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Pair-Wise Multipath Routing with Mobile Sink in WMSN

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Abstract— Multipath routing in wireless multimedia sensor network (WMSN) is used to transfer data simultaneously so can reduce delay and congestion of the network. The main problem with the multipath routing strategy is that the node energy near sink becomes obviously higher than other nodes. Multiple paths are used to transfer data from source to the destination that is many-to-one traffic patterns, the traffic of the whole network will be converge to a specific set of sensor nodes (e.g. neighbours of the sink) and results in the hotspot problem, which makes the network stop functioning. So we propose a Pair-Wise Multipath Routing strategy to solve the energy bottle neck problem. It uses all nodes around the sink in 360 degree scope. These nodes are called pair-wise nodes. Therefore, it can reduce the energy problem and can improve the network life. But when sink is at the edge of the network or when the node density is too small to find enough pair-wise nodes, the performance will be affected. However, as long as the sink is static, this issue cannot be fully solved. Therefore, there is a recent approach to exploit mobility of the sink to deal with these problems.

Keywords— Pair-Wise nodes, Hot-spot problem, mobile sink, Multipath Routing, WMSN

I. INTRODUCTION

Wireless sensor networks are highly distributed networks of small, thin material of wireless nodes deployed in large numbers to monitor the environment or system by the use of physical parameters such as temperature, pressure, sound etc. The nodes collect the information from surroundings, and send these data to Base station or sink node [1],[2]. Base station gather data from the sensor nodes. Energy of nodes is the main limitation in wireless sensor network. In multipath routing shown in Fig.1, transfer data simultaneously from source to the destination using different paths [3],[4]. In this many-to-one traffic patterns, the traffic of the whole network will be converge to neighbouring nodes of the sink and results in the hotspot problem [5],[6].

The Multimedia Wireless Sensor Network (MWSN) is a kind of new type sensor network and it deals with multimedia data such as video streams [7],[8]. In this types of network, Sensor nodes are generally provided with camera, mini-microphone. WMSN exploit high bandwidth and energy consumption to deal with multimedia data. So it use multipath routing strategy, in which Multipath route can make full use of the current network resources and provide sufficient bandwidth for multimedia as much as possible. Multipath route are paths built between source and sink node and distributes data equally to many paths so which can make more nodes participate and increase the life of nodes and network. Multipath routing can largely address the security and load balancing issues of single path routing.

However, the current multipath routing strategy may cause problem that the nodes near sink exhaust their energy rapidly than other nodes. This will make the hole in the network. And hence the network did not functioning. For transmitting a video stream, will drain more energy of nodes in the network. So the single stream is divided into several sub-streams and each one is transmitted through multiple paths in parallel. Directional Geographical Routing (DGR) is multipath routing strategy for transferring multimedia information [9],[10]. It uses deviation angle concept for create multiple paths. But it does not use full nodes around the sink.

For this, pair-wise node concept is used for make full use of nodes around the sink. Pair-wise Directional Geographical Routing (PWDGR) is proposed, so neighbour nodes within 360 degree scope around sink are fully used. Therefore, it can solve the energy problem, and can increase network life. And the source multipath selection is optimized by taking the energy consumption problem into consideration [11].

It calculates the distance from source to its neighbour nodes. The neighbour nodes which have minimum distance from source and which are least used is taken as cooperative node. The disadvantage of this scheme is that, Since pair-wise multipath routing needs to find pair-wise node for each path, when sink is at the edge of the network or when the node density is too small to find enough pair-wise node, it will affected the performance of the network. Mobile sink is used to resolve this problem.

A mobile sink is used to gather sensed data by travelling around the network [12]. Sink mobility can be classified into two categories: random mobility based [13] and controlled mobility based [14]. For the first category, the sink is designed to move randomly within the network. For the controlled mobility, there is a predefined path for the sink to travel around the network to collect data. It is obtained by properly setting the trajectory and the limited mobility increase the network life.

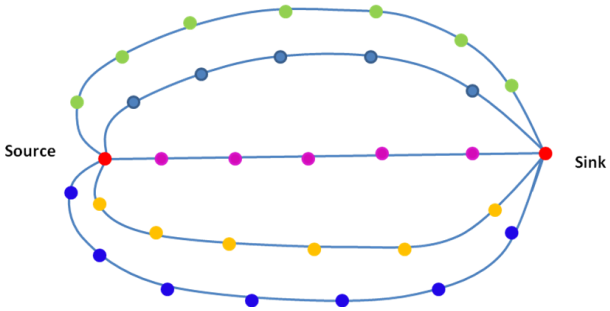

Fig. 1 Multipath Routing

II. RELATED WORKS

Our work is related to transferring multimedia information through the scheme PWDGR [11]. We will give a brief review of the existing work in these areas.

Multiple paths are used for transferring multimedia information. Video stream is divided into sub-streams and transferring these sub-streams through multiple paths in parallel. Energy Efficient Collision Aware (EECA) node disjoint multipath routing algorithm builds multiple paths using request/reply cycles. It creates two disjoint paths from source to the destination. It results in good performance, energy saving and data transferring [16].

Directional geographical Routing (DGR) aims to compute multiple paths for video sessions [9]. It creates different initial deviation angles to construct multiple disjoint paths. A probe message is broadcasted by source node to create direction aware path.

If the deviation angle is fixed, probe message may go farther from the sink, and may arrive at network border. So after a number of hops it may point back to the sink by adjusting the deviation angle [10].

III. PROPOSED SYSTEM

The proposed model increases the network life by pair-wise node concept with mobile sink.

A. Design of pair_wise node method

The proposed model increases the network life by using the pair-wise node concept. Nodes around the sink use more energy than other nodes in the network. So it may create energy hole in the network. So as to increase the network life, we use pair-wise node concept, in which nodes in the 360 degree scope around the sink is fully used, which is shown in figure 2.

There are several stages for transferring video streams using pair-wise node concept:

a) In the first stage, find neighbours of every node by sending "hello" messages, and the neighbours must be in a certain distance apart. The distance is calculated using the Euclidian equation.

Suppose (x_1, y_1) and (x_2, y_2) are the coordinates of two nodes, then the distance is calculated using the equation,

$$d = \sqrt{((x_2 - x_1)^2 + (y_2 - y_1)^2)} \qquad (1)$$

b) In the second stage, find the coorporative nodes. Nodes which are neighbours of source and have minimum distance from source node and are least used are called cooperative nodes. The flowchart in figure.3 shows selection of cooperative nodes.

c) For the construction of multiple paths Greedy Perimeter Stateless Routing (GPSR) [17] is used. In GPSR, packets are marked by their originator with their destination location. In which, a forwarding node transfer its packet to its neighbour node which is close to the destination node. That is, if a node knows its radio neighbours positions, the best choice for next hop is the neighbour geographically closest to the packet's destination. If a node receive more than one packets, it accept only the first one reached, rest of them are avoid.

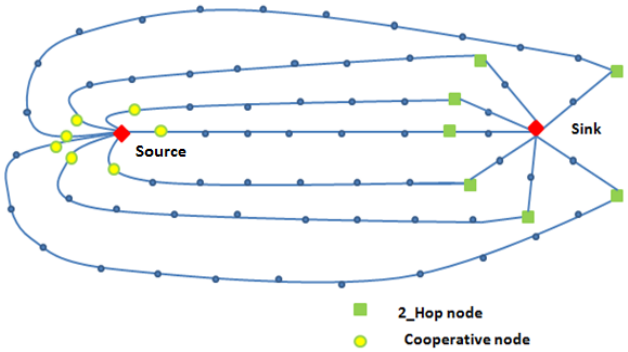

Fig. 2 Pair-Wise Multipath Routing

d) Design of multi-hop pair-wise node around sink. Multi-hop pair-wise nodes are select from multiple paths. These pair-wise nodes may be 1 hop, 2 hop or 3 hop or 4 hop distance from the sink shown in figure 4. The sink send "hello" message that contain hop count and hence find pair-wise node.

e) In the final stage, time scheduling [18],[19] is used to transfer data from pair-wise node to destination to avoid congestion. The first arrived packet is transferred to the sink, after a certain time interval the next arrived packet is transferred and so on.

The main problem with the of pair-wise node concept is that, when the sink is at the edge of the network or in the less density region then enough pair-wise node are not get to transfer the packets. In this case mobile sink is used, and it moved to density region, where it can get enough pair-wise nodes. For this, it uses sink sites which are ordered in linear trajectory [20]. We assume that only at certain locations, the sink can communicate with the outside network and then deliver the cached data to users. Only when the sink stays at one of sink sites, sensors will start transmitting data to the sink through multi-hop routing.

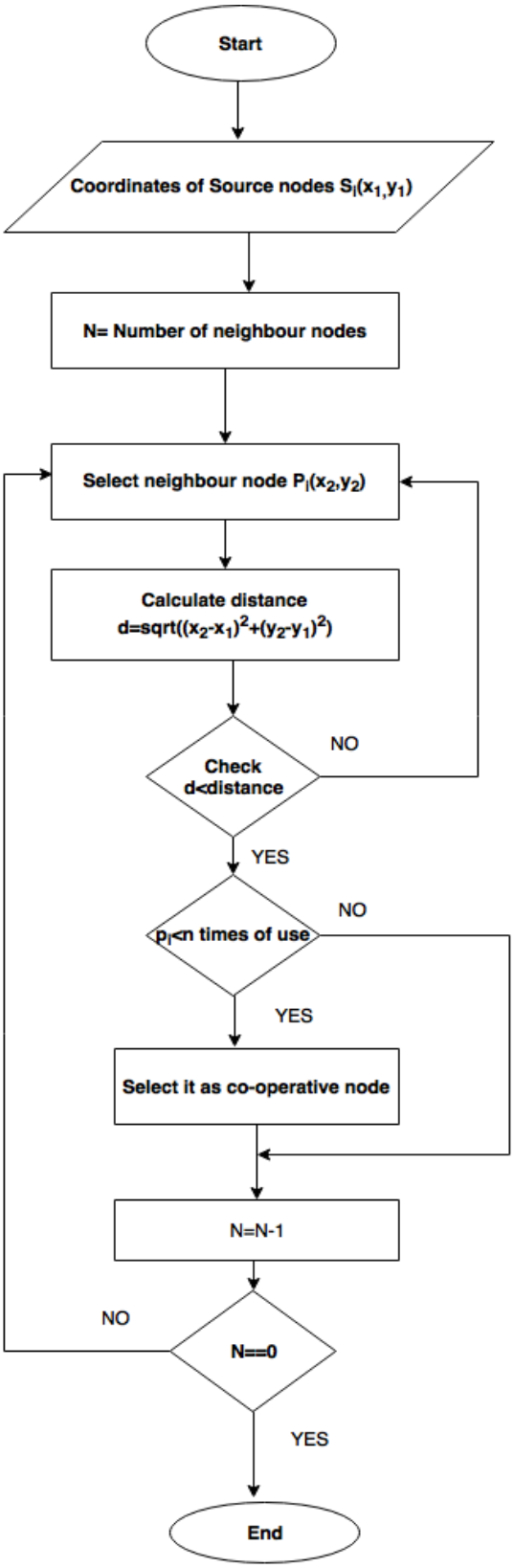

Fig.3 Flow chart for cooperative node selection

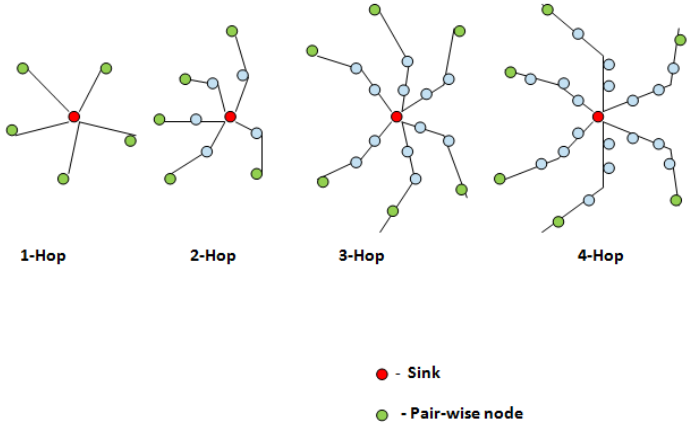

Fig. 4 Design of pair-wise node

B. Linear trajectory

If the base station did not get enough pair-wise node to transfer data, the sink will move through the linear trajectory. There are some sink sites along the path where the sink can stay and transmit data. The linear trajectory is made by using the coordinate of destination node and coordinate of node on the high density region. If one coordinate is (x_1, y_1) and other is (x_2, y_2) then the distance calculated using equation (1).

The linear trajectory contains some sink sites which are certain distance apart from each other, which is shown in figure 5. And the sink move from the current destination point to the nearest sink site, after reaching each sink site along the path it check there are enough pair-wise node to transmit data. If there is no enough pair-wise nodes, sink move to another sink site and so on. If the sink got enough pair-wise nodes, then transmit data from source to the sink.

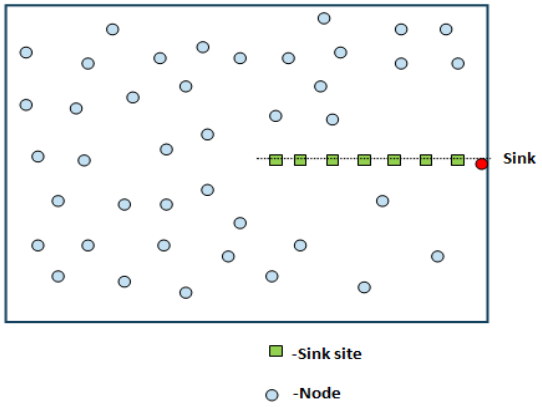

Fig.5 Linear trajectory with sink sites

IV. SIMULATION RESULTS

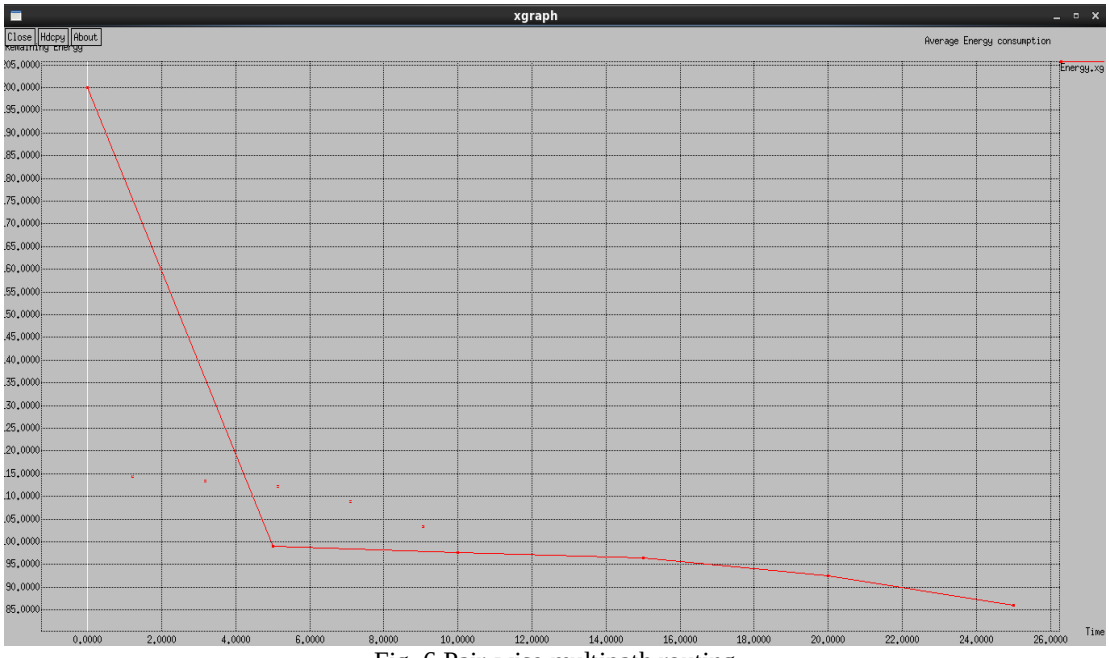

Fig. 6 Pair-wise multipath routing

Figure 6 shows average energy consumption of the network using pair-wise multipath routing method. The energy was found out to be 100J at 5ms. After 25ms the energy of the network got decremented to 85 J.

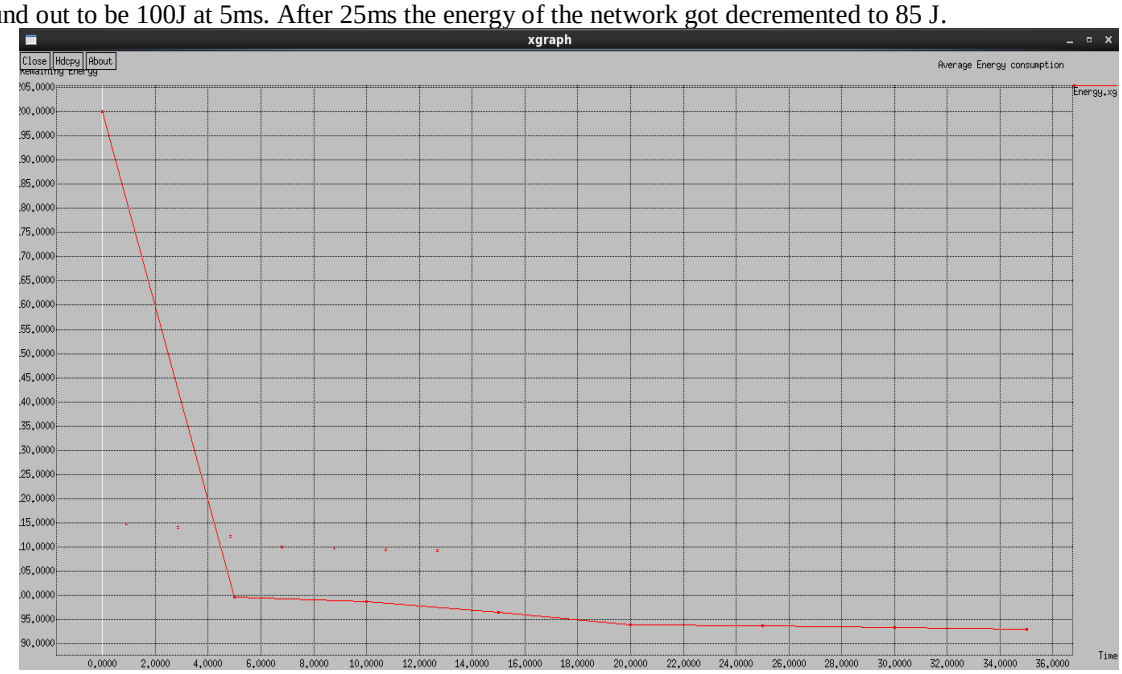

Fig. 7 Pair-wise multipath routing with mobile sink

Figure 7 shows average energy consumption of the network using pair-wise multipath routing with mobile sink. The energy was found out to be 100 joule at 5ms. After 35 ms the energy of the network got decremented to 95 J only. From this result, we can see a noticeable saving of the energy. Hence the use of mobile sink with pair-wise multipath routing in the network increases the network life by saving the energy.

V. CONCLUSION

Mainly multipath routing is used to transfer multimedia information. Nodes near the sink use higher energy than other nodes. Multipath routing strategy may converge to many-to-one traffic pattern, (that is neighbouring node of the sink). It may cause hot-spot problem. Pair-Wise Multipath Routing is used to avoid the energy bottle-neck problem. It uses all nodes around the sink in 360 degree scope. Thus we can increase the network life. But in some cases like, when the sink is at the edge of the network or when the node density is too small to find enough pair-wise node. Such situations mobile sink is used. The sink will move through the linear trajectory, which contain sink sites where mobile sink will stay and check whether there are enough pair-wise nodes. The above mentioned reasons therefore increase the network life even more.

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