
- High energy efficiency with voiding flooding
- Path length close to shortest Euclidean distance

Disadvantages:

- Because need distributed planarization algorithm, it doesn't suitable for 3D geographical routing
- Perimeter mode was almost impossible to find the optimal path
- It was not a self-learning algorithm

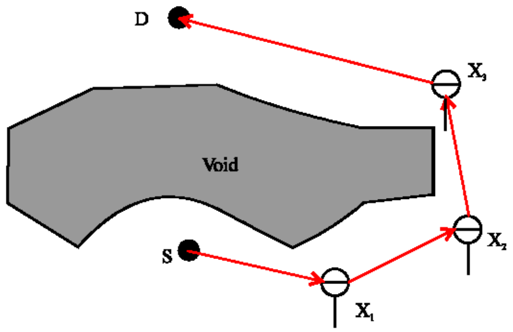

Fig. 4: Anchor-based geographical routing. S: Source node and D: Destination node. X_1, X_2 and X_3 are anchors

Anchor-based geographical routing: In order to avoid perimeter mode, Blazevic *et al.* (2005) introduced the concept of anchors, which are imaginary locations used to assist in routing. The location of anchors will add to the header of data packet. Hence, the route is controlled by these anchors, source node and destination node. The packet is sent by intermediate nodes in the direction of the next anchor until it reaches the destination node (Blazevic *et al*., 2005). As shown in Fig. 4, source S uses X_1, X_2, X_3 anchors to route the packet to D. Between anchors, such as, $\overline{X_1X_2}$, $\overline{X_2X_3}$, only greedy geographical routing is used for forwarding.

Advantages:

- It was suitable for static network and static void
- Pre-configuration avoid perimeter mode

Disadvantages:

- In MWSN, anchors need repeated configuration
- Source node need save all the anchors' locations
- It was not suitable for communication between two arbitrary nodes

Waypoint-based geographical routing: Huang (2004) define a relative coordinate system in which x-axis is aligned with the line determined by the sender S and the receiver D. Waypoints are the nodes the route must pass through. As shown in Fig. 5 and 6, W1, W2, W3 and W4 are waypoints. They are selected progressively as the packet makes its journey until the destination is reached. A small fixed number of bits in a packet header are used to encode waypoints' location of a path.

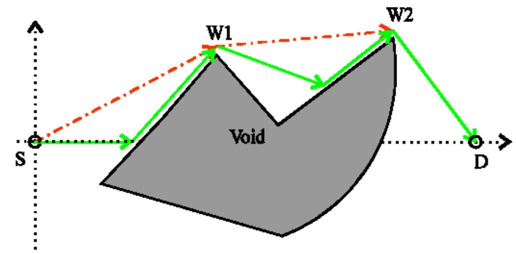

Fig. 5: Single-void network topology. (a) The route obtained by GPSR (Green solid line) and (b) The route obtained by Huang (2004) (Red dash line)

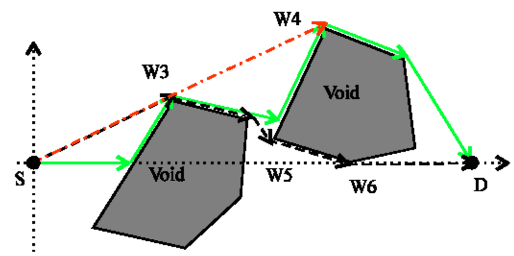

Fig. 6: Multi-voids network topology. (a) The route obtained by GPSR (Green solid line), (b) The route obtained by Huang (2004) (Red dash line) and (c) Optimal route (Black dash line)

Advantages:

- Flexible numbers of waypoint.
- Reduce inefficiency of perimeter routing
- Suit for dynamic networks

Disadvantages:

- The proposed path may not be optimal, for example in Fig. 6, the optimal route is black dash line, not red dash line
- Changed the header of data packet in ordinary geographical routing protocol
- The additional bits in the header of packet will slow down information transmission rate (Li *et al*., 2009)

Asymptotically optimal geographical routing: Li *et al.* (2009) presents Asymptotically Optimal Geographical Routing (AOGR) for MWSN. Its goal is to optimize the average routing hops per packet. In AOGR, the reference of delivered packets to subsequent packets in routing will be exploited. That is to say, as the number of delivered packet increases, the routing path asymptotically converges to the optimal path. By selecting some of the nodes as features, the route will be controlled by the

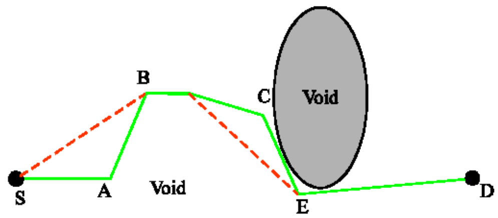

Fig. 7: S: Source node and D: Destination node. (a) GPSR (black solid line) and (b) AOGR (red dashed line)

source node, destination node and these features. As shown in Fig. 7, the first packet's path is obtained by GPSR (black solid line), the second packet's path is obtained by AOGR(red dashed line).

Advantages:

- Routing path converges to optimal path asymptotically
- Easily be embedded in existing geographical routing protocols
- Ensure information transmission rate

Disadvantages:

- It incurs little storage overhead
- Feedback channel is needed

DIRECTIONS OF FUTURE RESEARCH

In the survey it has been shown that there are a number of geographical routing protocols in multimedia wireless sensor networks. However, there still exist some interesting problems that need to be addressed in the future research.

Combining the character of multimedia source in order to design routing protocol. In multimedia wireless sensor networks, there are many kinds of data flows, such as control data flow, periodic time-driven data flow and sudden event-driven data flow and so on. Moreover, they have complex data structures, different QoS (Quality of Service) and different size. Hence, we need to involve the character of multimedia data flow into the design of geographical routing protocol.

Different users having varying requirement for the same multimedia data. Geographical routing protocol must have configured UI (User Interface) and flexible QoS-configurations for all users.

CONCLUSION

In this survey article we have reviewed the state of the art of geographical routing protocols in multimedia wireless sensor networks. We have discussed different forward mechanism and got a comparison table. In addition, we have analyzed four classic geographical routing protocols of multimedia wireless sensor networks and compared their advantages and disadvantages. Finally, we summarized two directions of future research in order to stimulate more creative research.

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REFERENCES

Akyildiz, I.F., T. Melodia and K.R. Chowdhury, 2007. A survey on wireless multimedia sensor networks. IEEE Wirelesss Commun., 51: 921-960.

Bin, F., L. Renfa, X. Xiongren, L. Caiping and Y. Qiuwei, 2009. Non-interfering multipath geographic routing for wireless multimedia sensor networks. Proceedings of the International Conference on Multimedia Information Networking and Security, Nov. 18-20, Hubei, China, pp: 254-258.

Blazevic, L., J.Y. Le Boudec and S. Giordano, 2005. A location-based routing method for mobile ad hoc networks. IEEE Trans. Mobile Comput., 4: 97-110.

Finn, G.G., 1987. Routing and addressing problems in large metropolitan-scale internetworks. ISI Res. Report ISU/RR- 87-180, http://www.citeulike.org/group/2102/article/1094488.

Hou, T.C. and V. Li, 1986. Transmission range control in multihop packet radio networks. IEEE Trans. Commun., 34: 38-44.

Huang, H., 2004. Adaptive geographical routing in wireless ad-hoc networks. Proceedings of the IEEE 60th Vehicular Technology Conference, Sept. 26-29, IEEE Xplore, London, pp: 2749-2753.

Karp, B. and H.T. Kung, 2000. GPSR: Greedy perimeter stateless routing for wireless networks. Proceedings of the 6th Annual International Conference on Mobile Computing and Networking (Mobicom), Aug. 6-11, Boston, Massachusetts, USA., pp: 243-254.

Kranakis, E., H. Singh and J. Urrutia, 1999. Compass routing on geometric networks. Proceedings of the 11th Canadian Conference on Computational Geometry, (CCCG'99), Vancouver, Canada, pp: 51-54.

Li, Z., R. Li, D. Wu and C. Mohamed, 2009. Asymptotically optimal geographical routing for multimedia wireless sensor networks. Inform. Technol. J., 8: 791-795.

Nelson, R. and L. Kleinrock, 1984. The spatial capacity of a slotted ALOHA multihop packet radio network with capture. IEEE Trans. Commun., 32: 684-694.

Ruifang, L., L. Renfa, L. Juan and W. Yehua, 2009. DSMAC: Media access control protocol for wireless multimedia sensor network. Comput. Res. Dev., 46: 2014-2023.

Takagi, H. and L. Kleinrock, 1984. Optimal transmission ranges for randomly distributed packet radio terminals. IEEE. Trans. Commun., 32: 246-257.

Tingrui, P., Z. Wenli, Z. Zhaoxia and P. Tao, 2009. An improved hierarchical AODV routing protocol for hybrid wireless mesh network. Proceedings of the 2009 International Conference on Networks Security, Wireless Communications and Trusted Computing, April 25-26, IEEE Computer Society Washington, DC, USA., pp: 588-593.

Zhaoxiao, Z., P. Tingrui and Z. Wenli, 2009. Modified energy-aware AODV routing for ad hoc networks. Proceedings of the WRI Global Congress on Intelligent Systems, May 19-21, Xiamen, China, pp: 338-342.