

Mobile Data Gathering with Load Balanced Clustering and Dual Data Uploading in Wireless Sensor Networks

MR.K.GOUTHAM RAJU¹& MS. B.SASHI BINDU²

¹Assistant Professor Department of CSE Vaagdevi Engineering College, Bollikunta, Warangal, and Telangana State, India.

²M-Tech Computer Science & Engineering Department of CSE Vaagdevi Engineering College, Bollikunta, Warangal, and Telangana State, India.

Abstract: In this project, a framework which consists of three layers is introduced for the mobile data gathering in the wireless sensor networks. The three layers of the framework are given as the sensor layer, clustered head layer, mobile collector layer (also called as SenCar). This framework is made use of with a LBC-DDU, which is called as the load balanced clustering and the dual data uploading. The main aim of employing this project is to get a good scalability and a long lifetime for the required network and for the lower data gathering recess. Now, a distributed LBC algorithm is introduced for the sensors to classify themselves into some parts called clusters by itself, at the sensor layer. To differentiate from the existing clustering models, this project employs many cluster heads in each of the clusters to provide symmetry for the work load and for facilitating the dual data uploading (DDU). At the second layer called the clustered head layer, the difference between the cluster to cluster transmission ranges is observed perfectly and chosen carefully for guaranteeing the connectivity among many no of clusters. Here in this second

layer, the multiple cluster heads which are inside the same cluster layer will cooperate with each other for performing the communications in between two clusters along with saving the energy. Then with these transmissions, the information of these cluster heads is transferred to the SenCar for its moving trajectory planning. Finally, at the mobile collector layer, the SenCar is fitted with two antennas, which enables the two cluster heads for simultaneously uploading the data to the SenCar in each time by using the multi-user, multiple-input and multiple-output (MU-MIMO) technique. This trajectory planning for the SenCar is optimized to fully utilize the ability to perform the DDU by properly selecting the polling points in each cluster. After reaching each selected polling point, the SenCar is made efficiently useful for gathering of the data from the cluster heads and then for transporting the data into the static data sink. Extensive simulations were conducted on this project for calculating the effectiveness of the working of the introduced LBC-DDU scheme. Here, the results obtained have shown that when each cluster layer has

utmost two cluster heads, the LBC-DDU achieves over 50 percentage of saving the energy per node and 60 percent of saving the energy on the cluster heads when compared with the data gathering through multi-hop relay to the static data sink, and 20 percent of the shorter data collection time when

Introduction:

The generation of the fulfillment of the sensors with the low cost, low powered, and the multi functional capability has made the WSNs an important data collection or data gathering pattern for extracting the local measures of the interests. In all such applications, the sensors are generally arranged at some distant places and randomly distributed over a sensing field and left free or without looking after about its maintenance, which makes it difficult for again recharging or replacing their batteries, after they have been depleted. After the sensors form into the various independent organizations, the sensors which were near to the data sinks will typically deplete their batteries much faster than the others due to the fact that they have more relaying traffic. If the sensors around the data sink deplete their energy completely, then the connectivity of the network and coverage may not be guaranteed. Due to these obstacles, it is important to design an energy efficient data collection or data gathering scheme that consumes the complete available energy uniformly across the sensing field to achieve the long lifetime for a network. In addition to above, as the sensing data in some of the applications is sensitive to time, the data collection or data gathering may be required to perform within a specific period of time-interval. Therefore, an efficient, large-scale data collection scheme should have an objective of good scalability, long lifetime for a network and lower data latency.

we compare with the conventional mobile data gathering.

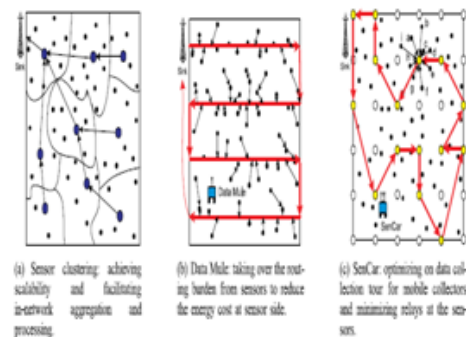
Index Terms: Wireless sensor networks (WSNs), data collection, load balanced clustering (LBC), dual data uploading (DDU), multi-user multiple-input and multiple-output (MU-MIMO) technique, mobility control, and polling points.

Various techniques have been proposed for the efficient data gathering in the literature previously. Based on the focus of those works, we can then classify them into the following three categories. 1) The first category is the enhanced relay routing, in which the data is relayed among the sensors. Besides relaying, some other elements, like the load balance, schedule pattern and the data redundancy are also considered. 2) The second category will be organizing the sensors into the clusters and allow the cluster heads to take the responsibility for forwarding the data to the data sink. Clustering is mainly used for the applications with the scalability requirement and is effective in local data aggregation since it can be used for reducing the collisions and balance the load among the sensors. 3) The third category is to employ the mobile collectors to take the load of the data routing from the sensors (as in Fig. 1b). Although these works provide the effective solutions to data gathering in WSNs, their inefficiencies have been noticed. Specifically, in the relay routing schemes, minimizing the energy consumption on the forwarding path does not necessarily increase the network lifetime, since some of the critical sensors on the path may run out of energy faster than others. In cluster-based schemes, cluster heads will inevitably take much more energy than other sensors due to handling the intra-cluster aggregation and the inter-cluster data forwarding. Though using the mobile collectors may alleviate

the non-uniform energy consumption, it may result in the unsatisfactory data collection/gathering latency. Based on these observations, we introduce a three-layer mobile data collection framework, named as the Load Balanced Clustering and Dual Data Uploading (LBC-DDU). The main motivation is to utilize the distributed clustering for scalability, to employ the mobility for energy saving and uniform energy consumption, and to exploit Multi-User Multiple-Input and Multiple-Output (MU-MIMO) technique for concurrent data uploading to shorten the latency.

The main contributions of this work can be summarized as follows. Firstly, we introduce a distributed algorithm to organize the sensors into clusters, where each cluster has many cluster heads. In contrast to the existing clustering techniques introduced in previous works, this algorithm balances the load of intra-cluster aggregation and enables the dual data uploading (DDU) between multiple cluster heads and the mobile collector. Secondly, many cluster heads within a cluster can collaborate with each other to perform the energy efficient inter-cluster transmissions. Different from the other hierarchical schemes, cluster heads do not relay the data packets from other clusters, which effectively alleviate the burden or load of each cluster head. Instead, the forwarding paths among the clusters are only used to route the small-sized identification (ID) information of the cluster heads to the mobile collector for the optimization of the data collection tour. In the third step, we fix a mobile collector with two antennas (called SenCar) to allow the concurrent uploading from two cluster heads by using MU-MIMO communication simultaneously. Then SenCar collects the data from the cluster heads by visiting each cluster. It will choose the stop locations

inside every cluster and then determines the sequence to visit them, in such a way that the data collection can be done in minimum time. Our work mainly distinguishes from the other mobile collection schemes in the utilization of MU-MIMO technique, which enables dual data uploading (DDU) technique to shorten the data transmission latency. We co-operate the mobility of the SenCar to fully enjoy the advantages of the dual data clustering uploading (DDU), which will ultimately



Lead to a data collection tour with both the short moving trajectory and the shorter data uploading time.

2 ASSOCIATED WORKS:

Relay Routing and Clustering Schemes: Relay routing is a simple and powerful technique to routing messages to the data sink in a multi-hop style. Cheng et al. devised a coordinated transfer time table through selecting alternate routes to avoid congestions. Wu et al. studied the development of a maximum-lifetime information accumulating tree by using designing an algorithm that starts off evolved from an arbitrary tree and iteratively reduces the weight on bottleneck nodes. Xu et al. studied deployments of relay nodes to elongate community lifetime. Gnewali et al. evaluated series tree protocol (CTP) through test beds. CTP computes wireless routes adaptive to wi-fi hyperlink reputes and satisfies reliability,



robustness, performance and hardware independence requirements. But, whilst some nodes at the vital paths are subject to power depletion, data series performance can be deteriorated. Every other approach is to allow nodes to form into clusters to reduce the number of relays. Heinzelman et al proposed a cluster formation scheme, named LEACH, which results inside the smallest anticipated number of clusters. However, it does no longer guarantee top cluster head distribution and assumes uniform electricity consumption for cluster heads. Younis and Fahmy further proposed "HEED," wherein a combination of residual power and price is considered because the metric in cluster head selection.

HEED can produce nicely-allotted cluster heads and compact clusters. Gong et al. taken into consideration energy efficient clustering in lossy wireless sensor networks primarily based on hyperlink satisfactory. Amis et al. addressed d-hop clustering with each node being at maximum d hops far from a cluster head. In those cluster-primarily based schemes, except serving because the aggregation factor for neighborhood records collection, a cluster head also acts as a scheduler or controller for in-community processing.

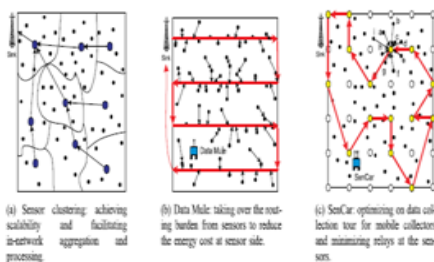
Zhang et al. taken into consideration green scheduling of cluster heads to alleviate the collisions amongst unique transmissions. Gedik et al. and Liu et al. explored the correlation of sensing records and dynamically partitioned the sensor nodes into clusters. The cluster heads utilize the spatio-temporal correlation to decrease the readings for energy saving. However, traditional unmarried-head clustering schemes won't be like minded with mu-mimo. As a result, for generality, we advocate a load-balanced multi-head clustering algorithm.

Cellular data Collections: As compared with facts series via a static sink, introducing mobility for statistics series enjoys the advantages of balancing electricity consumptions inside the network and connecting disconnected regions. Shah et al. investigated mobility below random walk in which the mobile collector choices up statistics from close by sensors, buffers and eventually offloads facts to the wired access point. However, random trajectory can't assure latency bounds that's required in many packages. Jea et al. further proposed to control facts mules to traverse the sensing subject along parallel straight traces and collect records from nearby sensors with multi-hop transmissions. This scheme works nicely in a uniformly disbursed sensor community. To achieve extra bendy records accumulating excursion for cellular collectors, Ma and Yang proposed an efficient shifting path making plans set of rules by means of figuring out some turning factors on the immediately strains, that is adaptive to the sensor distribution and might successfully keep away from obstacles on the course. They as a substitute proposed a single-hop data amassing scheme to pursue the proper uniformity of strength intake amongst sensors wherein a mobile collector called SenCar is optimized to stop at some locations to accumulate information from sensors inside the proximity thru unmarried-hop transmission. The paintings become similarly prolonged in to optimize the statistics accumulating tour through exploring the tradeoff among the shortest transferring tour of SenCar and the full utilization of concurrent information uploading among sensors. Furthermore, Somasundara et al. proposed a set of rules to examine the scheduling of mobile factors such that there's no records loss because of buffer overflow. Despite the fact that these works don't forget utilizing cellular collectors, latency may be

increased because of statistics transmission and mobile collector's journeying time. For this reason, in this paper, we exploit MU-MIMO to reduce facts transmission time for cellular statistics series.

MU-MIMO in WSNs:

The feasibility of employing MIMO techniques in wireless sensor networks is envisioned. Due to difficulties to mount multiple antennas on a single sensor node, MIMO is adopted in WSNs to seek co-operations from multiple nodes to achieve diversity and reduce bit error rate. An overview of MIMO-based scheduling algorithms to coordinate transmissions was discussed. Another challenge in MIMO is that the energy consumption in circuits could be higher than a traditional Single-Input-Single-Output (SISO) approach. It was demonstrated that MIMO can be out performed SISO when the transmission distance is larger than certain thresholds (e.g., 25 m). It was shown that with proper designs of system parameters, significant energy saving can be achieved with MIMO techniques. In our framework, since it is not difficult to deploy two antennas on the mobile collector, when a compatible pair of transmitting nodes and the locations of the mobile collector is given, we can enable MU-MIMO uploading to the mobile collector to greatly reduce data collection latency.



3. SYSTEM OVERVIEW:

An overview of LBC-DDU framework is depicted which consists of three layers: sensor layer, cluster head layer and SenCar layer. The sensor layer is the bottom and basic layer. For generality, we do not make any assumptions on sensor distribution or node capability, such as location-awareness. Each sensor is assumed to be able to communicate only with its neighbors, i.e., the nodes within its transmission range. During initialization, sensors are self-organized into clusters. Each sensor decides to be either a cluster head or a cluster member in a distributed manner. In the end, sensors with higher residual energy would become cluster heads and each cluster has at most M cluster heads, where M is a system parameter. For convenience, the multiple cluster heads within a cluster are called a cluster head group (CHG), with each cluster head being the peer of others. The algorithm constructs clusters such that each sensor in a cluster is one hop away from at least one cluster head. The benefit of such organization is that the intra-cluster aggregation is limited to a single hop. In the case that a sensor may be covered by multiple cluster heads in a CHG, it can be optionally affiliated with one cluster head for load balancing.

To avoid collisions during data aggregation, the CHG adopts time-division-multiple-access (TDMA) based technique to coordinate communications between sensor nodes. Right after the cluster heads are elected, the nodes synchronize their local clocks via beacon messages. For example, all the nodes in a CHG could adjust their local clocks based on that of the node with the highest residual energy. After local synchronization is done, an existing scheduling scheme can be adopted to gather data from cluster members. Note that only intra-cluster synchronization is needed here because data are



collected via SenCar. In the case of imperfect synchronization, some hybrid techniques to combine TDMA with contention-based access protocols (Carrier Sense Multiple Access (CSMA)) that listen to the medium before transmitting are required. For example, hybrid protocols like z-mac can be applied to decorate the strengths and offset the weaknesses of tdma and csma. Upon the advent of sencar, each chg uploads buffered statistics through mu-mimo communications and synchronizes its local clocks with the global clock on sencar thru acknowledgement messages. Subsequently, periodical re-clustering is completed to rotate cluster heads among sensors with higher residual energy to keep away from draining energy from cluster heads.

4. SENSOR LAYER: LOAD BALANCED CLUSTERING: In this phase, we gift the distributed load balanced clustering set of rules at the sensor layer. The essential operation of clustering is the selection of cluster heads. To lengthen community lifetime, we evidently assume the chosen cluster heads are those with higher residual strength. For this reason, we use the share of residual strength of every sensor as the initial clustering precedence.

Initialization Phase: In the initialization phase, each sensor acquaints itself with all the neighbors in its proximity. If a sensor is an isolated node (i.e., no neighbor exists), it claims itself to be a cluster head and the cluster only contains itself.

The pseudo-code describing the initialization phase of a sensor is given in Algorithm 1, and notations used in the pseudo-codes are listed in Table 1 for reference.

STATUS CLAIM: In the second segment, every sensor determines its popularity by means of iteratively updating its nearby facts, refraining from right away claiming to be a cluster head. We use the node diploma to control the most number of iterations for every sensor. Whether or not a sensor can finally come to be a cluster head broadly speaking depends on its priority.

Cluster Forming: The third phase is cluster forming that comes to a decision which clusters head a sensor should be associated with. The criteria may be described as follows: for a sensor with tentative fame or being a cluster member, it would randomly associate itself with a cluster head among its candidate peers for load stability purpose. In the uncommon case that there is no cluster head a few of the candidate peers of a sensor with tentative popularity, the sensor would declare itself and its modern-day candidate friends as the cluster heads. The info is given in set of rules. the very last end result of clusters, wherein every cluster has two cluster heads and sensors are affiliated with exceptional cluster heads in the clusters.

Synchronization amongst cluster heads: To perform records collection by using tdma strategies, intracluster time synchronization amongst mounted cluster heads must be taken into consideration. The fourth phase is to synchronize local clocks amongst cluster heads in a chg by

TABLE 2
Traveling Cost without Time Constraints

Side length l (m)	100	150	200	250	300
Moving cost (m)	347	557	974	1,511	1,846

using

$$P_{SHC} = \mu \cdot \frac{(4\pi)2L}{GtGr \times 2} \cdot \frac{[2(\sqrt{5} + 1)Rs]^2}{\alpha^2}$$



$$\rho^M = \frac{E(P_{SHC})}{E(P_{LBC})}$$

$$= \begin{cases} \frac{4(\sqrt{5} + 1)^2}{(\sqrt{26} + 2)^2 / M^2} \approx 0.83M^2, M > 2 \\ \frac{4(\sqrt{5} + 1)^2}{(\sqrt{17} + \frac{3}{2})^2 / 4} \approx 5.3, M = 2. \end{cases}$$

Beacon messages. First, each cluster head will ship out a beacon message with its preliminary precedence and nearby clock statistics to other nodes inside the chg. then it examines the received beacon messages to peer if the concern of a beacon message is higher. In our framework, such synchronization amongst cluster heads is best accomplished whilst sensor is collecting information, because statistics series is not very frequent in most cellular data accumulating programs, message overhead is definitely do able within a cluster.

$$P_{LBC} = \begin{cases} \mu \cdot \frac{(4\pi)^2 L}{G_t G_r \lambda^2} \cdot \frac{[(\sqrt{26} + 2)R_s]^2}{\sum_{i=1}^{\Delta t} \sum_{j=1}^{\Delta t} a_{ij}^2}, a_t = a_r = M > 2 \\ \mu \cdot \mu \cdot \frac{(4\pi)^2 L}{G_t G_r \lambda^2} \cdot \frac{[(\sqrt{17} + \frac{3}{2})R_s]^2}{\sum_{i=1}^{\Delta t} \sum_{j=1}^{\Delta t} a_{ij}^2} a_t = a_r = M = 2 \end{cases}$$

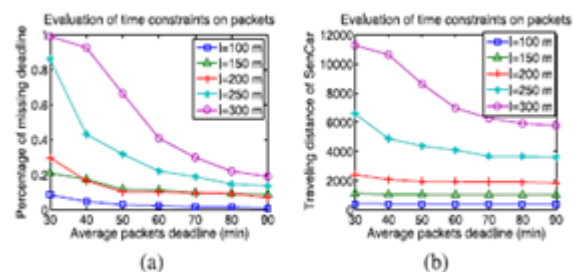
5. CLUSTER HEAD LAYER: CONNECTIVITY AMONGST CHGS:

We now recollect the cluster head layer. As aforementioned, the multiple cluster heads in a CHG coordinate among cluster contributors and collaborate to speak with different CHGs. Consequently, the inter-cluster communicate in LBCDDU is basically the conversation amongst CHGs. By using employing the mobile collector, cluster heads in a CHG need no longer to ahead

statistics packets from different clusters. Instead, the inter-cluster transmissions are most effective used to forward the data of each CHG to SenCar. The CHG records may be used to optimize the shifting trajectory of SenCar, in order to be discussed within the next phase. For CHG information forwarding, the primary problem at the cluster head layer is the inter-cluster agency to make certainly the connectivity amongst CHGs.

Connectivity among CHGs:

The inter-cluster organization is determined by the relationship between the inter-cluster transmission range R_t and the sensor transmission range R_s . Clearly, R_t is much larger than R_s . It implies that in a traditional single-head cluster, each cluster head must greatly enhance its output power to reach other cluster heads. However, in LBC-DDU the multiple cluster heads of a CHG can mitigate this rigid demand since they can cooperate for inter-cluster transmission and relax the requirement on the individual output power. In the following, we first find the condition on R_t that ensures inter-cluster connectivity, and then discuss how the cooperation in a CHG achieves energy saving in output power.



Inter-cluster communications: Next, we talk how cluster heads in a chg collaborate for power-green inter-cluster communicate. We treat cluster heads in a chg as a couple of antennas both within the transmitting and receiving facets such that an equal mimo machine can be built. The self-pushed



cluster head in a chg can either coordinate the nearby statistics sharing at the transmitting aspect or act because the destination for the cooperative reception at the receiving side. Each collaborative cluster head because the transmitter encodes the transmission collection in step with a detailed area-time block code (stbc) to reap spatial diversity. As compared to the single-input unmarried-output device, it's been shown that a mimo gadget with spatial variety results in higher reliability given the same power budget. An alternative view is that for the identical receive sensitivity, mimo structures require much less transmission electricity than siso structures for the same transmission distance. Consequently, given two related clusters, in comparison with the single-head structure, in which the inter-cluster transmission is equal to a siso machine, the multi-head shape in lbc-ddu can store strength for inter-cluster verbal exchange.

6 SENCAR LAYER: TRAJECTORY PLANNING: In this section, we consciousness on a way to optimize the trajectory of SenCar for the data series excursion with the CHG information, that is known as the mobility control at the Sen-car, vehicle layer. As cited in segment three, SenCar could forestall at a few decided on polling factors inside each cluster to gather information from multiple cluster heads via single-hop transmissions. Accordingly, locating the most appropriate trajectory for SenCar may be reduced to finding decided on polling factors for each cluster and figuring out the collection to go to them.

Houses of Polling points: We recollect the case that SenCar is prepared with antennas, as it is not hard to mount two antennas on Sen-car, To assure a success deciphering whilst SenCar gets the blended streams, we need to restriction the number

of simultaneous data streams to no extra than the quantity of receiving antennas. In different phrases, in view that SenCar is equipped with two receiving antennas, at maximum two

cluster heads in a CHG can concurrently ship statistics to SenCar in a time slot. subsequently, an equivalent 2×2 MIMO system for an uplink transmission is shaped, which achieves spatial multiplexing advantage for higher information rate. With such concurrent transmissions, information uploading time can be substantially reduced. If there are always cluster heads that simultaneously add their facts to Sen- automobile in each time slot, records uploading time can be reduce into half in the ideal case.

MU-MIMO Uploading: We jointly consider the selections of the schedule pattern and selected polling points for the corresponding scheduling pairs, aiming at achieving the maximum sum of MIMO uplink capacity in a cluster. We assume that SenCar utilizes the minimum mean square error receiver with successive interference cancellation (MMSE-SIC) as the receiving structure for each MIMO data uploading.

Records series with time constraints: On this section, we, in addition keep in mind the case while there are time constraints on records messages. in exercise, it's miles common place for a few emergent records messages to be added inside a distinctive closing date. If the cut-off date has expired and the message is but to arrive at the vacation spot, it might carry much less value and cause performance degradation. Cellular facts series with dynamic closing date was considered and an earliest deadline first set of rules changed into proposed. of their answer, the cell collector would visit the nodes with messages of the earliest cut-off date. here, we extend and adapt their



solutions to the clustered network. our approach is described in the following. first, the cluster heads acquire data messages and calculate a closing date by averaging all of the cut-off dates from messages in the cluster. all the clusters then ahead their closing date data to sencar. the sencar selects the cluster with the earliest common deadline and actions to the polling factor to collect statistics through mu-mimo transmissions. After sencar finishes data gathering, it tests to peer whether collecting records from the following polling factor would purpose any violations of closing date in its buffer. if yes, it right now moves back to the information sink to add buffered statistics and resumes records collection inside the equal manner. by prioritizing messages with in advance cut-off dates, sencar might do its first-rate to avoid lacking deadlines.

7.Overall performance evaluations: On this phase, we examine the overall performance of our framework and compare it with other schemes. due to the fact the primary awareness of this paper is to discover extraordinary alternatives of data collection schemes, for fair evaluation, we count on all of the schemes are carried out under the same obligation-cycling MAC approach. the primary scheme for contrast is to relay messages to a static data sink in multi-hops and we name it Relay Routing. considering nodes with higher battery electricity offer extra robustness and mistakes immunity, sensors choose the subsequent hop neighbor with the very best residual power even as forwarding messages to the sink. Once a few nodes on a routing direction eat an excessive amount of strength, an alternative course could be selected to avoid these nodes. in this way, the relay routing technique can offer load balance amongst nodes along the routing course.

8 CONCLUSIONS AND FUTURE WORKS:

On this paper, we have proposed the LBC-DDU framework for mobile statistics collection in a WSN. It consists of sensor layer, cluster head layer and SenCar layer. It employs allotted load balanced clustering for sensor self-enterprise, adopts collaborative inter-cluster conversation for electricity-efficient transmissions among CHGs, makes use of twin information importing for instant information collection, and optimizes SenCar's mobility to absolutely revel in the blessings of MU-MIMO. Our overall performance look at demonstrates the effectiveness of the proposed framework. The results display that LBC-DDU can greatly reduce strength consumptions with the aid of alleviating routing burdens on nodes and balancing workload among cluster heads, which achieves 20 percentage less facts series time as compared to SISO cell facts gathering and over 60 percentage strength saving on cluster heads. we have additionally justified the electricity overhead and explored the outcomes with special numbers of cluster heads within the framework. sooner or later, we would like to point out that there are some interesting issues that may be studied in our future paintings. the first problem is how to find polling points and well matched pairs for every cluster. A discretization scheme should be advanced to partition the non-stop space to locate the optimum polling factor for every cluster. Then finding the like minded pairs turns into an identical problem to obtain most advantageous usual spatial range. the second problem is the way to schedule MIMO importing from a couple of clusters. An algorithm that adapts to the present day MIMO-based totally transmission scheduling algorithms have to be studied in destiny.

REFERENCES:

- [1] W. C. Cheng, C. Chou, L. Golubchik, S. Khuller, and Y. C. Wan, "A coordinated data collection approach: Design, evaluation, and comparison," *IEEE J. Sel. Areas Commun.*, vol. 22, no. 10, pp. 2004–2018, Dec. 2004.
- [2] O. Gnawali, R. Fonseca, K. Jamieson, D. Moss, and P. Levis, "Collection tree protocol," in *Proc. 7th ACM Conf. Embedded Netw. Sensor Syst.*, 2009, pp. 1–14.
- [3] Y. Wu, Z. Mao, S. Fahmy, and N. Shroff, "Constructing maximum-lifetime data-gathering forests in sensor networks," *IEEE/ACM Trans. Netw.*, vol. 18, no. 5, pp. 1571–1584, Oct. 2010.
- [4] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "An application-specific protocol architecture for wireless microsensor networks," *IEEE Trans. Wireless Commun.*, vol. 1, no. 4, pp. 660–660, Oct. 2002.
- [5] O. Younis and S. Fahmy, "Distributed clustering in ad-hoc sensor networks: A hybrid, energy-efficient approach," in *IEEE Conf. Comput. Commun.*, pp. 366–379, 2004.
- [6] D. Gong, Y. Yang, and Z. Pan, "Energy-efficient clustering in lossy wireless sensor networks," *J. Parallel Distrib. Comput.*, vol. 73, no. 9, pp. 1323–1336, Sep. 2013.
- [7] A. Amis, R. Prakash, D. Huynh, and T. Vuong, "Max-min d-cluster formation in wireless ad hoc networks," in *Proc. IEEE Conf. Comput. Commun.*, Mar. 2000, pp. 32–41.
- [8] A. Manjeshwar and D. P. Agrawal, "Teen: A routing protocol for enhanced efficiency in wireless sensor networks," in *Proc. 15th Int. IEEE Parallel Distrib. Process. Symp.*, Apr. 2001, pp. 2009–2015.
- [9] Z. Zhang, M. Ma, and Y. Yang, "Energy efficient multi-hop polling in clusters of two-layered heterogeneous sensor networks," *IEEE Trans. Comput.*, vol. 57, no. 2, pp. 231–245, Feb. 2008.



Mr. K. GOUTHAM RAJU was born in India, in the year of 1989. He received B.Tech degree in the year of 2010 & M.Tech PG in the year of 2012 from JNTUH. He was expert in Software Engineering, Software Testing, Object Oriented Analysis and Design, and Design & Analysis of Algorithms. He is currently working as an Assistant Professor in the Department of CSE, Vaagdevi College of Engineering, Bollikunta, Warangal, and Telangana State, India.

Mail ID: kgrvaag@gmail.com



Ms. B. SASHI BINDU was born in India. She is pursuing M.Tech degree in Computer Science & Engineering, in CSE Department in Vaagdevi Engineering College, Bollikunta, Warangal, and Telangana State, India.

Mail ID: sashibindu.banka@gmail.com