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Interference Minimization Protocol in Heterogeneous Wireless Sensor Network for High Quality Data Transmission

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ABSTRACT
High-quality data transmission is the primary objective of WSN for achieving quality of service. Heterogeneous wireless sensor networks (HTWSN) can be used to deploy in sensitive and unmanned areas to monitor the objects. HTWSN is high configured network used to capture high-quality images and videos of targeted objects. During the data transmission in HTWSN, we identified that, the formation of interference with in the network due to link capacity overhead. Due to that, the quality data transmission is not possible through the network. In this research paper, we described the deployment of HTWSN network and identifying the primary sources for interference and introducing the proposed Interference Minimization Protocol (IMP). The IM protocol has achieved better quality of service by minimizing the interference in HTWSN.
Keywords – Wireless Sensor Networks, Interference Minimization Protocol, Heterogeneous WSN.

I. INTRODUCTION

Wireless sensor network (WSN) is an emerging technology consists of small sensor nodes having low power, limited communication and computing capabilities. Heterogeneous and homogeneous are two modes of deployments in WSN. Heterogeneous WSN (HTWSN) is having distinct configured sensor nodes which are highly effective and economical for military applications as compared to homogeneous WSN (HOWSN). HOWSN is having low configured sensor nodes which may not handles complex events for longer duration. HTWSN consist of few sensors are highly capable in terms of sensing, computation, wireless communication. These nodes are having electro optic capability [1] to capture the images and videos of sensor targeted objects [2]. Large numbers of low configured sensors are deployable as intermediate nodes (IN) in HTWSN. All these devices cooperatively establish the HTWSN to monitor targeted objects from remote locations and transmit the sensed data to destination node (DN) over flexible network architecture. However, interference is the major problem results data collision, high packet drop and high end to end delay and minimization of network life time. Due to the interference [3], the HTWSN will become useless for user community.

II. RELATED WORK

Jenn-yue Teo [1] proposed I2MR protocol for minimization of interference by discovering the node dis-joint multiple paths for load balancing. Gerla and Xu [2] propose the deployment of large-scale sensor network with deployment of Unmanned Air Vehicle (UAV) for high rate of streamlining in WSN. Jain et al [3] considered the effects of interference in wireless sensor networks. Pearlman et al [4] demonstrated benefits of multipath load balancing for multichannel wireless networks. Nguyen et al had given [5] the electric field lines to select physically separated paths for multi load balancing. Based on the review of all these related works, we propose interference minimization protocol in HTWSN.

III. HTWSN DEPLOYMENT

Large numbers of low capable sensor nodes (LCSN) and few number of high capable sensor nodes (EOSN) are air dropped into area of operation (AO). The nodes can establish the network with provided bandwidth and frequency by unmanned air vehicle (UAV) or base station. The High-power gateway sensor nodes (HPGSN) are known as DN or sink nodes are located near the HTWSN to receive the data to forward the control station (CS). DN nodes are capable of linking up the ground HTWSN and UAV. When targeted objects may enter into the AO, EOSN of respective location can start to capture the images of the enemy object images of object. This information can forward to the DN through LCSN in multi hop mode through the shortest routes for efficient load balancing [4]. The data DN receives the data from HTWSN and forwards to control station (CS) through UAV. The received data at CS can helps to take intelligent decisions.

IV. PROBLEM STATEMNT

4.1 Identifying Interference in Heterogeneous WSN

After deployment of HTWSN, source nodes (SNs) can start the sensing the enemy objects' data. The SNs can send the data packets to intermediate nodes (INs) which are in the active route towards DN. The IN nodes receive the data and send to DN through multi hop mode. Due to simultaneous data packets transmission by multiple SNs to intermediate nodes, the interference can exists at any IN with in the network. Because all the nodes within the network are sharing same wireless medium. Once if any node experiences the interference, it can lose its healthy physical properties like quick discharge of battery, poor performance, high packet dropping and high end to end data delivery [13]. Consider the network with two sender nodes SN_1 and SN_2 , IN_n is intermediate nodes DN sensor nodes, CL_n is communication links between nodes, RP_n is routing path and total number of nodes are N.

$$N= \Sigma(SN_n + IN_n) \text{ where } n>=1 \qquad (1)$$

$$RP_{(SN\ n\ to\ DN)} = \Sigma\ (CL\ n)\ +\ IN\ n,\ n >= 1 \qquad (2)$$

Node level interference [14] is Ω and estimated based on the link capacity α between the node N_i and its sender node SN_i. α is estimated as

$$\alpha = 1/ (P_s + A_s) \qquad (3)$$

P_s is the number of packets successfully transmitted through the link and A_s is number of successful acknowledgements received by SN_I from N_i. if the data packet delivery through the link is beyond its capacity leads to interference. So each node with in the network should have to estimate the required number of data packets to transmit through the link based on the pre estimated link capacity. The data packet delivery overhead over link is β, δ is the total number of packets transmitted during the data delivery process, γ is the number of data packets successfully received at receiver node. β = δ / γ where β=1. If the β is exceeding the value 1 which indicates the link between the two sensor nodes are experiencing interference.

V. INTERFERENCE MINIMIZATION PROTOCOL (IMP)

IMP in heterogeneous Wireless Sensor Network can efficiently estimates the link capacity of each link between the any nodes. IM protocol can consider the following assumption as static HTWSN, location of SN and DN are known, single radio channel and uniform transmission range for all the sensor nodes. The IM protocol can estimate the link quality of each link which is exists between the nodes in active route. Based on the link quality factor, the nodes can estimates the required number of data packets delivery through the link to its neighboring nodes. The data delivery ratio Π = γ / δ. When simultaneous data transmission takes place through routing paths within the network, the nodes and their communication links are affecting highly with interference [9]. IM protocol can estimates the interference factor on each link [8]. Based on the estimation of IF value for the link, the IM protocol can decides the number of data packets can be released through it. When the nodes IF value is higher than defined threshold value of the link, IM protocol concludes the link is poor quality link. Many routing protocols like AODV [7], DSR, DSDV and I2MR don not consider the link quality during the data delivery phase. Even though the efficient route established in WSN, but link quality will not consider which results poor quality of service [12]. However, IM protocol identifies the total number of nodes N and their communication links CL_n. There are three types of links active, passive and hybrid. Active link is communication links in between the active nodes, whereas passive link quality means communication links between the nodes which are not involving in the route. Hybrid links means the links between active and passive nodes. IM protocol can mainly focus on the active links. The sender node communication area is C_A. The C_A can be divided in to three equal regions as C_{A1}, C_{A2}, C_{A3}. The sender sensor node estimates the distance D from itself to receiver node. If D value is $0>=D<= C_{A1}$, the sender node can have good communication link and D value is $C_{A1}>=D<= C_{A2}$, the communication links is moderate. D value is $C_{A2}>=D<= C_{A3}$, the communication links is weak. IM protocol prefers the moderate communication links MCL_n to maintain the better communication link quality and optimized routes. During the neighbor node discovery phase, nodes can start the identification of each node within the network. In this phase the Hello message can be broadcast in the network. T_1 is the time of Hello message sent by the sender node. T_2 is the tome of reply Hello message received by sender node form receiver node.

$$T_D = T_2 - T_1 \qquad (4)$$

If T_D is higher than threshold time T_T the link quality of MCL $_n$ is low MCL $_L$. The T_D is equals to T_T the link quality moderate MCL $_M$ and T_D is less than T_T, the link quality is high MCL $_H$. So IM protocol is prefers the MCL $_H$ for high quality data delivery. But many times high quality links may not available within the network for route constructions. During the situation, it is highly essential to estimate the link capacity. The link capacity α can estimate through equation 3.

VI. RESULT ANALASIS

All of our experiments are conducted based on simulations with static heterogeneous wireless sensor network. IM protocol is implemented in GloMoSim simulator [15]. Consider the scenario with heterogeneous sensor nodes in 1000*1000 terrain area dimension. The type of deployment is random deployment and no mobility of the nodes. The propagation limit is -111.0; noise level is 10 and radio type is used as RADIO-Accnoise, which is stander radio model and available bandwidth is 244.14KB, frequency 2.4 GHz ISM. The routing protocol is interference minimization protocol (IMP) where the interference zone hot spot nodes and links are identified in HTWSN. With this mechanism, the energy consumption and traffic load is minimized. Figure 1, describes the interference level at node in the network without IM protocol by introducing single and multiple events in to the network. We observed that, the nodes experienced high interference. Figure 4, represents the interference minimization with IM protocol at node and link level. IM protocol has given satisfactory results for single and multiple events during high traffic conditions also. The energy consumption can also estimate at each node with the IM protocol and with IM protocol. Figure 3 and 4 are represents the energy preservation with IM protocol. IM protocol has given satisfactory results to extend the network lifetime.

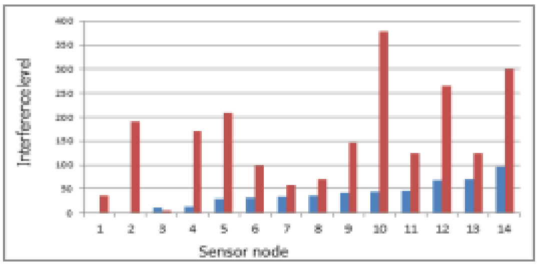

Fig 1. Interference level of a sensor node in HTWSN with single events (blue color) and multi events (red color)

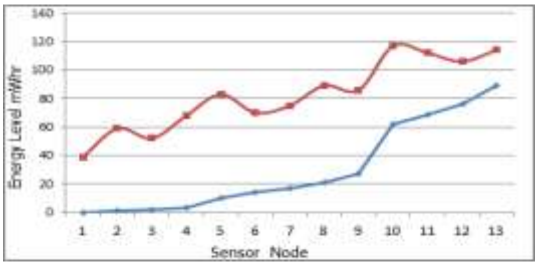

Fig: 2 Energy Consumption due to interference with single events (blue color) and multi events (red color)

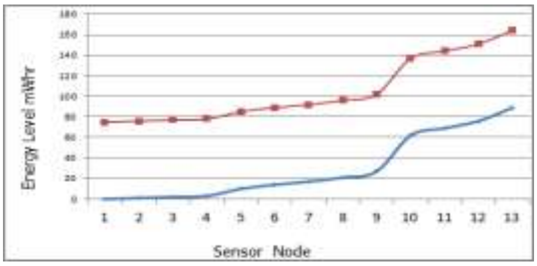

Fig: 3 Energy Consumption with IM protocol in HTWSN with single events (blue color) and multi events (red color)

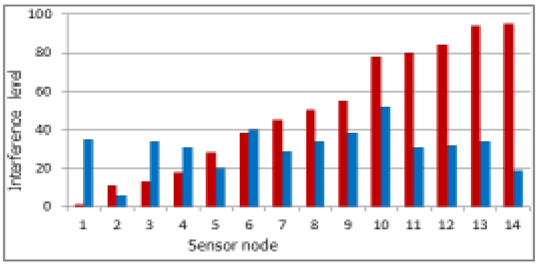

Fig: 4 Interference minimization with IM protocol in HTWSN with single events (blue color) and multi events (red color)

VII. CONCLUSION AND FUTURE DIRECTIONS

Interference minimization protocol (IMP) has implemented successfully for heterogeneous WSN environment. It is tested with various simulation parameters like single and multiple events detection. The IM protocol has given satisfactory results in terms of energy saving and performance in heterogeneous WSN environment at variable data traffic load. We are extending our research work on the proposed protocol to improve the performance by increasing the node density up to 500 nodes.

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