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Mobile Clustering Algorithm for Effective Clustering in Dense Wireless Sensor Networks

Hamid Ali Abed Al-Asadi

Professor, Department of Computer Science, Faculty of Education for Pure Science, Basra University, Iraq
865.hamid@gmail.com

ABSTRACT

A wireless sensor node is poised by a sensor, processor, confined memory, transceiver and a low-powered battery. To lessen the data communication period and energy intake, the sensor nodes are accumulated into a quantity of minute clutches denoted as clusters and the occurrence is mentioned as clustering. Essentially, clustering could be categorized into centralized, distributed and hybrid clustering methodologies. In centralized clustering method, the cluster head (CH) is immobile. The rest of the sensor nodes in the cluster deed as cluster member nodes. In case of distributed clustering mechanism, the CH is not static. The CH keeps on fluctuating form one sensor node to another sensor node within the cluster on the base of few fixed constraints. Hybrid clustering is the grouping of both centralized clustering and distributed clustering mechanisms. A dynamic clustering algorithm for mobile wireless sensor networks, the mobile clustering mechanism (MCM) has been examined and analysed appropriately. The anticipated method is hierarchical, dynamic and energy efficient algorithm. This system displays numerous clusters, with each clusters having a unique CH and two deputy CHs. The sensors start gathering the data only when the base station approaches in range with the cluster head. The performance of the projected algorithm has been assessed against the present LEACH-Mobile algorithm. This approach displays a large decrease in average communication energy and node death rate. The network lifetime has been extended by assimilating the fresh concepts to the proposed methodology, thereby finds valuable when both the nodes and the base station are moderately moveable.

Key words: Wireless sensor network, cluster head, energy efficiency, base station, routing efficiency, clustering efficiency, network lifetime, distributed clustering

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INTRODUCTION

Wireless sensor network is skilled for retrieving real-world data about the corporeal atmospheres. Few placements of wireless static sensor network are done by means of Berkley smart dust, micro-Adaptive multi-domain power aware wireless sensors and integrated sensor networks. In static wireless sensor network, scarce restrictions like mobility is not deliberated thereby mobility becomes the subsequent evolutionary principle to be prudently measured. The dynamic atmosphere of wireless sensor network familiarizes fashionable challenges like data management, correctness, coverage, safety and software pattern. One of the energetic inspections in wireless sensor nodes are the route preservation when the node moves. The traditional protocols for static sensor network are to be improved prudently when mobility is announced. To acquire the evaluation of these protocols, the mobility configurations and mobility metrics have to be individually deliberated. In this research work, an enhancement over the LEACH-M protocol has been projected, which is appropriate for mobile wireless sensor networks (MWSN). The proposed clustering algorithm, the mobile clustering mechanism (MCM) has been well-evaluated to provision mobility [1]. This is a hierarchical one, and the idea of cluster head panel has been engaged in the proposed algorithm to lessen re-clustering period and energy feasting. By engaging these methods to the proposed algorithm, the energy efficiency and network lifetime of the sensor nodes have been found to be significantly extended.

The marvel of grouping the sensor nodes into small-sized clusters is named clustering. Every cluster would have a leader, frequently discussed to as cluster-head. The cluster membership might be motionless or variable. Clustering has some strange benefits like supporting network scalability, localizing the route setup within the cluster, preservation of communication bandwidth, alleviating the network topology at the level of sensors, employment of enhanced

management policies to extend the battery life of distinct sensors and accumulation of the composed data by the sensors in its cluster [2-6].

Very fundamentally clustering mechanism in wireless sensor network could be categorized in to centralized, distributed and hybrid clustering methods. Fig. 1 reveals the dissimilar groupings of clustering mechanisms in wireless sensor network. The centralized clustering is the one in which, a central design is used in the clustering procedure with a static cluster head and the left over nodes in the cluster act as cluster member nodes. Distributed clustering is the process in which, there is no static central CH and this retains on altering from one node to another node based on few constraints. Hybrid clustering mechanism is the one which is shaped by the grouping of both the above stated mechanisms. When centralized design is used in wireless sensor network and if the dominant node fails, the whole network will ruin and hence there is no assurance for consistency in centralized clustering mechanism as pointed out by Murugananthan et al 2005. The dependability of wireless sensor network could be much enhanced by using a distributed manner as stated by Noritaka et al 2009. As there in no centralized body to assign the resources, they have to be self-organized which could be obviously agreed from the mechanisms carried out by Sedghani and Lighvan 2014.

Concentrating on these expected compensations of distributed algorithms above centralized algorithms, some of the present distributed clustering algorithms have been deliberated in this paper with their topographies. This segment concisely summaries the associated works in mobile wireless sensor network and enhancements of LEACH protocol.

In common, the movement of sensor nodes perquisites the sensing exposure as worked out by Liu et al 2005. Few methods like the Robotic Fleas project in Berkeley, the Robomote and the Parasitic Mobility efforts to permit movement in wireless sensor network as confirmed by Laibowitz and Paradiso 2005. The data mule method could be used to powerfully gather the information by plummeting information delivery latency with unadorned minutest energy consumption in mobile sensor network (MSN) as expressed by Anastasi et al 2007 and Ekici et al 2006.

One real world solicitation of MSN is the Adaptive Sampling and Prediction (ASAP) in which a navy of submarine mobile sensor nodes accomplishes and gathers the dimensions of ocean deprived of any human involvement. An adaptive navigation system has been invented, in which the sensors armed on vehicles is talented in gathering the real time traffic data and swapping them amid the neighbouring automobiles as framed by Huifang et al 2007 [7-10].

A mobility administration service layer in the Sensor-Net Protocol has been realized, which is a cross layer method and the mobility data is deposited in a catalogue so that it is obvious crossways all the layers as exemplified by Ali et al 2006. An innovative impression called the network dynamics has been examined to bang the mobility management subject which is a preceding exertion to plan the commandments that supervise mobility infuriated by traditional dynamics as explored by Ma et al 2008 [11-14].

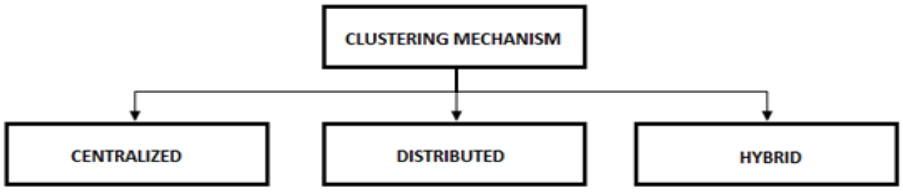

Fig. 1 Groupings of clustering mechanism

PROPOSED METHODOLOGY

The wireless sensor nodes are all alike in hardware capability, software capability and proficiencies. Originally all the wireless sensor nodes have identical quantity of primary energy of 1 Joule, but after some period of time of process, the sensor nodes could be left with unsatisfactory energy stages. The wireless sensor nodes as well the BS are temperately moveable. The BS is extremely dependable and ingenious. After placement of wireless sensor nodes in the arena, the arena is rationally separated into logical clusters. The BS customs these clusters and each cluster comprises one CH node and two secondary deputy CH (DCH) nodes. Communication takes place in graded fashion from wireless sensor node to the BS over the CH. The communication amid a CH node and BS will be in multi-hop style dependent on the condition. The assortment of sensor nodes for numerous characters such as CH or deputy CH will be supported at the BS level.

The important goal of this exertion is to enterprise an energy efficient clustering procedure for MWSN that functions in unattended and sometimes in aggressive surroundings. As the wireless sensor nodes are resource inhibited (particularly imperfect energy and imperfect on-board storage), the procedure should ingest low power and should not load the sensor nodes with storing overhead. The procedure should safeguard that connectivity is upheld in the sen-

sor network and in occurrence of link or node catastrophe it should be accomplished by posing all alternative and possible routes without permitting much deprivation in throughput level at the BS. Most prominently, the lifespan of the WSN should be protracted. In this segment, the mobile clustering mechanism (MCM) has been examined for effective clustering in MWSN, where both the wireless sensor nodes as well as the BS are moderately mobile.

The objective of the proposed procedure is to progress the network lifetime of wireless sensor nodes in the network. In the prevailing procedure (LEACH-M), the wireless sensor nodes keep on sensing the data and directing the data to its CH, and this CH directs the data only when the BS arises in range with the CH. In the projected procedure, the wireless sensors start sensing the data only when the BS emanates in range with the CH. The procedure achieves the energy efficiency of the routes as well as the dependability of the routes. The data packets are routed through numerous multi-hops in order to diminish the transmission energy obligation at the sender nodes. This aid to trim down great quantity of energy and also the battery lifespan of the wireless sensor nodes get augmented.

After the placement of wireless sensor nodes, the BS sets dissimilar wireless sensor nodes into clusters. Each cluster comprises of one CH node and two deputy CH nodes. There are three principles to select the CH: the energy effectiveness of the wireless sensor node, the movement of the sensor node and the convenience to the neighbouring sensor nodes. This procedure is also named as cluster head panel. The sensor nodes direct the data to their individual cluster head. At the CH level, data combination has been carried out to eliminate data dismissal and then the CH onwards the amassed data to the BS. The DCH nodes do numerous cluster organization errands such as mobility observing and also endure prepared to turn as intermediary multi-hop in the occurrence of culpability. The DCH sensor nodes are also called as cluster management nodes.

If the base station detects that the entrance of information packets is smaller than an onset value, then it notifies the conforming CH to plaid the connectivity with its members. The CH deliberates this as response from the base station and therefore draughts the current wireless connectivity with its members. If the current connectivity situation of the members with the CH is appropriately deprived, the base station selects to change the supervision of CH to alternative apposite cluster member from the CH panel previously determined or to one of the deputy CHs liable on the condition. If this fresh CH also efforts out of the coverage range of the BS, the sensed data from the wireless sensor nodes will be progressed to the CH of adjacent cluster, thus the information will be progressed to the BS. If this CH also goes out of assortment with the BS, then the information from the first CH and the data composed from this CH will be progressed to the next adjoining CH. In this condition, this CH directs the information of all the three cluster heads. Since the base station retains on amassing the data, data accumulation will be done by the CH to eliminate data severance.

After the placement of sensor nodes, the chief stage is the self-organization stage. Throughout this segment, clusters are moulded and CH becomes confirmed. The existing CH and DCHs are also nominated by the BS. Originally, the BS gathers the present position information from each wireless sensor nodes and then procedures a wireless sensor field map. Grounded on the velocity of a sensor node, the BS makes an uneven approximation of the region in which the wireless sensor node is profitable to be in the next time interim. The charge of the subsequent time interval can be fixed physically contingent on the kind of application and this custody is treacherous as maximum of the designs e.g., cluster setup cogency period, medium access slot, etc., are reliant on the subsequent time interval. Using this data, the BS calculates the topology. Once the BS generates the wireless sensor field map, it methods the corresponding clusters. The cluster creation method is fairly diffident. The rudimentary knowledge is to support physically invariable and dispersed clusters, so that the coverage is invariable and also the CH nodes are consistently distributed over complete sensor field. Consequently, the whole wireless sensor field is physically and consistently alienated into numerous multiple clusters. After creation of clusters, the BS recognises a set of appropriate sensor nodes which can take the character of CH and DCHs. This assortment is based on increasing credit point received from the three parameters explicitly the enduring energy level of the sensor node, degree of the sensor node and mobility level of the sensor node.

The operator can custom a proper normalization function to compute the swelling credit point received by a wireless sensor node through these three non-homogeneous parameters. An idyllic node apropos for CH role would have advanced enduring energy, advanced degree and squat mobility. The BS then makes the CH panel containing sensor nodes having increasing credit point beyond the onset value. This onset value can be fixed physically at the time of execution, also dependent on the kind of application and normalization function. The sensor node with uppermost credit point is designated as the current CH. The next two sensor nodes in the list with second and third uppermost credit points are chosen as DCHs for the same cluster.

The CH is accountable for gathering information from each wireless sensor nodes. After information collection, the CH conveys out data aggregation on the poised data to eliminate data redundancy. The amassed data is directed to the BS moreover unswervingly or in multi-hop manner based on the communication design distributed by the BS.

The DCH keeps checking the wireless sensor nodes in their cluster and keeps on testing the mobility pattern of the wireless sensor nodes. They are also mentioned as cluster management nodes, as they take the foremost apprehension in gathering the current location information from the cluster members and collaborating it to the BS. Furthermore, in the event of instant link or sensor node failure in the route of CH near the BS, the CH pursues the assistance of one of the DCH nodes to onward the data to the BS.

The CH panel is designated originally and rests useable till re-clustering procedure is started. If the current CH drips out the connectivity with most of its clusters members, due to which throughput at the BS reduces, the CH might be requested to surrender the custody of cluster headship. Even a CH node might sewer out its energy outside an onset value and develops useless, whereas in this state a fresh CH is essential. Under such situations, the BS stretches the charge of headship moreover to one of the two DCHs or to a node from inside the CH panel. This protects huge cost and time tangled in the procedure of picking a CH. An example of fluctuating the charge of cluster headship from CH to DCH is precise noteworthy, as the BS also inculcates the wireless sensor nodes to link the DCH as their fresh CH.

SIMULATION RESULTS AND DISCUSSIONS

For simulation persistence, a wireless sensor network of 30 wireless sensor nodes is randomly organized over an arena of measurement 500 x 500 m^2 area. The sensor nodes change in haphazard ways. The simulation has been performed for a time duration of 1800 seconds. All the wireless sensor nodes are expected to possess equal quantity of initial energy. The initial energy of the wireless sensor nodes is deliberated to be 1 Joule. All the simulation mechanisms have been approved using NS-2. The simulator contains of dissimilar components such as deployment component, topology construction component, mobility management component, medium access control component, routing component, energy expenditure computing component and throughput computing component. The performance of the projected procedure has been appraised in contradiction of LEACH-M in terms of average communication energy, network lifetime and node death rate. Fig. 2 demonstrates the performance evaluation of the projected MCM procedure with LEACH-M, in terms of the average communication energy. Originally at 100 seconds, the average communication energy of LEACH-M is 0.17 Joules and that of MCM is 0.13 Joules. Likewise, at 1800 seconds, the average communication energies of LEACH-M and MCM are 0.28 Joules and 0.18 Joules correspondingly. At a mediocre, the projected MCM procedure displays a decrease of 29.05% in terms of average communication energy when associated to LEACH-M. Thus the average communication energy is instituted to be abridged linearly in MCM, when associated to the present LEACH-M algorithm, which is mostly because of the above stated fresh topographies employed in the projected MCM procedure.

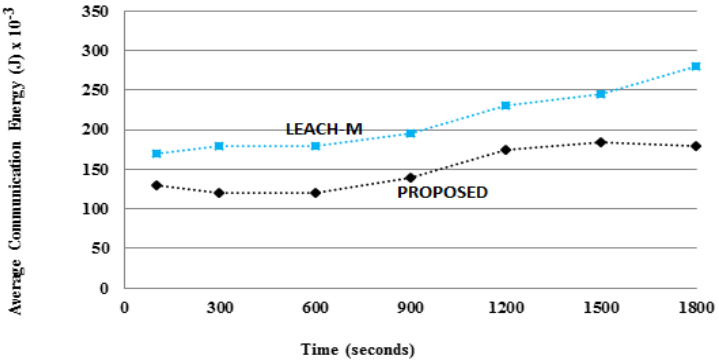

Fig. 2 Average Communication Energy of LEACH-M and MCM

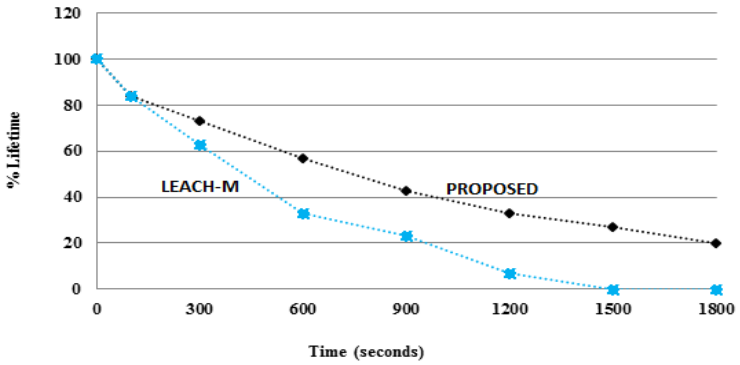

Fig. 3 Lifetime comparison of LEACH-M and MCM

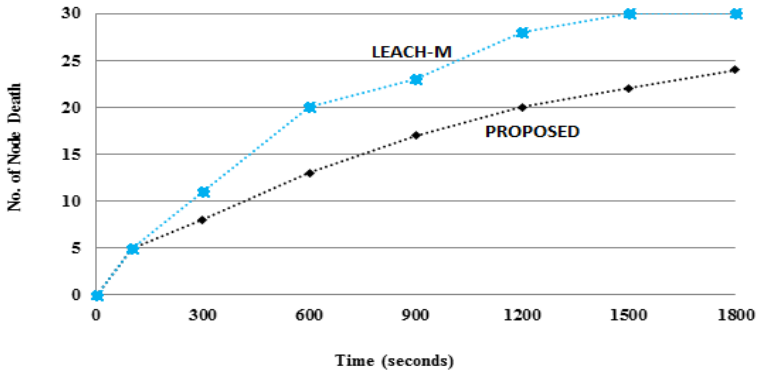

Fig. 4 Node death versus Time (LEACH-M and MCM)

Fig. 3 displays the lifetime assessment of both LEACH-M and MCM procedures. At 100 seconds, the lifetime of both LEACH-M and MCM are 84%. The network lifetime falls quickly in LEACH-M, but in MCM the network lifetime decreases gradually. In 1500 seconds, the lifetime of LEACH-M drips to 0%, but in MCM the lifetime is 27%. At an average, MCM displays 15.87% development in network lifetime when associated to LEACH-M. This lifetime development is mostly due to the fresh ideas engaged in the proposed MCM methodology.

Fig. 4 portrays the assessment of node death for both LEACH-M and MCM. At 100 seconds, the number of node death is merely 5 nodes for both LEACH-M and MCM. Node death is extreme in LEACH-M and at 1500 seconds every node perishes. But in MCM, the node death is fewer and even at the end of simulation process (1800 seconds) 6 nodes are still alive. Thus, MCM displays abridged node death when associated to the existing LEACH-M clustering method.

CONCLUSION

A dynamic clustering algorithm for mobile wireless sensor network, the mobile clustering mechanism (MCM) has been anticipated. The anticipated method MCM is hierarchical, dynamic and energy efficient algorithm for MWSN. In MCM, there are numerous clusters, with each cluster having one CH and dual DCHs. The sensors begin collecting the information only when the base station emanates in range with the cluster head. The enactment of the proposed algorithm has been assessed and associated with LEACH-M. The projected MCM method displays an outstanding decrease in average communication energy. The network lifetime has been importantly amended when associated to LEACH-M. Thus, the projected MCM method has been found to be importantly valuable in terms of energy usage and lifetime, when mutually the wireless sensor nodes as well as the BS are moderately mobile.

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