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BYPASSING VOID USING AOMDV ROUTING PROTOCOL IN WIRELESS SENSOR NETWORK

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***Abstract*—Inlatest years, applications of wireless sensor networks (WSNs) have been increased due to its vast potential to connect the physical world to the virtual world. It becomes a trend to deploy the large number of portable wireless sensors in wireless sensor networks to increase the quality of services (QOS). The QOS of such WSNs is mainly affected by the malfunction of sensor nodes. Probability of sensor node malfunction increases with increase in number of sensors. In this work malfunction of sensor node is avoided by using Ad-Hoc On-Demand Multipath Distance Vector Routing Protocol (AOMDV). AOMDV is based on distance vector concept and uses hop by hop routing approach. It also finds routes on demand using a route discovery procedure. Unlike other routing protocols AOMDV finds multiple routes in a single route discovery procedure. The core of the AOMDV protocol lies in ensuring that multiple paths discovered are loop free, link disjoint and fault tolerance paths. It may improve the network lifetime by minimizing packet loss, routing overhead and energy consumption.**

***Index Terms*—Geographic routing protocol, Multipath routing, On-demand routing, Quality of services, Routing void.**

I INTRODUCTION

Over the former years, wireless sensor networks (WSNs) have been broadly useful in many diverse fields [1] in which routing protocol is one of the significant technologies. Since a sensor node exploits a route depending only on the position information of neighbor nodes in geographic routing [2], routing protocol based on geographic data is well-organized. Owing to its great expansibility and small influence by network size, geographic routing has extensive application prospects in large scale WSNs [3]. For illustration, plenteously of nodes furnished with geophones is extentregularly on the ground and have the ability to get their own positions by global positioning system (GPS) [4] in seismic exploration [5], where geographic routing has latent to help as routing protocol. However, if a routing void, called local minimum [6], is encountered subsequent from the unplanned distribution of sensor nodes, the greedy algorithm in geographic routing will be unsuccessful, and finally data transmission also be unsuccessful in such situation.

To reduce the effect of the routing void, a plan to segregate certain region nearby a routing void is projected in [7]. Ring-constraint forwarding (RCF) proposed in [8] forms a multi-ring region adjoining a routing void, in which relay nodes are wisely chosen to avoid routing void and balance energy consumption. In [9], relay nodes are carefully chosen rendering to the geographic location link between the destination node and the routing void in order to avoid failing of greedy algorithm. These algorithms above have low difficulty, but more overhead of control packet and time delay consequence in extraordinary energy consumption and useless transmission.

Beyond that, routing void problem still happens everywhere those well-known regions, and that no additional scheme is proposed to solve this problem. Greedy perimeter stateless routing (GPSR) collected of greedy forwarding and face mode is proposed in [10]. After routing void is encountered, GPSR works under face mode as an alternative of greedy forwarding in anticipation of conclusion a neighbor node closer to the destination. Boundary state routing (BSR) proposed in [11] approves the same approach as GPSR to bypass the void. In [12], network is distributed into some hexagon sub-nets each of them is measured as a virtual node. Once void is encountered, face forwarding mode initiates to work among the virtual nodes. Though, paths recognized by face forwarding are not optimized, a longer path may be preferred even if there exists a short one.

Recently, to solve void problem by means of virtual location information, some unique routing protocols have been recommended [13]. The core strategy of these routing protocols is to construct sensor node's virtual coordinate translation to certain referenced nodes [14] or neighbor nodes [13]. When the destination node is changed, virtual coordinates of consistent nodes on the routing path have to be recreated, so recent routing protocols created based on virtual coordinates are more appropriate to the situations with stable destination nodes. Moreover, routing voids still occur in the network.

Routing protocols based on virtual coordinate have several forms, which make them flexible to implement according to practical network conditions without constraint from the physical locations. Though greedy algorithm is simple in value and little in complexity, it cannot be applied to all sensor nodes when some routings based on virtual coordinate are adopted in the network. To solve previous problems by means of on-demand protocols. In this paper, we extend an innovative on-demand multipath protocol called ad hoc on-demand multipath distance vector (AOMDV). AOMDV is based on asignificant and well-studied on-demand sole path protocol recognized as ad hoc on-demand distance vector (AODV) [15]. AOMDV extends the AODV protocol to find out multiple paths between the source and the destination in each route discovery. Therefore, a latest route discovery is required only when all these paths fail. They also contain the potential to poorer the routing overhead because of less route discovery operations. AOMDV has three novel aspects. First, it does not comprisegreat inter-nodal coordination overheads like additional protocols (e.g., TORA, ROAM). Second, it ensure disjointness of alternate routes through distributed computation lacking the make use of source routing. Finally, AOMDV calculates alternate paths with negligibleadded overhead in excess of AODV

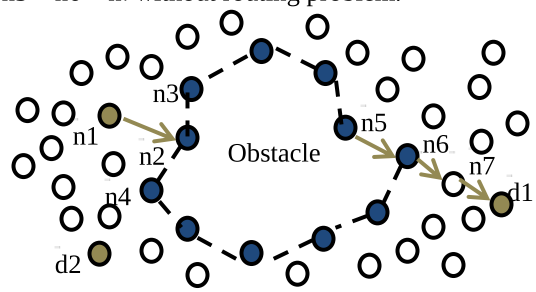
The remainder of this paper is systematized as follows. Section II describes problem definitions while in Section III we propose anAd_hoc on demand multipath distance vector routing protocol. In Section IV, we provide simulation results and show that the performance ofthe throughput, packet loss and energy loss. At last, Section V presents our concluding remarks.

II. PROBLEM DEFINITIONS

We consider the following situation: sensor nodes are modeled by a unit graph. All nodes inside communication range *R*cof a node *n* are considered as neighbors of *n* and bidirectional relations survive between *n* and its neighbors.

A. Routing Void in Geographic Routing

In geographic routing, when greedy forwarding is assumed, it can be easily disturbed due to the terrain or radio exposure, for example, ponds, hills or buildings which locate in the sensor area. The finite distance of communication range can also cause greedy forwarding failing. When a sensor node goes to forward the packet to one neighbor node that is geographically nearer to the destination node than itself, but such node doesn't occur, then a routing void is encountered. Greedy forwarding fails in this situation. For instance shown in Fig. 1, a node n1 tries to forward a packet to the destination node d1by greedy forwarding. A node n1 sends the packet to n2 by greedy forwarding. Since the neighbor nodes set ofn2 is {n1, n3, n4}, none of which is nearer to the node destination d1, and then a routing void is encountered and greedy forwarding flops to deliver the packet. Likewise, a routing void is encountered at node n5 when it tries to forward a packet to the destination node d2. Around the obstacle area in Fig. 1, greedy forwarding fails at node n5 as defined above. But for different destinations, greedy forwarding may not fail at the identical node. For sample, if n5 tries to forward a packet to the destination node d1, packet can reach at d1 alongside with the path n5→n6→n7without routing problem.



: edge node
others: isomorphic node

Fig.1. Routing void in greedy forwarding

B. Structure Without Routing Void

Assuming the number of edge nodes around an obstacle in WSNs isN_b, the set of edge nodes is $\{b_k|$ k =1,.$N_b\}$, both of the following conditions should be satisfied:

$$\begin{cases} d(b_k, b_{k+1}) < T_c, k = 1,..N_b - 1 \\ d(b_1, b_{N_b} < T_c \end{cases} \quad (1)$$

and

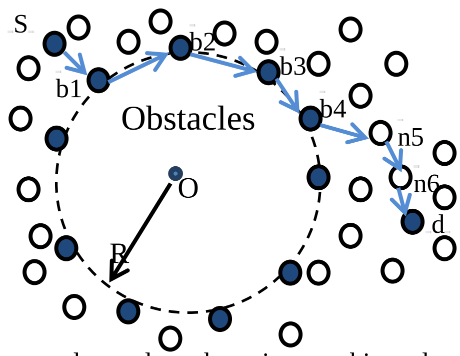
$$\begin{cases} \{b_{k+1}|(d_k, b_{k+1}) < T_{c,} k = 2, \ldots N_b - 2, \\ \quad 2 \leq i \leq N_b - k\} = \emptyset \\ \{b_k|d(b_1, b_k) < T_c, k = 3,..N_b - 1 = \emptyset \end{cases} \quad (2)$$

Whered(x, y)represents the Euclidean remoteness between node xand y, T_c denotes the communication remoteness of nodes, i is an integer. According to formula (1), (2), every edge node can only communicate with its two neighbors belonging to the set $\{b_k|$k = 1, · · ·N_b }. If all the edge nodes around the obstacle have the same distance to a point *O* as following:

d (b_k ,O) = R, k = 1, . . . N_b(3)

whereRis a constant. In this condition, all the edge nodes detect on a circle with center point Oand radius Ras shown in Fig. 2. In this type of structure composed of the edge nodes, every edge node has two and only two neighbors detecting on the circle. Rendering to the geometrical structures of circle, there is no routing void around this obstacle area for any destination node in the network.

In Fig. 2, all nodes in the network adopt greedy algorithm to select relay nodes; node s, ddenotes source and destination correspondingly. Packet sending process is used as amodel to define the structure without routing void. First, edge node b1 receives a packet from source s,it has two relay candidates in neighbors, b2 and b5. Since the two candidates locate on the same circle, there is at least one node that can be selected as relay node by greedy algorithm in this condition, so b2 is selected and no routing void is encountered. Similarly, the packet reaches edge node b4, and then b4 selects n5 by greedy algorithm. Finally, the packet reaches destination node dall by greedy algorithm without routing void problem in the delivering process.



● edge node others: isomorphic node

Fig.2.Edge structure without routing void

III AD-HOC ON-DEMAND MULTIPATH DISTANCE VECTOR ROUTING

The key idea in AOMDV is calculating multiple loop-free paths each route discovery. By multiple redundant paths obtainable, the protocol changes routes to a different path when aprevious path fails. Thereforeainnovative route discovery is avoided. Route discovery is originated only when all routes to a specific destination fail. For efficiency, single link disjoint paths are calculated so that the paths fail independently of each other. Reminder that link disjoint paths are necessary for our purpose, as we use multipath routing for falling routing overheads rather than for load balancing. For the final, node disjoint paths are more beneficial, as shifting to an alternative route is assured to escape any congested node. Link disjoint paths, on the other hand, may need common nodes. Since node disjointness is severer than link disjointness.

Detailed Protocol Description

In this portion, we describe the protocol in four mechanisms: routing table structure, route discovery,routemaintenance, and data packet forwarding.

A. Routing table

Figure 3 shows the difference in the routing table entry structure between AODV and AOMDV. AOMDV route table pass has a new field for the advertisedhop count. Moreover a route list is used in AOMDV to store extra information for each dissimilar path including: next hop, last hop, hop count, and expiration timeout. The last hop information is advantageous in testing the disjointness of alternative paths.Whenever the destination sequence number for d(destination)at I (node)is updated, the corresponding advertised hop count is initialized. For a given destination sequence number, let $\text{hop\_count}_{ik}^{d}$ denote the hop count of kth path in the routing table entry for dat i,

$$\left(\text{next}_{\text{hop}}{}_{ik}^{d}, \text{last}_{\text{hop}}{}_{ik}^{d}, \text{hop}_{\text{count}}{}_{ik}^{d}\right) \in \text{route\_list}_{i}^{d}$$

When I indicate about to sends its first route advertisement for d, it informs the advertised hop count as follows:

$$\text{advertised\_hop\_count}_{i}^{d} := \max_{k}\{\text{hop\_count}_{ik}^{d}\}, i \neq d$$
$$:= 0, \text{ otherwise.}$$

Destination
Sequence number
Hop count
Expiration_ timeout
Nexthop

(a)AODV

Destination
Sequence number
Advertised_ hop count
Expiration_ timeout
Route list {(nexthop1, hopcount1), (nexthop2, hopcount2),}

(b) AOMDV

Fig 3: Structure of routing table entries for AODV and AOMDV.

Whenever a node receives a route advertisement, it raises the AOMDV route update rules listed in Figure 4.

If$(\text{seqnum}_i^d < \text{seqnum}_j^d)$ **or** (1)
$((\text{seqnum}_i^d = \text{seqnum}_j^d)$ **and**
$(\text{hopcount}_i^d < \text{hopcount}_j^d))$ **then**
$\text{seqnum}_i^d := \text{seqnum}_j^d;$ (2)
$\text{hopcount}_i^d := \text{hopcount}_j^d + 1;$ (3)
$\text{nexthop}_i^d := j;$ (4)
endif

Figure 4: AOMDV route update rules

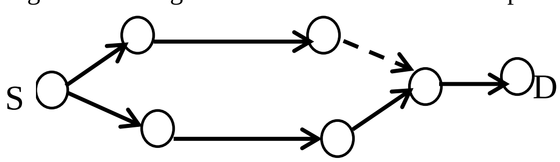
B. AOMDV Route Discovery

Several changes are neededin the simple AODV route discovery mechanism to allow computation of multiple link disjoint routes among source destination pairs. Note that some intermediate node I on the route connecting a source S and a destination D can also form such many routes to D, thus making available a huge number of routes connecting S and D.

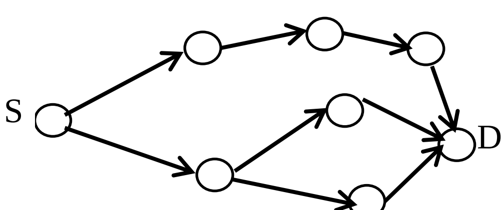
Recall that in the route discovery procedure a reverse path is deposit up backwards to the source via the same path the route request (RREQ) has crossed. If replacements of the RREQ coming through different paths are ignored as before, only one reverse path can be formed. To shape multiple routes, all duplicates of the RREQ incoming at a node are examined, as each duplicate defines an alternate route. See Figure 5(a). However, each of these alternate routes may not be disjoint. For example, in Figure 5(b) three copies of RREQ reach destination D, two of which are not through disjoint paths.

Note that the duplicates of a RREQ accomplishment D via node disjoint paths essential take different first hops from S. Were their trajectories to meet again at another node (e.g., node A in Figure 5(c)), the copy arriving later in that node will not be propagated further.Therefore, every trajectories of a RREQ among any pair of nodes with only one of its kind first hops are assured to be disjoint. Each node remembers the first hop of each RREQ (in a firsthop list) it has seen with the similar source id and transmission id. Aninverse path is constantlydesigned when the first hop is single. However, as in regular AODV, only the major copy of the RREQ is forwarded. Therefore there is no additional routing overhead. All these reverse paths can be used to transmitnumerous RREPs to the source so that several forward paths can be formed which are node disjoint.

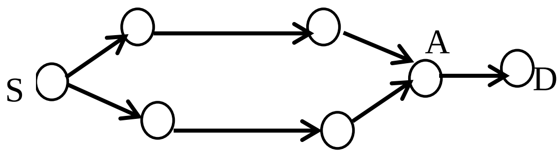
The destination node adopts a looserreply policy. It replies up to k copies of RREQ received via single neighbors, ignoring the first hops of these RREQs. Single neighbors guarantee link disjointness in the principal hop of the RREP. Outside the first hop, the RREP follow the reverse routes. Each RREP incoming at amiddle node takes a dissimilar reverse route when numerous routes are formerly available. Note that because of the looser reply policy it is probable for the trajectories of RREPs to annoy at an intermediate node. See Figure 6. The factor k is used to avoid a RREP detonation. Also, our former observation [24] indicates that added routes beyond a few provide only marginal advantage. We have used k=3 in our experiments.



(a)



(b)



(c)

Fig 5: Numerous network configurations explanation various protocol features. (a) Suppose, the second copy of RREQ is transmit over the dotted link. AODV ignore it. But AOMDV forms a reverse path throughout the previous hop. Either protocol does not forward the second copy. (b) Three copies of RREQ will reach D; but only two are via disjoint routes. (c) Use of this figure is explained in the content.

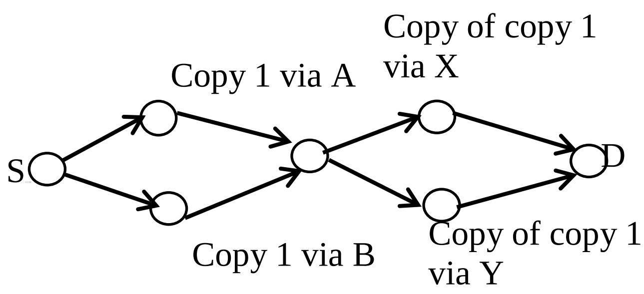


Fig 6: The second copy of RREQ via B is concealed at intermediate node I. Although two copies of the first copy (via A) still reach the destination D. Both are replied to by D even though both carry the same first hop. The reverse paths will combine at I and then divided again. But they will stay link disjoint.

C. Route maintenance

Route maintenance in AOMDV is similar as a simple extension to AODV route maintenance. AOMDV routines RERR packets like AODV. A node produces or forwards a RERR message for aendpoint when the lastpath to the destination breaks. AOMDV also consist of an optimization to salvage packets forwarded over failed links by re-forwarding them over alternate paths. This is related to the packet salvaging mechanism in DSR.

The timeout mechanism also ranges from a single path to multiple paths (Fig 3) even though the problem of setting timeout values is more difficult for AOMDV when compared to AODV. With multiple paths, the option of paths becoming stale is more probable. The benefit of multiple paths is used to avoid the stale paths by using small timeout values. We use a moderate setting of timeout values and additionally use HELLO messages to remove stale routes. Hence, the timeouts of AOMDV mainly serve as a soft-state mechanism to deal with unexpected events such as routing table corruption and to a lesser extent for quickly removing stale routes. As an alternative, timeout selection can be established on logical characterization of link behavior in ad hoc networks.

D. Data packet forwarding

In this data packet forwarding at each node having multiple paths to a destination, we agree a simple method of using a path until it fails and then change to an alternate path. There are other changes for data packet forwarding which synchronously use all those paths. An overhead is added to every data packet (coding) and the resultant coded packet is split into smaller blocks each of which is transmitted along a different path in diversity coding [15]. With acceptable redundancy, this scheme can improve the packet delivery probability and also employ in a selective way to guarantee delivery of important packets in highly dynamic mobile networks.

In another alternative, alternate paths are used instantaneously for load balancing where data packets are distributed over all the available routes, so successful the network utilization and end-to-end delay. The well-known problems of adaptive traffic splitting across multiple paths and allocating with the chance of packet re-ordering, effective load balancing has addressed the single problem of route coupling rising from interference between alternate paths.

IV SIMULATION RESULTS

In this section, simulation results is performed by Ad_hoc on demand multipath distance vector routing protocol which is described below in Fig 7, the packets are forwarded from source to destination and then establishes the routes around void.

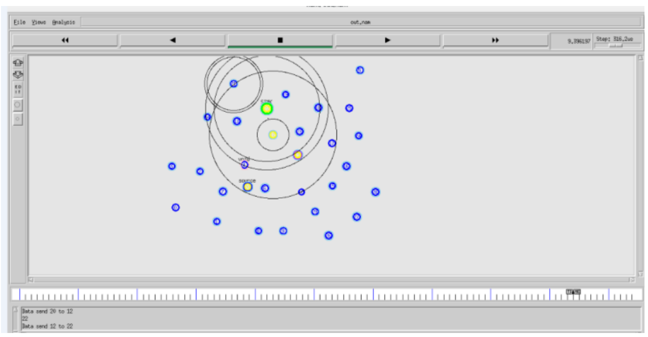


Fig 7: Forwarding the Packets

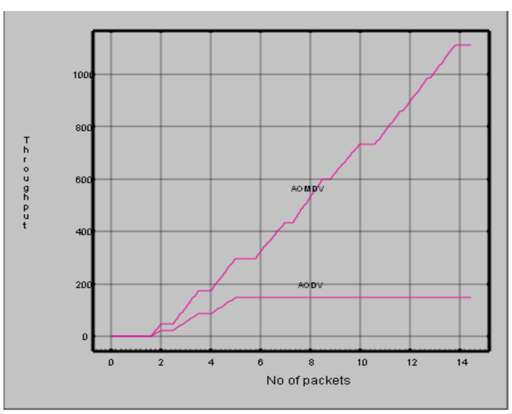


Fig 8: No of Packets Vs Throughput

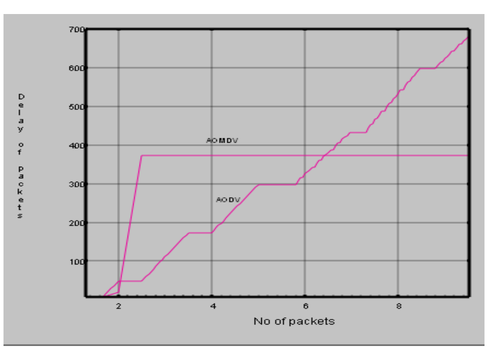


Fig 9: No of Packets Vs Delay

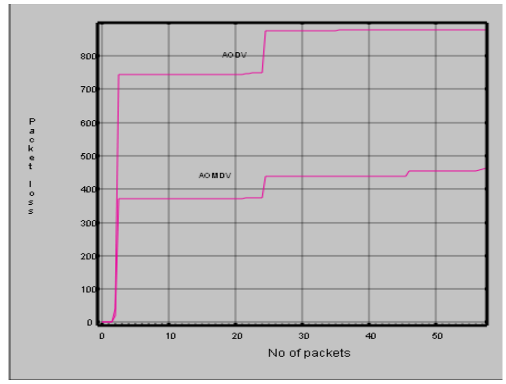


Fig 10: No of Packets Vs Packet Loss

Fig 8 describes AOMDV throughput is higher than AODV.Delay &packet loss of AOMDV is lower than AODV as shown in Fig 9 and Fig 10

V CONCLUSION

To resolve routing void problem in geographic routing, AOMDV is proposed by utilizing the edge structure without routing void. AOMDV uses void detectingto solve void problems and then establishes the path around void according to the of edge nodes. Besides, lower control overhead in AOMDV also reduces the energy consumption. Due to the hardware source, the application range of the proposed protocol may be limited to particular fields, in which sensor nodes are prepared with an adequate amount of redundant resources. In future an alternate method of void detecting protocol will be proposed to remove the possibility of detecting large voids, thus introducing the effectiveness of void detection.

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