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Data Aggregation and Broadcasting in Sensor Network via Multipl Sampling Reverse Direction Broadcast

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Abstract: In wireless sensor networks, the sensor nodes collect information and it sends the information to a base station occasionally. Some important messages are required to be broadcasted in all nodes proficiently. Data aggregation and broadcasting are important operations that consume significant amount of battery power. Constant approximation algorithm for the 2-Disk model does not broadcast the data back to a fixed sink node. The major difference is that in a broadcast, a sink node transmit packets to many nodes at the same time while in a data aggregation, many nodes cannot transmit to one sink in one time slot. Energy efficient MAC protocol for WSN avoids overhearing and reduces contention delay by asynchronously scheduling the wakeup time of neighboring nodes but data aggregation property is not introduced effectively. To overcome this Multiple Sampling Reverse Direction Broadcast (MS-RDB) method was constructed. MS-RDB uses the data aggregation process to transmit all node information to sink node in one time slot. Because of limited battery life, energy efficiency is becoming a main demanding problem in these power-constrained networks. MS-RDB constructs a reverse transmission sequence for connecting all nodes to save energy dissipation of data transmission. An energy efficient MS-RDB algorithm is developed which uses a sequence of insertions to add the least amount of energy consumption on the whole sequence. It consumes less transmission power on data aggregation processes compared to the existing 2-disk model and energy efficient MAC protocol. NS2 simulator is used to perform the experimental work of MS-RDB method in terms of normalized throughput, energy consumption, reverse broadcasting efficiency, delay rate, transmission latency and packet loss rate.

Key words: Multiple sampling, normalized throughput, reverse direction broadcast, energy dissipation, data broadcast, MAC protocol, data aggregation process

INTRODUCTION

Wireless Sensor Network (WSN) consists of several low-cost and less-power Sensor Nodes (SN). Sensing and short range communication transmits the sensed information to the base stations. Base stations are the most significant functions of a SN in a WSN. The main task of Wireless Sensor Network (WSN) is to detect and report the events of the physical world. In most cases, nodes are battery powered with inadequate energy resources. Suppose when a node runs out of power and stops functioning, the original transmission paths will be changed. Nodes nearby will go through heavier work, because of sharing accountability of the exhausted node which casts serious burden to them.

Probability model as shown by AlHamadi and Chen (2013) investigates the most excellent redundancy level in terms of path redundancy and source redundancy. The most excellent intrusion detection settings in terms of number of voters and the intrusion invocation prolong lifetime of a HWSN but explored to different types of malicious attack. Packet dropping and bad mouthing attack occurs in probability model. Min-max approximation approach as described by Xu *et al*. (2013) approximation of location for tracking professionally resolves via Semi Definite Programming (SDP) relaxation and to be relevant is a cubic function for mobile sensor navigation.

Neighboring node-disjoint redirects the bidirectional paths to discuss its computational difficulty and presents a framework of polynomial time approximation algorithms with undersized estimation ratios. Relay node placement under the weaker connectivity requirement are not performed (Misra *et al*., 2010). The process spreads towards the wireless network cause packets loss or even network congestion. An adaptive quorum-based MAC protocol as mentioned by Ekbatanifard and Monsefi

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(2012), separately and adaptively schedules nodes wake-up times. Queen MAC decreases the redundant eavesdrop and collisions increases the network throughput and expands the network lifetime. Queen-MAC is extremely appropriate for data group applications. Furthermore, the performance of the system depends on the perseverance of the sensors to a huge extent.

Forwarding schemes as designed by Valles *et al*. (2011) exploit the significance of their individual transmitted messages. Optimal threshold depends on the distribution of messages which brought into practice is unknown. The decision maker compares the significance of the received message with a time-variant threshold. It is not integrated with variety of existing data collection approaches.

The sensor field data varying can be done by a mobile object. There are some aforementioned works that employ analogous concept of bands but in diverse contexts (Rajasekar and Prakasam, 2014). Bands are commenced to assist principles and evaluate the energy utilization of sensors at diverse distances from a sink.

To begin with initially it provides a brief background of the data aggregation methods of WSN. In current years, methods of data aggregation are attracting the attention of the researchers. A huge quantity of works on data aggregation protocols in wireless sensor networks for energy preservation is published. DAACA for data aggregation as demonstrated by Lin *et al*. (2012). take the advantages of both global and local merits for fade or deposit pheromones. Four different pheromones modification strategy which compose DAACA family are designed to prolong the network lifetime with sleep-wake cycles scheduling problem.

The problem of scheduling the sleep-wake cycles of nodes is addressed by Jang *et al*. (2012) beneath aim constraints. After legitimately modeling the problem being addressed, an Optimal Wake-up Frequency Assignment (OWFA) algorithm which takes into description the information rate at each node and the total allowable delay. Any cast based packet forwarding scheme in (Kim *et al*., 2010) still provides effective solution for sleep-wake cycles scheduling problem but fails to take into account non-poisson to wake-up the processes and other lifetime definition. Recoverable concealed data aggregation as depicted by Chen *et al*. (2012 for data integrity in WSN retrieves the maximum value of all sensing data. The base station (i.e.,) sink node cannot confirm the data integrity and legitimacy via attaching message digests or signatures to each sense example.

The key idea is to combine the data coming from different source nodes which eradicates redundancy, minimizes the broadcast quantity and thus accumulate energy. Broadcast is a general communication resource in wireless sensor network. In directed diffusion protocol, broadcast is used to publicize interest, discover routing path and restore the routing path. However, uncomplicated broadcast scheme such as flooding results in severe broadcast storm problem, particularly with respect to large densely deployed wireless sensor network. Off-line optimal scheduling in energy harvesting communication systems for the parallel and evaporation broadcast channels is shown by Ozel *et al*. (2013) broadcast power policy and it achieves the boundary of the maximum departure region. The most favorable policy for the non-fading broadcast channel which does not depend on the priorities of the users and consequently the optimal policy for the non-fading scalar single-user channel are obtained.

Hill Climbing key dissemination approach as described by Yu and Guan (2010) ensures the data sources with the stronger filtering capacity. Moreover, making use of the broadcast property of wireless communication is to conquer DoS attacks and approve multipath routing to deal with the topology changes of sensor networks. Various energy-efficient data aggregation and dissemination protocols for wireless sensor networks are not addressed.

In this work, MS-RDB method is used to constructs the reverse transmission sequence for connecting all nodes to save energy dissipation of data transmission. In addition, Discriminating Onward of packets (DO) where the forwarding choice is taken energetically, hop-by-hop, based on the conditions of downstream forwarding nodes. The reverse direction broadcasting with data aggregation property to each sub sequence transfers all data to the sink node. The sub sequence is constructed through a sequence of insertions. End-to-end coding is also used to keep away from acknowledgment-based redirection. A new multiple sampling reverse direction broadcast which requires an inferior control overhead, lesser nodal record and chronological searching approaches is developed.

Literature review: The main challenge for the energy-constrained network is to design energy-efficient routing protocols with agreement and balance the energy consumption of the network. The energy dissipating rate of these nodes will become faster. SCP-MAC, a synchronous scheduled energy-efficient scheduling

MAC protocol in (Jang *et al*., 2013) decreases the preface by combining preamble sampling and scheduling techniques. However, it does not avert energy loss due to eavesdrop in addition, due to its synchronization procedure. Energy efficient MAC protocol for WSN avoids overhear and decrease contention and delay by asynchronously scheduling the awaken time of neighboring nodes.

The geometric progression acts as a coordination mechanism in (Rajasekar and Prakasam, 2014), the sensor field which coordinates the multiple sampling tasks rebroadcast by the sensor nodes at the appropriate time. While the sensor nodes keep on rebroadcast the data for one region to attain the mobile sink, then the region overlap occurs. Cooperative Networking protocol (CONET) which energetically reforms clusters does not hold up multiple rates as illustrated in (Yoo and Park, 2011). Due to the severe energy constraint, energy resource of sensor networks should be predictable sensibly to generate bigger lifetime of sensors. The aim of TDEEC (Threshold Distributed Energy Efficient Clustering) protocol as described by Saini and Sharma (2010) is to augment the energy efficiency and stability of the heterogeneous wireless sensor networks. Time scheduling on a single frequency channel as shown by Incel *et al*. (2012) aim at minimizing the integer of time slots essential for unqualified converge cast. It combines scheduling with transmission power control to advance the property of interference.

Duty-cycled multi-hop wireless networks (IAGS-UDC problem) as demonstrated by Jiao *et al*. (2013), fails to solve the gossiping problem under physical interference model. IAGS-UDC problem denotes the ratio of the interference radius to the transmission radius. Approximation algorithms is based transmission range in (Tiwari *et al*., 2009) devises efficient coloring methods for coloring a hexagonal tiling in 2D. Truncated octahedragonal tiling in 3D leads to O-approximation ratio for transmit scheduling problem in 2D and 3D, correspondingly. MLAS problem in the more realistic physical model as shown by Tiwari *et al*. (2009) derives Signal-to Interference-Noise-Ratio (SINR) at lower bound level.

Redundant Radix Based Number (RBN) as represented by Sinha *et al*. (2011), encode and transmit data for different applications coupled with noiseless periods for communicating the digit zero, encoded communication scheme, called as RBNSiZe Comm. RBNSiZe Comm unite data to its comparable redundant binary number representation. Analysis does not consider ripple effect of symbol errors in RBN encoded data. RBNSiZeComm provides an energy benefit of only about 33%-62% at the transmitter and hence the energy parameter lacks in maintaining efficiency. Redundant Radix Based Number (RBN) as represented by Sinha *et al*. (2011), encodes and transmits data for different applications coupled with noiseless periods for communicating the digit zero, encoded communication scheme, called as RBNSiZeComm. RBNSiZeComm unite data to its comparable redundant binary number representation. Analysis does not consider ripple effect of symbol errors in RBN encoded data. RBNSiZe Comm provides an energy benefit of only about 33%-62% at the transmitter, so the energy parameter lacks in maintaining efficiency. Signal-to-Interference-plus-Noise Ratio (SINR) models as described by Huang *et al*. (2008) deals openly with transmission laws in general physics. SINR is more reasonable as it essentially models the case where numerous far-away nodes are transmitting concurrently but not applied to directional antennae with geometrical properties.

MATERIALS AND METHODS

Reverse direction broadcasting on multiple sampling Tasks: Multiple sampling reverse direction broadcasting method performs effective data gathering and broadcasting of the packets in the reverse direction (i.e.,) from all nodes to sink nodes at one time slot. The flow diagram of the multiple sampling reverse rirection broadcast method is shown in Fig. 1.

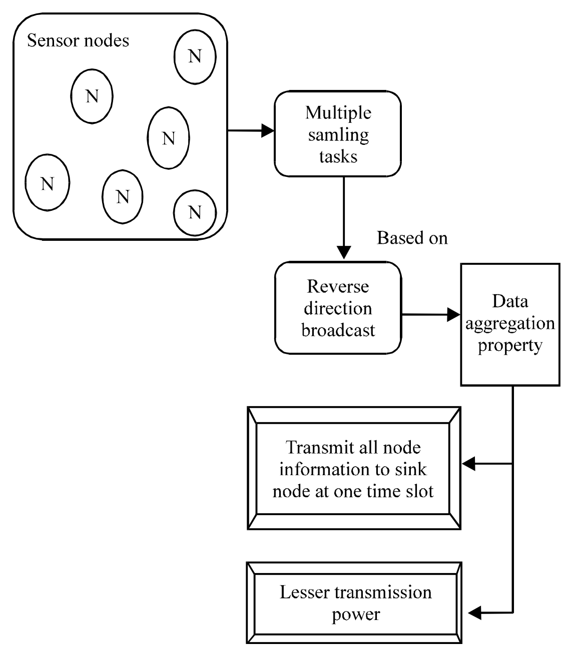

Fig. 1: Flow diagram of multiple sampling reverse direction broadcaast method

MS-RDB method accomplishes a data aggregation process to multiple sampling tasks. Multiple Sampling Reverse Direction Broadcasting (MS-RDB) method divides the whole network into regions based on the sink node. An independent linear sequence ending at this particular sink node is generated in each region. The sink nodes collect all packets from the nodes at one time slot through reverse direction broadcast process. The Reverse direction transfers all data to the sink node in each sub sequence. The sub sequence is constructed through a sequence of insertions. Single node insertion is done at every round of reverse direction broadcast, so that the smallest amount of energy consumption takes place on whole sequence. MS-RDB method consumes less energy and leads sensor networks to a longer life.

MS-RDB method avoids the situation where two nodes located far away from each other become neighbors in the sequence constructed for the whole network to avoid the problem occur in existing system. The main goal of MS-RDB method is to construct an energy-efficient chain and transmit all node information to sink node at one time slot. The algorithm constructs a sequence where each node communicates with any type ϑ of nodes in sensor network.

Preliminaries: MS-RDB method treats the sensor networks with static nodes. A sensor network contains a huge scale of sensor nodes that are motionless and energy controlled. Each node regulates the area of coverage with its transmission using transmission power control. All live nodes sense the data. Among them, all nodes need to transmit data to sink node at one time slot. End users access data through the sink node. The sink node is fixed and located far from the sensors. Sink node has sufficient power supply therefore, it has no energy constraints. The source of power consumption is classified into three types with regard to operations such as sensing relation, communication correlated and computation correlated. Decreasing energy indulgence prolong the lifetime of a network. Distance is a major factor in energy indulgence.

In a wireless sensor network, communication is the major consumer of energy. MS-RDB method concentrates on conserving communication power. Reverse direction broadcast transmit data to the sink node with minimal energy consumption at one time slot and it is formulated as:

$$\text{Energy} + \epsilon_{amp}\, d^n = d^n\, nJ \tag{1}$$

Thus, to broadcast one bit message at distance‘d’ in sensor network where ‘n’ is a stable depending on the location circumstances. is the transmit speed amplifier to compute the reverse direction broadcasting speed and ‘J’ joules consumed to average the Energy consumed. The energy dissipation for sending data in reverse direction consists of two parts consists of redirection electronic and redirection amplifier. It depends on the data size and the redirection distance. The energy dissipation for receiving data using MS-RDB method only concerns the data size.

Based on the analysis of energy consumption, it needs to minimize the redirection distance and data size to conserve energy on multi sampling tasks. Depending on applications, different methods will reduce data size. In reverse direction broadcasting, each node upholds the size of the header and concatenates its data to the data from other nodes in sink node. Because ~~of~~ broadcasting the entire message from all nodes is made easier, as of that no data fusion is allowed in this operation. Data aggregation sensor networks will collect useful data while broadcasting using MS-RDB method.

RDB on multi sampling tasks: Multi sampling tasks decrease the total transmission distance for reverse direction broadcasting. The main idea of MS-RDB method is to divide the whole sensing area into six regions centered at the node that is closest to the center of the sensing area. MS-RDB method constructs a linear sub sequence in each region. The maximum distance between two neighboring nodes in a sub sequence is smaller than that in a single linear sequence generated within the whole area.

For example by dividing an n*n area into six equal regions, the maximum neighboring distance in a sub sequence is given by $\frac{\sqrt{2}}{4}n$. However, it doubles to $\frac{\sqrt{2}}{2}$ in a single sequence. Thus MS-RDB method minimizes the total neighbor distance, especially for sparse node distribution. Sink node does become a bottleneck as it has to handle more receiving and transmissions from all other nodes. The transmission of packet from sink node to all nodes and from all nodes to sink node is shown through Fig.2.

Through the wireless sensor network, MS-RDB method aggregates and transmits packets to the sink node at one time slot. Initially, it sends the packet to all six neighbors which transmit the packet to the end of all sub sequences. In aggregate approach, each sub sequence in MS-RDB method independently transfers and concatenates data from the end of sequence to sink node. After sink node collects all data, it produces a packet which contains information of the whole network system. Transmit approach broadcasts each sub sequence independently and accumulates data packet to sink node. Subsequently, sink node transmits all received packets to all sub sequences. To avoid redundancy, the neighbors of sink node check each receiving packet.

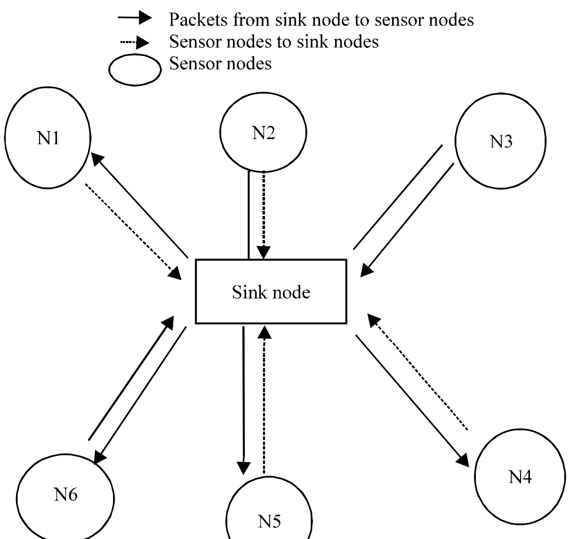

Fig. 2: Multiple sampling task

If a packet is the same as what a node just sent to sink node, then it discards the packet to avoid redundancy. If a packet is the first new packet the node receives, it sends this packet combined with its own sensing data along the sequence. Each reverse direction broadcasting node performs the analogous combination, generates and sends a larger packet to the next node, until transmission terminates at the end of sub sequence. If the packet does not belong to the proceeding two cases, the neighbor node only transmits this packet. No other data is concatenated to the packet.

In MS-RDB method, simplified assumptions are taken such that the number of nodes 'n' associated with 'r' disjoint source destination routes such that

$$n^{(d)}\, r\,(l\text{-}1)+2 \tag{2}$$

$n^{(d)}$ is the distance computed in between the nodes with 'r' disjoint routes. On the other hand, with inward (i.e.,) receiving and outward (i.e.) transmitting branches at each node in WSN is computed as:

$$n^{(m)}=\begin{Bmatrix}\left(\frac{1+2}{2}\right)^2, l\,\text{is even}\\ \left[\frac{1}{2}\right]\left(\frac{1}{2}\right)+1, l\ \text{is old}\end{Bmatrix} \tag{3}$$

Hereafter, for each packet, transmission is computed using $n^{(m)}$equation $n^{(m)}$. Satisfies two conditions (i.e.,) length in odd and even condition. The link error and intermediate node failure probabilities are denoted by S_l $S_l$and S_t, respectively in reverse direction broadcasting.

$$S_l = 1\text{-}(1\text{-}S_b)^I \tag{4}$$

$$S_b = p\left(\frac{1}{\sqrt{\frac{k-1}{3D}+\frac{No}{2E_b}}}\right) \tag{5}$$

While S_l captures noise as well as the error due to medium access conflict S_b captures the packet loss due to input buffer overflow and node failure while reverse direction broadcasting. In order to highlight the differences between different multiple sampling tasks, the end node (i.e., destination) is considered ready to receive all packets. E_b is the signal to noise ratio bit of packet 'p'. No is the average bit error probability computed based on time slot and I is the packet size.

Reverse direction broadcast with minimum total energy algorithm: A packet schedule along a reverse direction computes the total energy indulgence of the network which contains two parts such as aggregating and transmitting energy consumption at each node. The total energy used by all nodes in receiving a packet is (n-1)*I* where I is the packet size. The energy consumption of receiving is independent of the type of the sequence used. The transmission energy depends on the distance between two nodes along a sequence. To simplify the analysis packet transfer at one time slot is considered. The analysis for conserving total energy consumption is to build a sequence with minimum $\sum d_n$ where d is the distance between two nodes along the sequence.

Alogrithm 1

Reverse direction broadcast algorithm begin:
Input: Sink node transmit packet to all other sensor nodes
Output: From all other nodes sink node at one time Slot
Step 1: Farther Nodes from Sink node
Step 2: Sequence = {Node1, node 2….Node 6}
Step 3: While! =Null
Step 4: For each I∈ n'
Step5: Do [I, D_j]←min [$d^2(D_j, I) + d^2(I, D_{j+1}) + (D_j, D_{j+1})$ at one time slot
Step 6: New←Extract MinEnergy (ń
Step 7:) Insert (Sequence, D_j, New
Step 8: Append (Sequence, Nodes)
End

The first stage in above algorithm is to find the farthest node from sink node as one end of the sequence. Then, each round selects a new node which is not in the sequence to redirect the packet from the sensor nodes to the sink nodes. The selection criteria are that $\sum d^2$ of the current sequence with new node increases to the minimum possible extent compared to the old sequence. There exist two cases depending on insertion position j. In MS-RDB algorithm, D_j represents the node at location j in the sequence. If D_j is already the end of the current sequence, simply append new to the sequence. Otherwise insert new between D_j and D_{j+1} at same time slot. The new transmission path from D_j- D_{j+1} through node D_j minimizes the delay cost to the sequence with all other sensor nodes in MS-RDB method.

Experimental Set-Up: Simulation takes over based on the sensor network package successively on the NS2 simulator. Our simulation scenarios used 50 sensor nodes, one BS and one event node. The event node represents a moving object which is being tracked by the sensor nodes. The sensor nodes use the AODV as the routing protocol. The movement of all nodes except the base station was randomly generated over an 800×800 m field, with a maximum speed of 45 m sec^{-1} and an average pause of 0.01 sec. Each simulation was over a time period of 950 simulation seconds.

In order to evaluate the effectiveness of reverse direction broadcast with the data aggregation, test was performed on the simulator. The effectiveness of Multiple Sampling with the Reverse Direction Broadcast (MS-RDB) method on varying parametric factors is normalized by? throughput, delay rate, energy consumption, transmission latency, reverse broadcasting efficiency, and packet loss rate.

The normalized throughput in MS-RDB method is the sum of the data rates that are delivered to all terminals in a network. Throughput is fundamentally identical to bandwidth consumption where the load in packets per time unit is denoted by arrival rate λ and the throughput in packets per time slot is denoted by departure rate μ. Subsequent factor, delay rate is measured as the amount of packet percentage delayed while packet transmitted at one time slot. The performance of the multiple sampling with the reverse direction broadcast consumption factor is the amount of energy consumed to send all packets information from all nodes to sink node.

Transmission latency factor is the amount of time required to move forward all of the packet's bits in sequence order. In other way, latency (i.e.,) delay is caused by the data rate in MS-RDB method. Broadcasting efficiency is defined as the significant change, maximizing efficiency with multiple sampling on wireless sensor network, measured in terms of percentage (%). Packet Failure rate factor is that the rate at which the packet drop is identified in links effectively and overcoming it successfully using the MS-RDB method.

RESULTS AND DISCUSSION

Performance results of multiple sampling using reverse broadcast: Multiple Sampling with the Reverse Direction Broadcast (MS-RDB) method is compared with the existing Constant Approximation (CA) algorithm for the 2-Disk model and Energy Efficient MAC protocol (EE-MAC) for WSN. The evaluations given in Table 1 and graph given in Fig. 3 describe the improvements in MS-RDB method with beneficial simulation results when compared with the existing system.

Table 1, 2 describes the normalized throughput on MS-RDB method, CA Algorithm and EE-MAC protocol, throughput is also increased gradually. The source to measured in terms of Kilo bits per second (Kbps). As the source to destination node distance ranges increases, destination node distance ranges from 2, 4, 6…up to 14.

Figure 3 describes the normalized throughput based on the node distance. At each round, a new node is selected which is not in the sequence to redirect the packet from the sensor nodes to sink nodes. The selection criteria of the current sequence with new node increases to the minimum possible extent compared to the old sequence. In MS-RDB Method, throughput value increased by 10-20 % when compared with the CA Algorithm and 4-8 % improved when compared with the EE-MAC protocol (2).

Figure 4 describes the delay rate on current methods and MS-RDB Method. The transmission path from D_j-D_{j+1} through node minimizes the delay rate to the sequence with all other sensor nodes in MS-RDB method. As the packet count increases, delay rate is reduced to 5% in MS-RDB method when compared with EE-MAC protocol and reduces to 7% when compared with CA Algorithm. Delay count is simply reduced in MS-RDB method using aggregation and transmitting shown in Table 3.

Table 1: Tabulation of normalized throughput

Source to destination node distance unit	Normalized throughput (Kbps)		
	CA Algorithm	EE-MAC protocol	MS-RDBMethod
2	1256	1451	1501
4	1310	1488	1600
6	1895	1997	2165
8	1536	1860	1922
10	1652	1785	1891
12	2192	2415	2625
14	1395	1735	1800

Table 2: Tabulation of delay rate

Technique	Delay rate (%)
MS-RDB method	5
EE-MAC protocol	10
CA algorithm	12

Table 3: Tabulation of energy consumption

Per hope count	Energy concuption (mW)		
	CA Algorithm	EE-MAC protocol	MS-RDB method
5	124	118	112
10	71	68	63
15	421	390	360
20	223	214	192
25	730	680	623
30	217	201	185
35	355	333	305

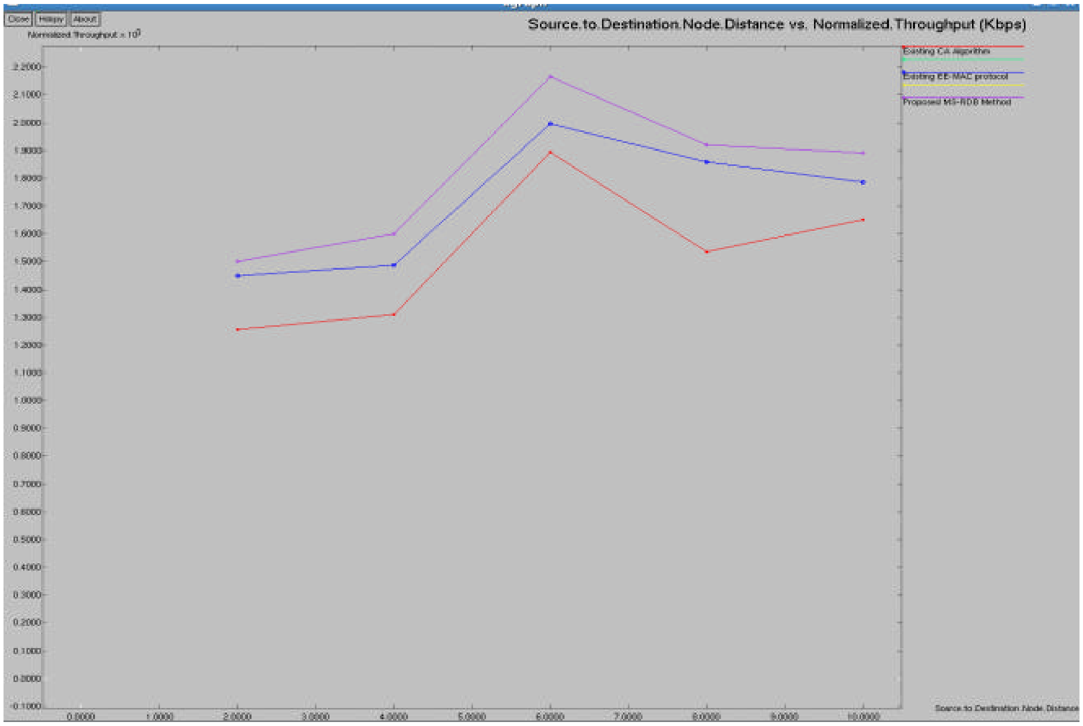

Fig. 3: Performance normalized throughput

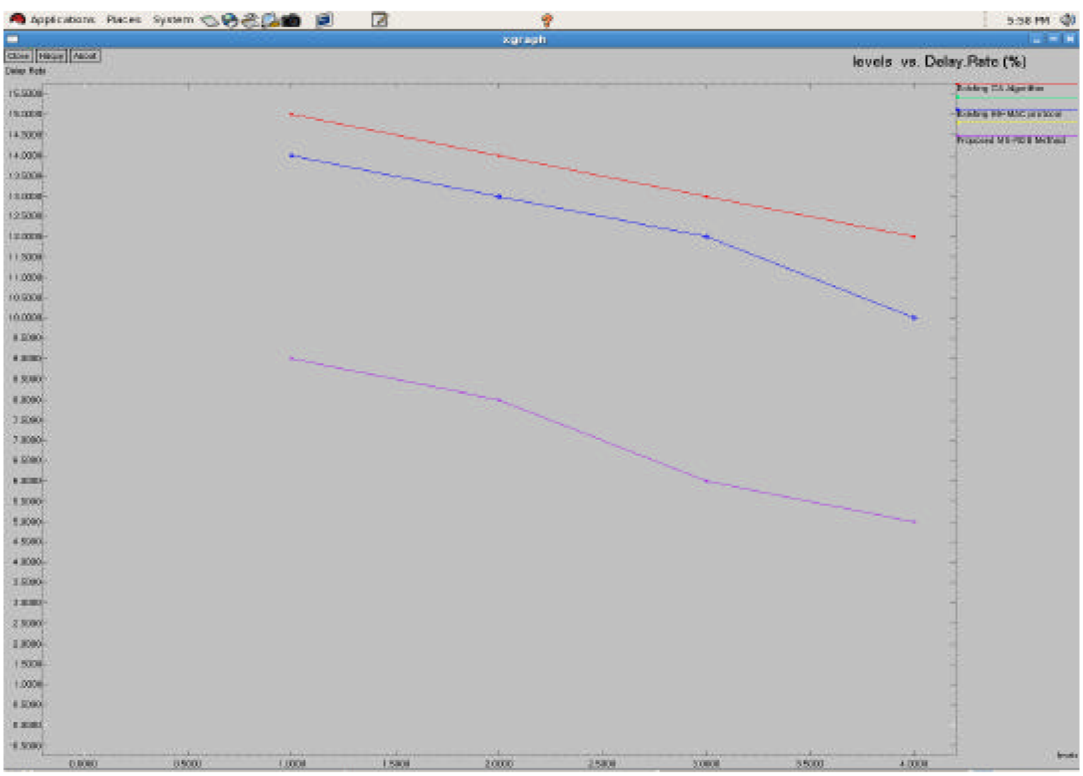

Fig. 4: Measure of delay rate on various techniques

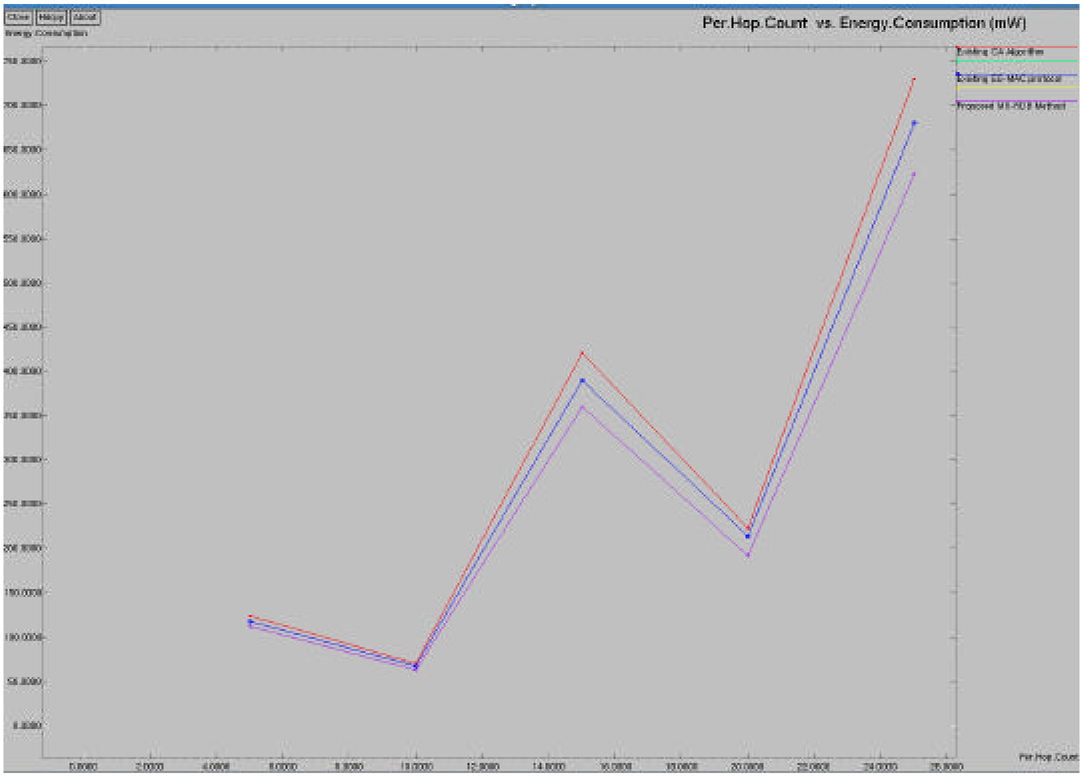

Fig. 5: Measure of energy consumption

Table 4: Tabulation of transmission latency

	Transmission latency		
No. of nodes	CA algorithm	EE-MAC protocol	MS-RDBmethod
100	13	12	11
200	63	59	54
300	72	68	62
400	95	92	84
500	76	70	64
600	156	147	135
700	62	58	53

Table 5: Tabulation for reverse broadcast efficiency

	Reserve broadcost efficiency (%)		
Average hop length	CA algorithm	EE-MAC protocol	MS-RDB method
4	85	91	95
8	66	72	75
12	78	86	91
16	56	66	69
20	80	91	93
24	83	93	96
28	79	88	93

Figure 5 illustrates the energy consumption based on the per hop count. Single node insertion at every round of reverse direction broadcast is done?, so that the smallest amount of energy consumption takes place on whole sequence. As the count increases, the energy consumption in MS-RDB Method is reduced to 5-15% when compared with CA Algorithm and decreases 5- 10% when compared with the EE-MAC protocol. Although, MS-RDB method, consumes less energy and leads sensor networks to a longer life shown in Table 4.

Figure 6 demonstrates the transmission latency based on the node count. As the node count improved, the transmission latency varied on each simulation result. The MS-RDB method minimizes the transmission latency total neighbor distance concept, especially for sparse node distribution. MS-RDB neighbor distance concept an n*n area into six equal regions and its sub sequence is $\sqrt{2}$. However, it doubles to $\sqrt{2n}$ in a single sequence, to reduce latency drastically. The latency is reduced to 12-16 % when compared with the CA algorithm. The MS-RDB method also reduced what approximately to 9% when compared with the EE-MAC protocol (Lin *et al*., 2012; An *et al*., 2012) (Table 5).

The measure of reverse broadcast efficiency factor obtains a better result in MS-RDB method when compared with CA algorithm and EE-MAC protocol shown in Fig. 7 ϵ_{amp} is the transmit speed amplifier used to compute the reverse direction broadcasting speed and it depends on the data size and the redirection distance. In reverse direction broadcasting, each node upholds the size of the header and concatenates its data to the data from other dividesnodes in sink node to improve the efficiency level.

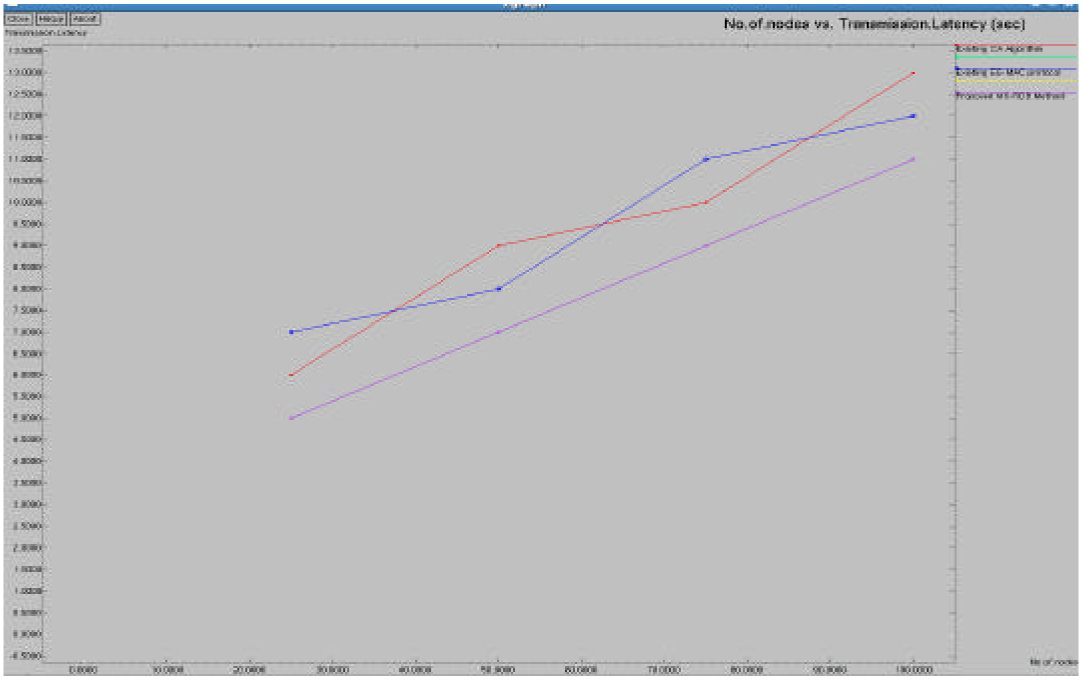

Fig. 6: Measure of transmission latency

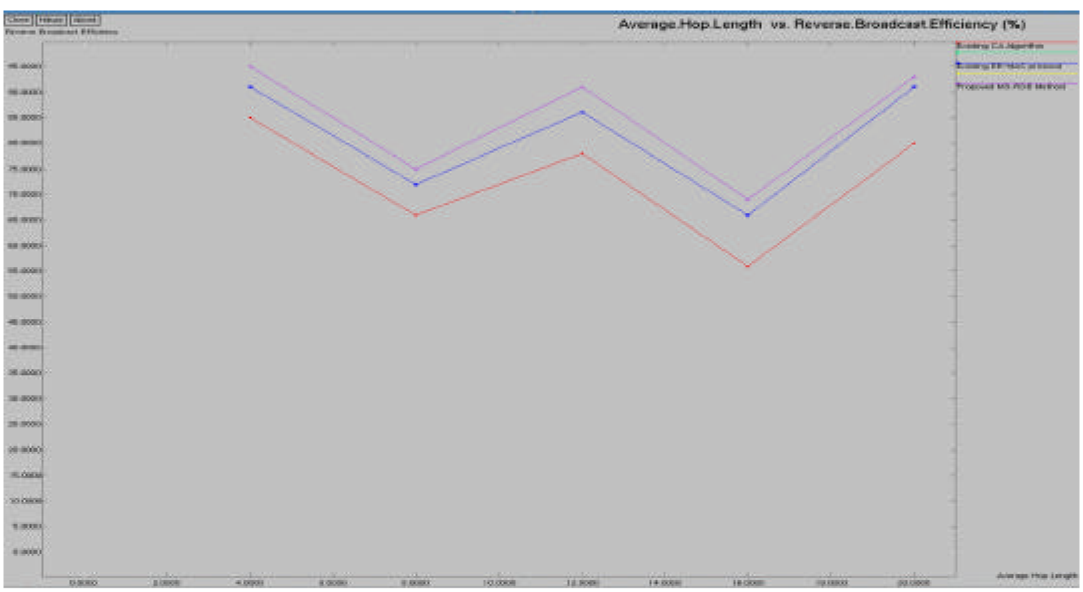

Fig. 7: Reverse broadcast efficiency measure

Reverse broadcast efficiency of MS-RDB method is 2-5 % higher when compared with EE-MAC protocol and 7-14% higher when compared with the CA Algorithm.

Table 6 and Fig. 8 describe the packet loss rate based on the transmission interval. The transmission interval is measured in terms of seconds (sec). The packet loss rate reduced in MS-RDB method because of using inward (i.e.,) receiving and outward (i.e.) transmitting branches. The transmitting branches are computed through Eqn $n^{(m)}$) formula. MS-RDB method reduces the packet loss ratio to 15-20% when compared with CA Algorithm and 7-10 % reduction when compared with EE-MAC protocol.

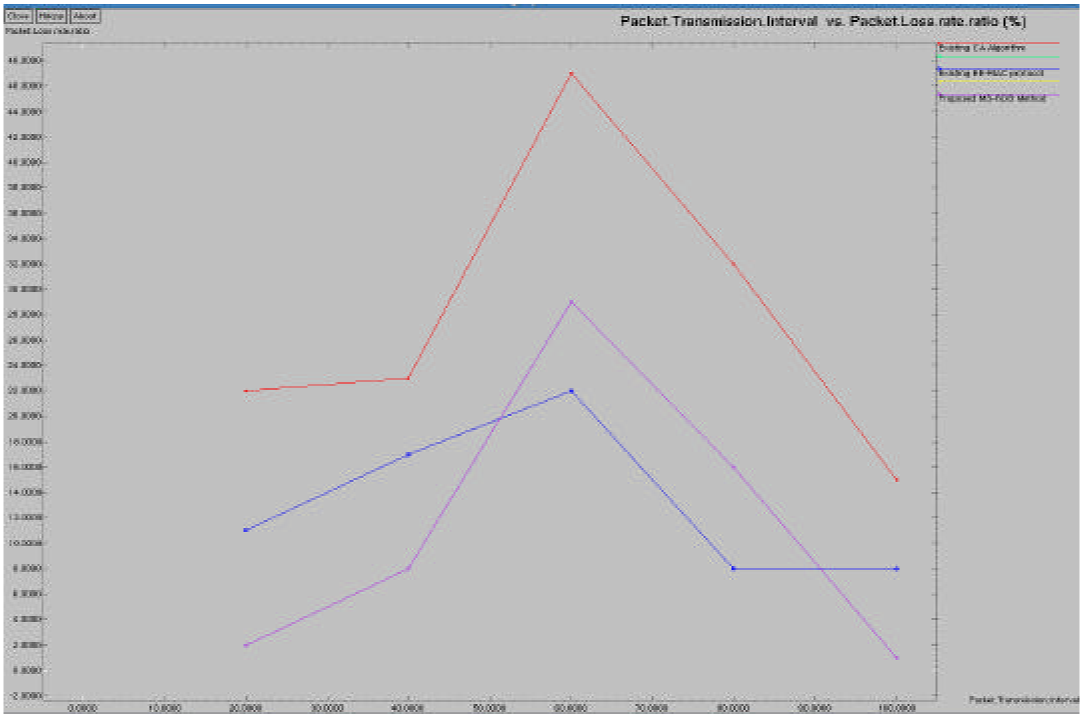

Fig. 8: Packet loss rate measure MAC protocol

Table 6: Tabulation of packet loss rate

Packet transmission interval (sec)	Packet loss ratio (%)		
	CA algorithm	EE-MAC protocol	MS-RDB method
20	22	11	2
40	23	17	8
60	47	22	29
80	32	8	16
100	15	8	1
120	24	15	6
140	30	22	12

Finally, MS-RDB method significantly decreases the packet loss ratio, latency and energy consumption rate. However in view of limited battery power and available location information of nodes in wireless sensor networks, MS-RDB method has the following distinct features. For route discovery in MS-RDB method, each source is restricted to not more than two best neighbors for discovery packet forwarding. Because of many sources to one destination (i.e.,) sink route discovery, routing table and discovery of packet lengths are condensed. To reduce power consumption in MS-RDB method, a node forwards merely one of many packets, established from its secondary sources to the destination.

CONCLUSION

Multiple sampling reverse direction broadcast method uses the data aggregation process to transmit information of nodes to sink node in one time slot. MS-RDB method ensures successful data communication with minimal buffering and flow control overhead and resourceful use of network resources such as bandwidth and battery power. The MS-RDB routing strategy is a more natural choice in multi hop wireless sensor networks which has high nodal density and where each node has only partial network information limited power and limited functionality. MS-RDB provides the significant improvement in throughput performance over its node and link-equivalent disjoint multipath, without consuming additional network resources. Overall, the MS-RDB with discriminating onward achieves a superior performance. Performance of the MS-RDB protocol has been evaluated and compared with the existing approaches analytically as well as via simulations. Simulation result of MS-RDB attains normalized throughput, reverse broadcasting efficiency, 3.571% minimized transmission latency, delay rate, energy consumption and packet loss rate.

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