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Study on Qos Routing Algorithm of Wmsns Based upon Data Fusion

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Abstract: Because wireless multimedia sensor networks(WMSNs) has a large data volume and is energy limited, a QoS routing algorithm which makes use of the differentiated services of data fusion mechanism is proposed. During interest flooding period, the two gradients, real time and best effort service, are set, while priority queuing model is established to staged processed data transmission service and data fusion retransmitting mechanism is introduced so as to provide the routing path of QoS for the two services. The experimental effect demonstrates that this algorithm not only makes sure the low delay of real time service, but also satisfies the QoS requirement of best effort service, balancing the energy consumption of all network nodes and prolonging network lifetime.

Key words: Wireless multimedia sensor networks, routing protocol, transmission delay, data fusion

INTRODUCTION

The availability of low-cost hardware such as CMOS micro-cameras and icrophones and the development of sensor network technology has fostered the development of Wireless Multimedia Sensor Networks (WMSNs) ,it is a new kind of sensor networks on the basis of the traditional Wierless Sensor Networks (WSNs), adding some multimedia data collection device to acquisition, processing and media transmission. It is a distributed network composed with some multimedia nodes. By collectiong multimedia data, such as audio, video and images and transmit them to sink node, it can monitor environment correctly (Ma *et al*., 2013). The application of WMSNs includes military investigation, environment moniotr, e-home and city transport etc. It has great application foreground.

But some traits of WMSNs, like energy limits, dynamic and instability, make the multimedia data transmit very difficult, so it is hard to support user's QoS. Under this situation, how to provide a better QoS to users becomes a problem to be solved urgently. One of the key problems for WMSNs is how to provide real-time communication support for the streaming applications. Another is to provide the differentiated services both for real-time traffic and best-effort traffic. In addition, it should improve transmission capacity and throughput performance when transmitting streaming over WMSNs.

PRELIMINARY STUDY

Currently, the study on QoS routing protocol of WMSNs is still in the initial stage (Sun *et al*., 2007). The literature put forward the first routing protocol sensed by QoS in WSNs, SAR. Integrating with path energy consumption and data grouping packet priority level, SAR protocol assesses QoS measurement but its originating nodes need to keep routing information. Besides, information maintenance, node QoS parameters and the update of energy consumption information demand a large amount of spending (Lu and Cheng, 2009). There are still some problems to be solved in WMSNs routing protocol, such as, how to effectively make use of network resource and to prolong network operating life to the maximum; how to design WMSNs routing protocol of differentiated service, while the constrained conditions of path include bandwidth, delay, packet loss rate, searching times, distance, flow condition and so on. Among them, the key problem is multi QoS parameter constraint: the types of service provided by WMSNs are various and the standard of every type of service is not alike (Huang *et al*., 2005).

In order to solve the problems above, in this paper, a QoS routing algorithm (DF-DSQR) which suits the differentiated service of data fusion of WMSNs is raised.

DATA FUSION MODEL

WMSNs have a large quantity of data and are energy limited, which can fuse data to reduce redundant information, eliminate unnecessary data transmission (Yin, 2011, 2012). If the data volume transmitted in unit time, the energy naturally will be saved. Meanwhile, the data transmitted in unit time is guaranteed to be effective, being benefit for the increase of networks' data collection efficiency and accuracy.

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DF-DSQR algorithm adopts clustering data fusion structure model. This paper divides network into clusters. Every cluster is formed by a cluster head and many cluster members. Several cluster heads make up the network of high level. The high level network can also be divided into clusters, forming a higher level network again, until to be the highest one.

In clustering data fusion structure, cluster head nodes are not only responsible for the collection and fusion of the information in the cluster they rule but also the data retransmit between clusters. The formation of each cluster always is based on the remaining energy of sensor nodes and the degree of closeness with the cluster head of previous level. Meanwhile, aiming at prolonging the whole network's lifecycle, the selection of cluster heads' nodes demands periodic updates (Christian and Oey, 2013). The data fusion of WMSNs is the process of integrating the processing, controlling and decision-making the data collected by different sensor nodes. The functions of data fusion system mainly contain detection, correlation, identification and evaluation. There are two levels in the system, including low-level and high-level processing. The former is made up of information detection, data association, target state evaluation and attributive classification; the latter is majorly the detection of behavior pattern, the association of targets and events, the estimation of behavior prediction and state. Low level processing is numerical processing to produce numerical results such as target position, speed and type.

DF-DSQR ALGORITHM IMPLEMENTATION

Interest flooding: Interest flooding is that sink nodes flood the minimum hop field news in networks. Every node receiving the news establishes or updates its minimum hop field, simultaneously sets up two arrays, Neighbor List-RT and Neighbor List-BE in the purpose of saving its neighboring node information. Neighbor List-RT saves the information of neighbor nodes whose sink node hop is 1 smaller than itself, while Neighbor List-BE saves other neighbor node's information (Ma and Tao, 2006).

The two arrays are used to save neighbor nodes' information, in order that nodes just choose suitable transmitting nodes in their Neighbor List-RT when transferring real time service, without searching all neighbor nodes to determine retransmitting nodes, consequently enabling real time service to obtain lower end-to-end delay in transmitting. On the basis of low time delay, the remaining energy information of sensor nodes can be considered. When transmitting best effort service, from Neighbor List-BE, nodes take priority selection to the nodes of which remaining energy is large as the next hop node and also consider the delay of sensor path transmission, so as to make sure the balance of network energy consumption (Hadim, 2006).

Establishment of gradient: The gradient establishment of DF-DSQR algorithm means during the flooding process of interest data's grouping, with the combination of MaxMPE and MHC, real time service and best effort service,the two gradients are established. As for real time service (RT), the minimum delay is given the priority and balanced energy is considered. As to best effort service, energy is the priority while smaller delay is given attention to. Gradient model can be seen in Fig. 1. In this figure, the number on top of nodes shows the remaining energy of nodes, while the numbers between nodes display the energy consumption of communication among nodes. Regarding real time service, the fist consideration of DF-DSQR algorithm is the delay of data transfer. When real interest grouping arrive at some node along multipath, this node selects a path with the smallest hop count from Neighbor List-RT array, so as to send data information to sink nodes in the shortest time along this path.

With regard to best effort service, DF-DSQR algorithm comprehensively considers path energy bottleneck (the remaining energy value of the node whose remaining energy is the smallest in the path) and path energy consumption for constraining its path, in other words, to choose the path with large path energy bottleneck and low path energy consumption. DF-DSQR algorithm takes their ratio as the constraining condition of the path selection of best effort service. When best effort interest grouping reaches a certain node along multipath, this node chooses a path with the largest path energy bottleneck/path energy consumption value from Neighbor ListBE array, in order to give priority to this path, along which data information is transferred to sink nodes. As a node is triggered by data grouping, it will check the attribute of data grouping and then according to QoS attribute (as in Fig. 2) select RT filter or BE filter. The chosen filter is assessed in corresponding information inflow entrance and the best node is selected to be next hop of retransmitting data clustering. As for BE, only the nodes which are cached in BE data inflow entrance can be chosen as next hop node. As to RT, if the initial next hop node can be regarded as RT data flow's entrance, it can be taken to be next hop node. Or else, the smallest node of HC in backup nodes is chosen.

Supposed that the initial energy of every sensor's node is the same and the positions of sink and target area

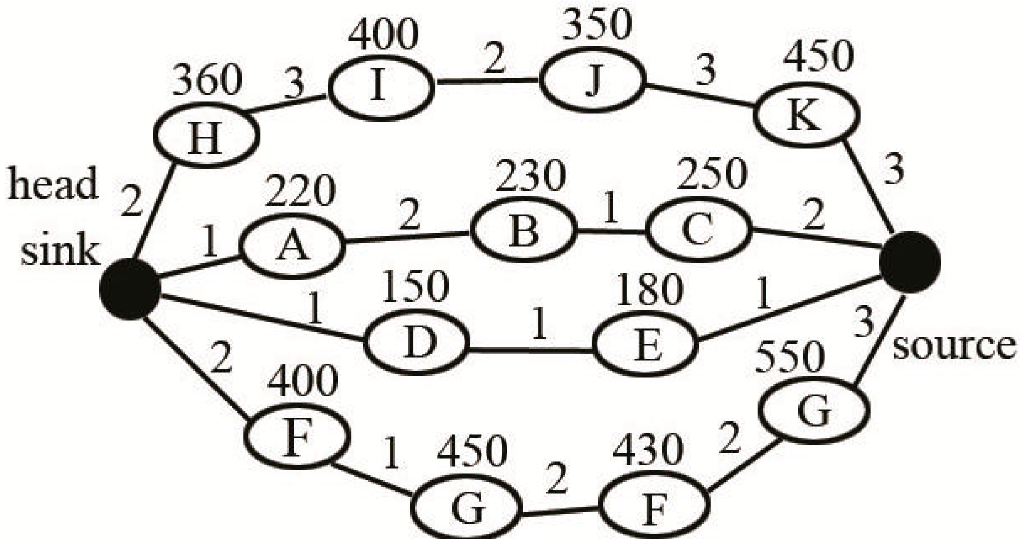

Fig. 1: Gradient model

Source sink	Data attribute e.g., key type IF reflag QoS (RT or Be)	Perivious hop next hop	Play load

Fig. 2: The form of data grouping

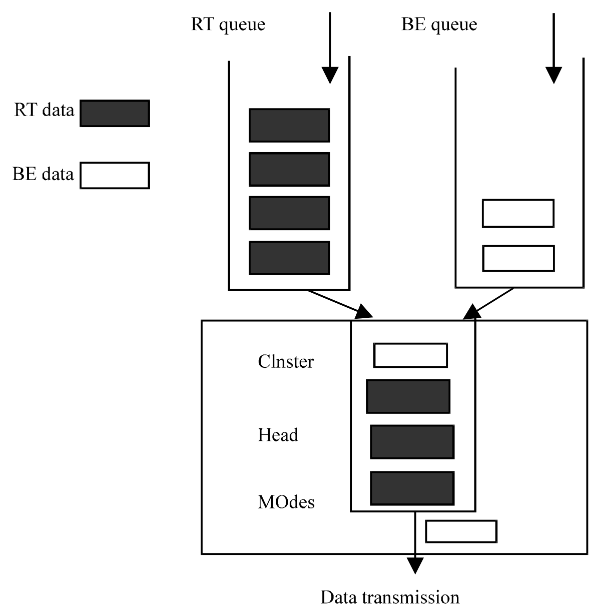

Fig. 3: Gradient fields of RT

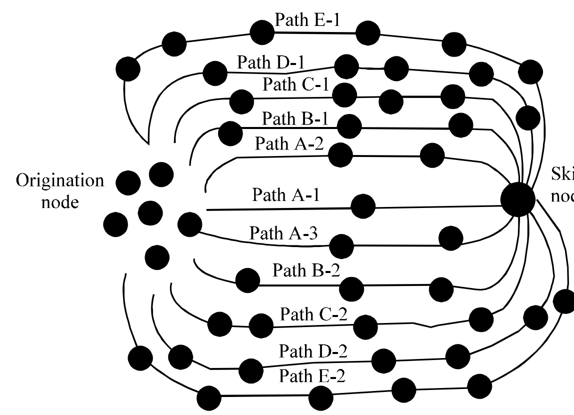

Fig. 4: Queue model

is fixed. As in Fig. 3, the path split in accordance with RT gradient is regular, whose shape is similar to the magnetic line of force in magnetic field. Assume that path A-1, A-2 and A-3 make up the Path Group (PG) with the smallest hop count, PG-A for short.

In regard to RT service, the path in PG-A can most satisfy its delay requirement. Among candidate paths (A-1,A-2 and A-3), the second level of MPE gradient is adopted and then the largest MPE path is selected (the path with the largest bottleneck energy) to transfer data. If the paths in PG-A are all blocked (some nodes cannot transfer data because the energy is used up), PG-B becomes the best choice of satisfying delay requirement. In general, RT service firstly seeks the low-delay path and then looks for partial energy balance in PG. The rest may be deduced by analogy. For BE service, BE service always select the path corresponding to the largest MPE to ensure the overall situation's balanced energy in the whole network. What to be noted is that the paths in PG are not strictly separated.

QoS routing selection: Routing selection algorithm is on the premise of the two types of gradients mentioned

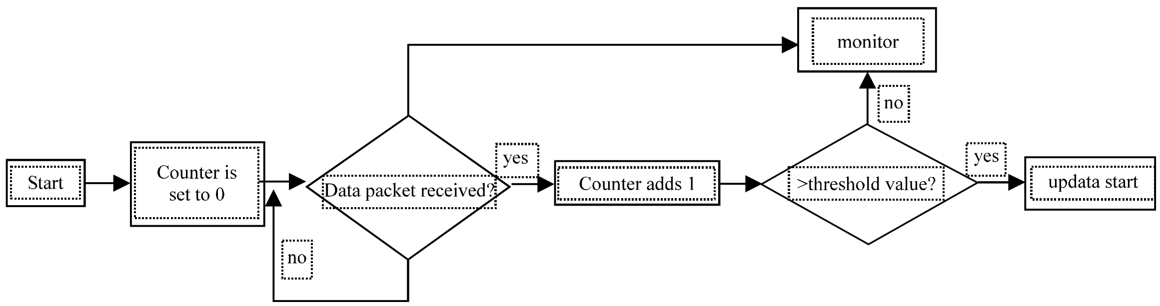

Fig. 5: Schematic diagram of energy update

above, which employs priority queuing mechanism to dispatch real time data and best effort data at cluster head nodes, as shown in Fig. 4. RT service is set to be high priority and BE to be low priority and both are non-preemptive priority queuing mechanism. If RT data packet with high priority is being sent, the arrived BE data cannot occupy communication channel, but only be at the back of all RT data in the queue; otherwise, if BE is being sending, the arrived RT data will seize the channel. Until RT data is sent, BE data can obtain the transmission right.

Real time service, delay is the first consideration; Neighbor node's hop count (HC) is checked and the nodes satisfying constraint requirement are added into available neighbors (ANs).

As delay is the major factor considered in real time service, when selecting next hop, the node with smallest hop count is chosen as much as possible:

$$p = \frac{1}{HC_i} \Big/ \sum_{i=t}^{n} \frac{1}{HC_i} \tag{1}$$

According to formula (1), the selected nodes' probability is calculated.

The process will continue until it reaches sink node. That is to say, an optimal path is established, because every hop guarantees the delay demand of real time service and also considers the balance of energy consumption of the whole network.

Best effort service gives first consideration to energy consumption.

Firstly, neighbor nodes MPE are checked. The nodes which are larger than maxMPE will be added into ANs according to given percentage r.

Supposed that n represents the node number of ANs. As nodes' remaining energy is the factor largely considered in best effort service, for best effort service, the selection probability of nodes is in direct proportion to nodes' remaining energy. In the light of formula (2), selected nodes' probability is calculated:

$$p = MPE_i \Big/ \sum_{i=t}^{n} MPE_i \tag{2}$$

where, As for best effort service, formula (2) can make sure that from nodes to sink nodes in available path with full energy, the smallest hop amount can be chosen in a large probability. The process will also continue until sink nodes and finally an optimized transmission path is established.

Energy maintenance and update of nodes: During the running of WMSNs, the energy of nodes is constantly changing. When choosing retransmitting nodes, if the running time of networks is too long, the selected transmitted nodes may deviate. Therefore, the energy information of nodes needs maintaining and updating. Traditional wireless sensor networks utilize periodic maintaining strategy that cannot dynamically adjust with networks' running, which will cause extra energy consumption when networks is comparatively spare, without timely update in the peak of networks.

DF-DSQ R algorithm adopts the energy maintenance and update strategy based on sink node's communications volume. Sink nodes maintains a counter. When the data packet received by sink nodes reaches preset threshold value, sink nodes start the flooding of energy updating information and the schematic diagram is shown in Fig. 5.

Compared with traditional periodic maintenance strategy, this energy maintenance and update strategy is flexible, which can dynamically adjust the cycle of energy maintenance and update according to networks' running situation. When the network is free, it will not additionally consume energy because of frequent energy updates. When the networks are busy, it can promptly update nodes' energy, guaranteeing the accuracy of selecting transmitting nodes.

SIMULATION ANALYSIS

Simulation environment: As a source of free software simulation platform, NS2 network simulation in for

Table 1: Experiment parameters

Parameter	Network coverage	Transm. range of nodes	Sink position	Total amount of nodes	Int. of sink node's Peri. flooding	Initial energy of nodes	Grouping size	Nodes' Distr. mode	Wireless channel rate
Value	(220*20)m^2	80m	(85,160)m	400	400s	2.0J	1024bits	random	2Mbps

Transm: Transmission, Distr: Distribution, Peri: Periodic, Int: Interval

researchers to provide a lot of convenience. Many commonly used lie proposed, such as network transmission protocol TCP and UDP. Routing queue management mechanism, such as Droptail, RED and CBQ, business source flow generator, such as FTP, Telnet, etc., have been integrated in the NS2, researchers can be directly call. In addition, as a discrete event simulator, it contains the simulation event scheduler, network component object library and network constructing model library, etc. In addition to provide abundant function library for the researchers call beyond, researchers can use based on the NS2 simulation method and the process instructions will be their relevant code to join in NS2, in order to extend NS2 or some application performance simulation. Finally, when after the simulation, the NS2 will produce one or more based on text trace file, based on the analysis of the data in the file and the use of gnuplot drawing tools. The simulation results clearly show come out. In addition, still can use the NS2 NAM, the whole process of simulation in the form of animation displayed.The author uses NS-2 to simulate DF-DSQR and SAR. The performance is compared by means of simulation results. The parameters selection of simulation experiment is shown as Table 1.

Comparison with SAR routing algorithm: Aiming at explaining the effectiveness of the algorithm in this paper, in the experimental environment above, the algorithm proposed in this paper is compared and analyzed with classic SAR routing algorithm. As for real time service and best effort service, the influence of the two service' routing on their QoS. From Fig. 6 of simulation results, it can be seen that (a) In DF-DSQR routing protocol, RT and BE service's end-to-end delay obviously separate. RT service's end-to-end always is lower than that of BE service, ensuring the QoS low-delay of real time service; (b) Compared to classic SAR routing protocol, DF-DSQR routing protocol realizes differentiated routing of real time service and best effort service. DF-DSQR routing protocol's delay obviously is lower than SAR protocol.

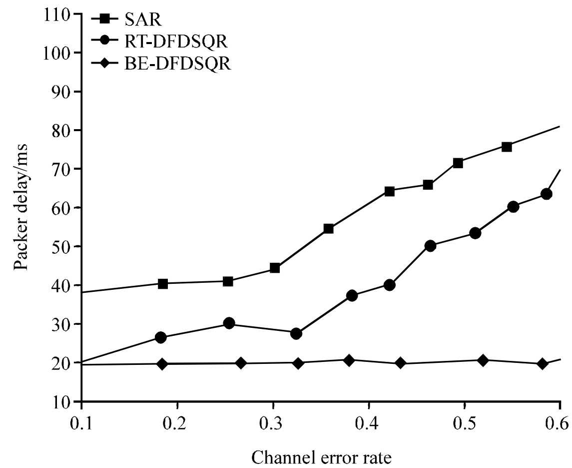

Fig. 6: Analysis of delay performance

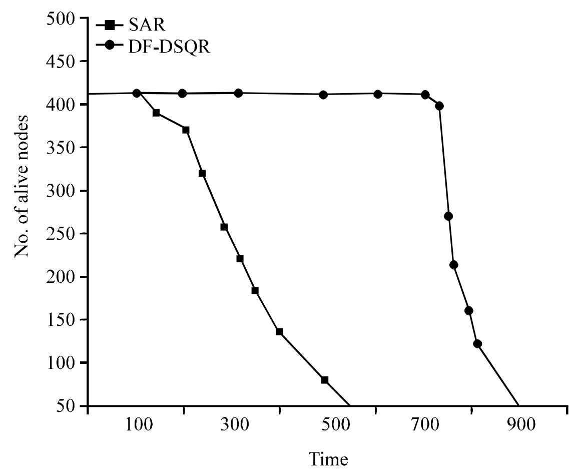

Fig. 7: Performance of networks survival time

Figure 7 displays the situation of networks' survival nodes amount of DF-DSQR and SAR routing protocol changing with time. It can be seen from the figure, no matter the death time of first node or last node, DF-DSQR algorithm is superior to SAR. DF-DSQR algorithm adopts data fusion transmission mechanism and effectively prolongs the life of WMSNs. What's more, the time span from the first node's death to the last node's death is small, which manifests that in DF-DSQR routing protocol, the balance of networks' energy consumption is given priority to best effort service, availably takes advantage of networks' limited energy, prolonging networks' lifecycle.

CONCLUSION

Targeting to the characteristics of WMSNs, this paper adopts data fusion transferring mechanism and priority service scheduling queuing model, puts forward a QoS routing algorithm for best effort service and real time service. The simulation results display that DF-DS algorithm can satisfy the different QoS demands of real time service and best effort service, choosing corresponding routing to reasonably and regularly utilize network sources, balancing network energy consumption and prolonging network lifecycle.

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