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POWER CONSERVATION TARGET PREDICTION IN WIRELESS SENSOR NETWORK USING SLEEP SCHEDULING

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ABSTRACT

Power conservation, target prediction and the routing path are some key element in the design of the wireless sensor network (WSN). Emerging application of wireless sensor network require Real-time quality of service (QoS) guarantees to be provided by the network. The idea of the duty cycle is to switch between the wake up state and the sleep state periodically. In some case, the sleep pattern of the node may also be forced to wake up or sleep based on the demand called sleep scheduling. Once the prediction of the target is processed the next step is to select the routing path to carry the information to the sink node. In this paper the power conservation, target prediction and reducing the latency (delay) are some of the main constrain. So we proposed Probability-based Prediction and Sleep Scheduling protocol (PPSS) and Anycast protocol to improve the power efficiency of proactive wake up and to reduce the latency (delay) in the wireless sensor network. Anycast protocol will reduce the expected one-hop-delay in wireless sensor network. The experiment is carried out in the network simulator and the output result is provided in the video format achieving the power conservation, target tracking and reducing the delay in wireless sensor network.

Index Terms—Power conservation, target tracking, QoS, sleep scheduling, anycast, delay, wireless sensor network.

1. INTRODUCTION

Wireless sensor network is used in many application and one of the typical application is the mobile target tracking. The wireless sensor node is small in size and hard to recharge once deployed [1].

In military application the main goal of the sensor node is to track the mobile target. Unlike prediction that studies target prediction [2], [3], target tracking system should ensure a continuous monitoring with low prediction delay [4], [5] (or) high coverage area [6]. Once the mobile target is predicted the sensor node should report to the sink node without loss in the tracking performance. In WSN the QoS is consider highly means then the power Conservation is negligible if power conservation is highly considered means then QoS is negligible. Today depending on the application many sensor node have been introduced. The common aspect is most of the probability – based target prediction and sleep scheduling protocol combined with anycast approach. Our proposed work will improve the power efficiency of proactive wake up, with limited loss on the time the sensor node will be put Into idle listening which leads to power consumption [7], in Order to avoid power consumption duty cycling is the most commonly used approaches [8]. The concept of the duty cycle is to put node in sleep state and wake them up periodically. In some case, based on the demand the node is forced to sleep or awakened. This is known as sleep scheduling [9]. The most commonly existing efforts about proactive wake up will simply awaken all the near by nodes in the area[6], [10], [12], where the target is expected to arrive and it is not necessary to put all the nearby nodes in awakened stage for target prediction[11], [13], [14]. So in order to reduce the power consumption for proactive wake up we go for sleep– scheduling [9]. This paper will focus on the sleep scheduling approach and anycast protocol approach [16]. To the best of our knowledge this may be the first paper with the concept of tracking performance and reducing the delay. The delay reduction will leads to power conservation. The target prediction approach is based on kinematics rules and theory of probability [12], [14], [15]. Once

the target is predicted based on the result, PPSS enhances power efficiency by reducing the number of proactively awakened nodes and controlling their active time in an efficient manner. We designed the flow chart for PPSS that run on every node. The concept of anycast protocol will select any one node from the awaken nodes based on the count of node to the sink node (i.e., the particular node will be selected based on the minimum count between the node to the sink node).

The efficiency of the PPSS is compared with the existing approaches like circle-based proactive wake up method (circle) [6], and the minimal contour tracking algorithm (MCTA) [12]. It is clear that PPSS provide around 25-45 percent on power conservation. Compared to MCTA it will provide 16.9 percent of power conservation [15].

We analysis the efficiency of PPSS any anycast protocol with simulation – based experiments that is carried out in the network simulation tool, which is represented by the video format. This paper contributed on

1. Designing a target prediction scheme based on both kinematics rules and theory of probability, here the power efficiency of proactive wake up with both awakened node reduction and active time control efforts.
2. Design flow of PPSS, which run on every node.
3. We designed a anycast protocol to carry the information to the sink node.

The upcoming section of this paper is organized as follows. In section 2, we presented the related works. In section 3, we provided the system architecture and the design flow. In section 4, we design the anycast protocol. In section 5, we had given the experimental result. Finally in section 6, we conclude the paper with the future work.

2. RELATED WORKS

In wireless sensor network power conservation and delay reduction is one of the attracted areas. So many research works had been done in recent years. The major application of the WSN is the target prediction and it is been widely studied. In [1], the authors proposed the PPSS for the target prediction and power conservation in WSN. In major application the role of the senor node is to keep track the mobile object continuously. Many of the existing research work are done on continuous target tracking and not focused on power conservation.

The mobile target has been predicted based on existing several algorithm like “circle-based method” (circle) and the minimal contour tracking algorithm (MCTA). These both will be similar in sleep scheduling pattern. While this algorithm put all the nearer nodes into active state. So that the mobile target is predicted continuously but power conservation is negligible. In the wireless sensor network every nodes is placed based on the x-axis and y-axis. Using GPS [20], the location of each and every node is well known to each other.

In [6], the author C.Gui explained about the target tracking using “circle-based method”. The concept behind is all the nodes are deployed on the circle basis. In “circle-based method” they do not go for the direction and distance of the target. Once the mobile target is predicted all the nodes in the circle pattern will follows the same sleeping pattern (i.e. all the nodes are in awakened state) and the tracking performance will be high.

The author Jeong.J in [12], explained about the MCTA algorithm depend on the kinematics to predict the tracking areas, as well as by reducing the active node compared to the “circle-based method”. The MCTA algorithm reduces the active node much smaller than that of the “circle-based method” without differentiated sleep scheduling. MCTA algorithm holds the continuous mobile target tracking and clears the way for power conservation.

Generally the mobile target prediction scheme includes Bayesian estimation method [17], [19], dynamics-based prediction [18], and kinematics-based prediction [12], [14]. The most widely used method is the kinematics-based prediction only.

The author in [17], [19], explained that the Bayesian estimation method will find new measures to modify the past states as well it can able to predict the future states, but the power conservation is not achieved by sleep scheduling. The example of Bayesian estimation is the particle filtering [17], [13], based on the distance the location is fixed and then going for the sleep scheduling as similar to the “circle-based method”. In [18], R.M.Taqi, explained about the dynamics-based prediction. It predicts the exact location at where the target is moving, but does not consider all the available possibilities. In [12],[14], the authors explained about the kinematics-based prediction. It explains about the motion of object without considering the causes for the motion, example is MCTA algorithm and prediction-based energy saving scheme (PES) [14].

Compared to the existing method the PPSS uses kinematics and theory of probabilities for target prediction and the power conservation. In this the alarm node will predict the mobile target and it will send the alarm message to all the nodes in the cluster. Based on the alarm message the node near to the mobile target is put into active mode and all other nodes in the cluster are forced to sleep mode. The nearer node to the mobile target will keep on tracking with some limited loss and achieving the power conservation. The alarm message consists of the ID and the position of the alarm node (based on x-axis and y-axis), the state vector state (n) and the predicted result. Once the target is predicted the node has to forward the information to the sink node. For the sensor node the sensing area will be small and communication range will be larger. If the existing

routing method like unicast and broad cast method are there, but some problem exist. In unicast the information will be carried out in a single path. If any one of the node fail means then the information to the sink node will fail and so no acknowledgment to the source node. Again the retransmission process will be carried out leads to power consumption. At the time of the traffic also the acknowledgment will be delay and leads to retransmission. This is the problem that we are facing in the unicast protocol. The next technique is the broad cast method, in this method the data will be received to the sink node. Here also power conservation is a problem. Compared to unicast the broad cast technique will achieve higher degree of data efficiency. If we use this technique at the sink node same data will be receiving many time because due to broad cast in nature, but only one time the actual date is accepted and all other copy of that data are been deleted. In the deterministic routing protocol the next hop is a fixed one. So the sending node must wait the next hop to wake up, here there will be delay. The node between the sending first nodes to the sink node will be in maximum number. The major problem with the deterministic routing protocol is the maximum delay. Here the path is already determined and no change of path under any condition (i.e., like node failure or at the time of congestion). The entire nodes in the path have to be waiting for the next node to wake up. So in order to reduce the delay and to overcome the problem we proposed Anycast technique. The concept behind is that it will select any one of the awakened node from the available node and start passing of the information in that path. Selection of that particular node will depend on the minimum count of the node to the sink node, here the data is send to the sink node and the power conservation is also achieved

3. PPSS DESIGN FLOW

In this part we are going to see the system architecture assumptions, PPSS protocol and the design of anycast protocol.

3.1System Architecture Assumptions

We consider the wireless sensor network work in a duty cycle mode (i.e., periodically on and off). Every node will have different active time. Communication will be based on the MAC protocol [29].

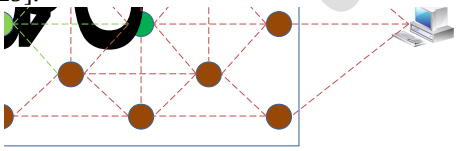


Fig. 1. System architecture.

In the cluster every node is been placed with respect to the x-axis and y-axis. Every node will know their location using GPS [30]. Once the mobile target is been predicted then the target location is determined by either sensing or by calculation [10], [24]. The sensing radius is termed as ‘r’ and the communicating distance is termed as ‘R’. R will be greater than ‘r’ by twice are even more.

When the target is predicted the alarm node in the cluster will send the alarm message to the entire neighbor node based on the predicted result the nearer node will put into active and the other entire node will be put into sleep.

In this paper, we consider the mobile target tracking and the tracking information about the target is been send to the sink node.

3.2 PPSS Design Chart

The PPSS flow chart is designed based on target prediction and power conservation. The network is formed with the PPSS that run in an individual node. If the alarm node predicted the target it will send the alarm message to the entire neighboring node based on the predicted result. The alarm message consists of the ID and the position of the alarm node (i.e. based on the X-axis and the Y-axis) and the predicted result. Once the alarm message is received the entire individual node decides for the awakened node or not. If no, means awakened node is reduced to save power. If yes, means then the schedule sleep pattern is made (i.e. when and how long the node has to be wake up). The predicted information is send to the sink node.

The PPSS has three stages.

1. Target prediction
2. Awakened node reduction
3. Active time

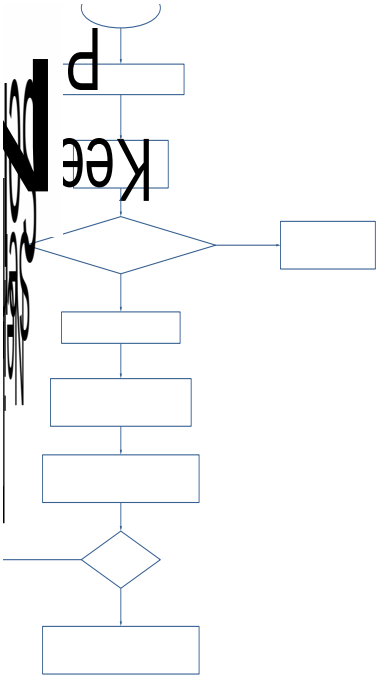


Fig. 2 PPSS flow chart.

4. ANYCAST PROTOCOL DESIGN

Anycast packet forwarding schemes will reduce the one- hop delay under asynchronous sleep–wake scheduling [21], [22].The optimal anycast technique is been proposed to save the power that used to carry the information. The concept behind is that it will select any one awakened node. The particular node selection will depend on the minimum count of the node to the sink node.

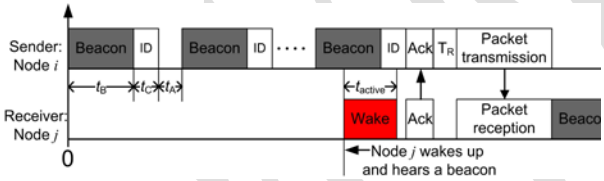
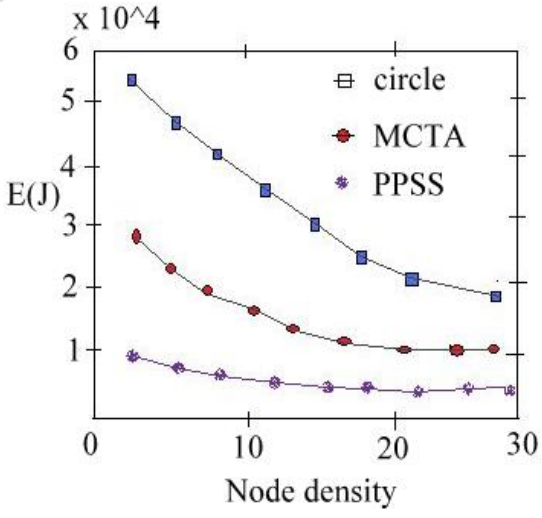


Fig. 3 communication between nodes

The anycast protocol [21], [23] uses the forwarding decision to its neighboring nodes. The work in [24], [25] proposes anycast packet – forwarding protocol. The anycast protocol in [26], [27] make use of the hop- count information (i.e., the number of hops for each node to reach the sink) such that the forwarding decision is taken to reduce the hop count to the sink as soon as possible. In our prior work [27], we developed deterministic routing protocol which will not reduce the end-to-end delay. In the asynchronous periodic wake – up patterns along with an optimal forwarding policy can minimize the expected end-to-end delay. In WSN the node i has a set Ni of neighboring nodes to which node i is able to directly transmit packet when the source node i has a packet to send means it has to wait for the neighboring nodes to wake up. The beacon signal of duration Tb and ID signal of duration Tc as shown in Fig. 3. Then the sender will listens for acknowledgements for duration Ta. This procedure is repeated until it hears an acknowledgement (CTS: clear-to-send) for duration Ta. The beacon signal is continuously send and the source node receives, CTS from all to neighbor and the decision is taken based on the count to the sink node s. The node that has the event information to be send means, first it will send the beacon signal to all the near by node. Until the awakened node receives the beacon signal the sender node will transmit the beacon signal. Once the awakened node receives the beacon signal the receiver node will send back the acknowledgement to the sender. Like this the packets are been forwarded to the neighbor node. Finally the event that is predicted is been send to the sink node. The sink node will be in active state for ever to receive the event information. Once the end-to-end delay is reduced means it leads to the power conservation.

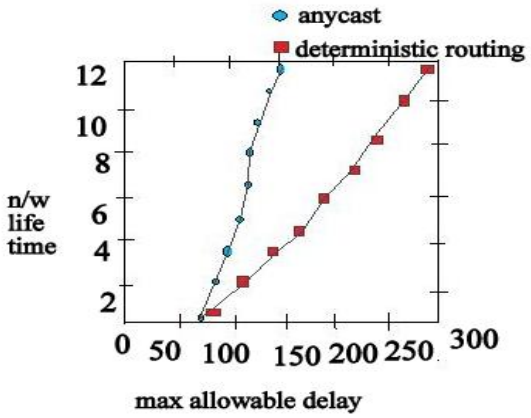
5. SIMULATION RESULT

PPSS protocol with simulation-based result is examined: the simulation was conducted in an environment developed in C++, and the prototype has been simulated using NS2 network simulator. PPSS was compared to Circle scheme [6] and MCTA algorithm [12]. The primary difference among the three protocols is how they reduce the energy consumption for proactive wake up: 1) Circle awakens all the one hop neighbors of the alarm node, thus consumes the most energy; 2) MCTA compresses the area where nodes are awakened, but still awakens every node in the area; and
3) PPSS compresses the awaken region, awakens selected nodes only, and further reduces their active time.



Compare to the all other algorithm used PPSS algorithm consume low power only. So the power conservation by PPSS is been achieved. Once the mobile target is been predicted the event information is carried out to the sink node by the anycast protocol. The end-to-end delay is been reduced by using anycast protocol. It is compared with the

deterministic routing where the delay is high compared to the anycast protocol.



6. CONCLUSION AND FUTURE WORK

The duty-cycle in the sensor network and the sleep scheduling of the PPSS algorithm reduces the awakened node reduction and the power is conserved. There is a small delay in the continuous target of the mobile target but the power is been conserved. Once the target is been predicted the event information is been send to the sink node by the optimal anycast protocol. While the end-to-end delay is been reduced which leads to the power conservation. In future we are trying to implement this concept and may go for the research with receiver based multicast with relay point. We assume that it will still reduce the end-to-end delay.

REFERENCE

[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless Sensor Networks: A Survey," Computer Networks, vol. 38, no. 4, pp. 393-422, 2002.

[2] Q. Cao, T. Yan, J. Stankovic, and T. Abdelzaher, "Analysis of Target Detection Performance for Wireless Sensor Networks," Proc. Int'l Conf. Distributed Computing in Sensor Systems (DCOSS), pp. 276-292, 2005.

[3] G. Wittenburg, N. Dziengel, C. Wartenburger, and J. Schiller, "A System for Distributed Event Detection in Wireless Sensor Networks," Proc. Ninth ACM/IEEE Int'l Conf. Information Processing in Sensor Networks (IPSN '10), pp. 94-104, 2010.

[4] T. He, P. Vicaire, T. Yan, L. Luo, L. Gu, G. Zhou, R. Stoleru, Q.Cao, J.A. Stankovic, and T. Abdelzaher, "Achieving Real-Time Target Tracking Using Wireless Sensor Networks," Proc. 12th IEEE Real-Time and Embedded Technology and Applications Symp. (RTAS'06), pp. 37-48, 2006.

[5] Q. Cao, T. Abdelzaher, T. He, and J. Stankovic, "Towards Optimal Sleep Scheduling in Sensor Networks for Rare Event Detection," Proc. Fourth Int'l Symp. Information Processing in Sensor Networks, p. 4, 2005.

[6] C. Gui and P. Mohapatra, "Power Conservation and Quality of Surveillance in Target Tracking Sensor Networks," Proc. 10th Ann. Int'l Conf. Mobile Computing and Networking, pp. 129-143, 2004.

[7] G. Lu, N. Sadagopan, B. Krishnamachari, and A. Goel, "Delay Efficient Sleep Scheduling in Wireless Sensor Networks," Proc. IEEE INFOCOM, vol. 4, pp. 2470-2481, Mar. 2005.

[8] Y. Gu and T. He, "Data Forwarding in Extremely Low Duty-Cycle Sensor Networks with Unreliable Communication Links," Proc. Fifth Int'l Conf. Embedded Networked Sensor Systems (SenSys '07), pp. 321-334, 2007.

[9] Y. Wu, S. Fahmy, and N. Shroff, "Energy Efficient Sleep/Wake Scheduling for Multi-Hop Sensor Networks: Non-Convexity and Approximation Algorithm," Proc. IEEE INFOCOM, pp. 1568-1576, May 2007.

[10] X. Wang, J.-J. Ma, S. Wang, and D.-W. Bi, "Cluster-Based Dynamic Energy Management for Collaborative Target Tracking in Wireless Sensor Networks," Sensors, vol. 7, pp. 1193- 1215, 2007.

[11] J. Fuemmeler and V. Veeravalli, "Smart Sleeping Policies for Energy Efficient Tracking in Sensor Networks," IEEE Trans. Signal Processing, vol. 56, no. 5, pp. 2091-2101, May 2008.

[12] J. Jeong, T. Hwang, T. He, and D. Du, "MCTA: Target Tracking Algorithm Based on Minimal Contour in Wireless Sensor Networks," Proc. IEEE INFOCOM, pp. 2371-2375, 2007.

[13] X. Wang, J.-J. Ma, S. Wang, and D.-W. Bi, "Prediction-Based Dynamic Energy Management in Wireless Sensor Networks," Sensors, vol. 7, no. 3, pp. 251-266, 2007.

[14] Y. Xu, J. Winter, and W.-C. Lee, "Prediction-Based Strategies for Energy Saving in Object Tracking Sensor Networks," Proc. IEEE Int'l Conf. Mobile Data Management, pp. 346-357, 2004.

[15] Bo Jiang, Binoy Ravindran and Hyeonjoong Cho "Probability-Based Prediction and Sleep Scheduling for Energy-Efficient Target Tracking in Sensor Networks" IEEE Transaction on mobile computing, vol. 12, NO. 4, April 2013.

[16] J. Kim, X. Lin, N. B. Shroff, and P. Sinha, .On Maximizing the Lifetime of Delay-Sensitive Wireless Sensor Networks with Anycast,. in *Proceedings of IEEE INFOCOM*, (Pheonix, AZ), April 2008

[17] S. Arulampalam, S. Maskell, N. Gordon, and T. Clapp, "A Tutorial on Particle Filters for Online Nonlinear/Non-Gaussian Bayesian Tracking," IEEE Trans. Signal Processing, vol. 50, no. 2, pp. 174-188, Feb. 2002.

[18] R.M. Taqi, M.Z. Hameed, A.A. Hammad, Y.S. Wha, and K.K. Hyung, "Adaptive Yaw Rate Aware Sensor Wakeup Schemes Protocol (A-YAP) for Target Prediction and Tracking in Sensor Networks," IEICE - Trans. Comm., vol. E91-B, no. 11, pp. 3524-3533, 2008.

[19] Y. Zou and K. Chakrabarty, "Distributed Mobility Management for Target Tracking in Mobile Sensor Networks," IEEE Trans. Mobile Computing, vol. 6, no. 8, pp. 872-887, Aug. 2007.

[20] J. Highstower and G. Borriello, "Location Systems for Ubiquitous Computing," Computer, vol. 34, no. 8, pp. 57-66, Aug. 2001.

[21] M. Zorzi and R.R. Rao. "Geographic random forward (GeRaF) for ad hoc and sensor networks: Energy and latency performance," IEEE Trans. Mobile Comput., vol. 2, no. 4, pp.349-365, oct.2003.

[22] J. Kim, X. Lin, N. B.Shroff, and P. Sinha, "Minimizing delay and maximizing lifetime for wireless sensor network with anycast," IEEE/ACM Trans. Netw., vol.18, no.2, pp. 515-528, Apr. 2010

[23] S. Lin, K. W. Fan, and P. Sinha, "CMAC: An energy efficient MAC layer protocol using convergent packet forwarding for wireless sensor network," in Proc. IEEE SECON, San Diego, CA, Jun. 2007, pp. 11-20

[24] R. R. Choudhury and N. H. Vaidya, "MAC-Layer anycasting in ad hoc networks," SIGCOMM Comput. Communication. Rev., vol. 34, pp. 75-80, Jan. 2004

[25] S. Jain and S. R. Das, "Exploiting path diversity in the link layer in wireless ad hoc networks," in Proc. WOWMOM, JUN. 2007, PP. 22-30.

[26] P. Larsson and N. Johansson, "Multiuser diversity forwarding in multihop packet radio networks." in proc. IEEE WCNC, 2005, vol. 4. Pp. 2188-2194.

[27] Joohwan Kim, Xiaojun Lin, Ness B. Shroff, and Prasun Sinha. "Maximizing the Life tisme of the delay Sensitive Wireless Sensor Network, anycast".