VOL. 13, NO. 5, MARCH 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

SWEEPING INCLUSIVE CONNECTIVITY BASED ROUTING IN WIRELESS SENSOR NETWORKS

C. R. Rathish[1] and A. Rajaram[2]
[1]St.peter's University, Chennai, India
[2]Department of Electronics and Communication Engineering, EGS Pillay Engineering College, Nagapattinam, India
E-Mail: c.r.rathishphd1@gmail.com

ABSTRACT

Wireless Sensor Networks are an important area in research and development was stimulated by military applications. Today WSN's are used in many industrial and consumer applications. One of the major challenges in WSN is to produce low cost, small sensor nodes and should be energy efficient. In order to find the cost-effective routing, Sweeping Inclusive Connectivity based Routing Algorithm (SICRA) is introduced. The primary goal behind the algorithm is to hold the sensors operating for as long as possible. It contains three stages. In first stage, secured multi-hop network is constructed. It securely forwards the received messages. The security is provided using packet-absorb approach. It provides rapid deployment due to multi-hop. Multi-hop improves the long life of sensors. In second stage, the algorithm computes the best routing path by analyzing the transmission coverage, shorter hop, transmission delay, connectivity link. Third stage shows the load balancing in minimal time. Sweeping Inclusive routing algorithm selects the most favourable path so that the fault transmissions are avoided. This causes the network to balance the load in minimal time. This algorithm offers lower communication overhead and reduces overall energy consumption. This reserves energy and enrich network lifetime. This extends the battery life due to low power transmission, extends coverage and improves connectivity. The performance analysis of proposed SICRA provides better quality of service than previous strategies. It improves security, delivery ratio and reduces energy consumption, transmission delay and overhead.

Keywords: multi-hop routing, coverage, connectivity, packet-absorb approach, load balancing, transmission delay, sweeping inclusive connectivity based routing.

1. INTRODUCTION

Wireless sensor networks supports suitable platform that suits various applications such as ecological monitoring [1], security surveillance and intrusion detection. For inter-node communication, a traditional ad-hoc routing protocols require a path discovery procedure that leads to intensive bandwidth consumption in a resource-constrained sensor network. It is hard to achieve accurate position information using geographic routing protocols as it achieves scalability for packet forwarding by using the location of node but results in routing failures.

Beacon Vector Routing [2] assigns coordinates to nodes based on the hop count to a small set of beacons and it defines the distance metric on these coordinates. This requires large number of landmarks to attain good performance. In this approach around 10 to 90 nodes are selected as beacons, from that 10 nodes that are closest to the destination are selected for routing. This large number of landmarks and routing components are very difficult to implement and also very expensive.

A logical coordinate framework [3] is introduced that encodes connectivity information for purpose of routing without the benefit of geographic knowledge, while maintaining the constant-state advantage of geographic routing. It improves robustness in the existence of voids compared to other coordinate frameworks, and it performs inferring bounds on route hop count from the logical coordinates of the source and destination nodes, that makes it a candidate for use in soft real-time systems.

Our approach uses sweeping inclusive connectivity based routing algorithm for the cost-effective routing. The proposed work constitutes three stages. In first stage, secured multi-hop network is constructed. Multi-hop relays are used for the node communication. Packet-absorb approach is introduced phase to give secured packet transmission. If any malicious nodes are identified, this approach seeks another route. Second stage deals with coverage and connectivity. Sweeping Inclusive Connectivity based Routing protocol selects the best path by choosing more optimal coverage and node links. Total coverage of the routing path is calculated. Third stage describes the load balancing with the proposed technique. It shows the time complexity of algorithm and effective load balancing.

The rest of the paper is organized as follows. The related work on multi-hop routing protocols is analyzed in section II. The details of proposed Sweeping Inclusive Connectivity based Routing Algorithm explained in section III. The simulation results of NS2 are presented in section IV. The conclusion is given in section V.

2. RELATED WORK

Abdul Razaque [4] have developed PEGASIS-LEACH (P-LEACH), a near optimal cluster-based chain protocol uses an energy efficient routing algorithm to transfer the data in WSN. As a result, the system will have higher lifetime, low energy consumption, and can also deal with a dynamic system. P-LEACH is the combination of two most well-known energy efficient protocols for WSN, LEACH (Low Energy Adaptive Clustering Hierarchy) considers dynamic cluster approach and energy efficiency during wireless transmission and PEGASIS (Power-Efficient Gathering in Sensor Information

Systems) considers the power consumption, reduced traffic overload, increased network lifetime and cost efficiency, but doesn't take into account dynamicity. The proposed P-LEACH protocol combines the chain formation technique within the clusters for data forwarding.

Juan Cota-Ruiz [5] presented a routing algorithm which is useful in the area of centralized range-based localization strategies. The proposed method is capable of estimating the distance between two non-neighboring sensors in multi-hop wireless sensor networks. It employs a global table search of sensor edges and recursive functions that finds all possible paths in between a source sensor and a destination sensor that satisfies with the minimum number of hops. By utilizing distance matrix the algorithm evaluates and averages all paths that evaluate a measure of distance between both sensors. The proposed methodology can produce effective results for large-scale wireless networks and it also most suitable for centralized localization schemes includes Multi-Dimensional Scaling (MDS), Least Squares (LS), and Maximum Likelihood (ML).

Elkamel Rabiaa [6] proposed an adaptive routing algorithm which is called Multi-KG based on clustering. The adaptive routing algorithm is integration of an improved unsupervised algorithm of the K-means on clusters and Gaussian elimination algorithm for choosing Cluster Heads (CH). To route data from source to the base station, a multi-hop communication Inter-CHs is used. From this, balanced-energy clusters are generated and distributed energy consumption is guaranteed. This approach greatly reduces computation time using K-means and reduces energy consumption using Gauss. The 'Multi-KG' gives better results as it prolongs the lifetime of CHs nodes and also the network lifetime by adopting an inter-cluster communication and intra-cluster in a multi-Hop. The multi-hop communications have led to an effective distribution of the energy consumption throughout the network, without any re-election of CH. This prevents the overhead caused by the periodic rotation of CHs.

Sebastian Kuhlmorgen [7] introduced a routing algorithm for wireless multi-hop ad hoc networks that applies distributed source coding (DSC) and also multi-path transfer of data packets. Distributed Source Coding enables the relay nodes that effectively encode the packets and makes the destination node to rightly decode the information from many erroneous copies of the same packet collected via different paths. In the proposed work, the relays are allowed to forward erroneous packets. In order to utilize DSC for ad hoc routing, it further extends contention-based geographical forwarding (CBGF) that helps multi-path packet transport and also allows the joint decoder to retrieve transmission errors.

Saman Siavoshi [8] proposed a geographical multi-layered clustering protocol for adhoc wireless sensor networks, where the size of clusters is unfixed so that the nearest clusters to the base station (BS) have a smaller size over farther ones. In each cluster, using some intelligent fuzzy rules, a novel subtree strategy is determined in a decentralised way. Some parent nodes are chosen in this way that are responsible for gathering and aggregating data from their adjacent common nodes and forwarding them to its cluster head, directly or via other parent nodes, which significantly reduces intra-cluster communication energy costs. These two suited techniques can fairly mitigate the hot spot problem evolving from multi-hop communication with the Base Station. This provides better functional longevity for both small-scale sensor networks and large-scale sensor networks.

Alami Chaibrassou and Ahmed Mouhsen [9] deals with virtual multiple input multiple output (MIMO) technique, where sensor nodes combine with each other in order to form an antenna array whereas multichannel frequencies technique that represents communication standards like IEEE 802.15.4 which helps to improve network throughput and eliminate collision, idle-listening or overhearing, that results overconsumption energy. A distributed multi channel cooperative MIMO routing protocol for cluster based WSNs (MCMIMO) is proposed based on this which aims to take advantages of both these techniques. Sensor nodes are arranged into clusters and each cluster head uses a weighted link function to choose some optimal cooperative nodes to forward or receive traffic from other nearby clusters.

Guillaume Gaillard [10] monitors KPIs in Synchronized FTDMA Multi-hop Wireless Networks. The proposed work provides tools to monitor individually and verify the requirements of each client to use the IETF 6TiSCH stack (IPv6 over the Time Slotted Channel Hopping mode of IEEE 802.15.4e), one of the promising basis to meet the end-to-end delay and packet delivery ratio constraints and it provides flow isolation intrinsically. The introduced mechanism collects the monitoring blocks for each application using efficient piggybacking Information Elements (IEs) onto the data packets and it saves 45% on monitoring overhead than other traditional approaches.

Prabhat Kumar [11] deals with energy efficient multi-hop routing. It improves the LEACH-CE protocol which is not suitable for multi-hop communication. The proposed work explores a modern approach for multi-hop routing such that selection of cluster head and cluster formation is accomplished by LEACH-CE protocol. Here the entire network is divided into two zones i.e., near zone and far zone based on threshold distance. Further, far zone is divided into different zones based on threshold distance. The near zone cluster head transfers data directly to the base station while the far zone cluster head transmits data via relay cluster head. The proposed work improves the lifetime of network and energy efficient. The proposed algorithm is suitable for large target area where the base station is located far away from the target area.

Hicham Lakhlef [12] introduces Collision-free Routing Protocol in Multi-hop Wireless Sensor Networks. This deal with two memory-efficient permutation routing protocols problem on WSN (p, n) and the network is multi-hop. The main goal of the permutation routing is to route to each sensor, its n/p packets, so it can achieve its task. The proposed protocol performs energy effective with respect to the number of transmit rounds and run without conflict and collision on the communication channels. The collision-free routing protocol uses distributed algorithms to provide colors for sensor nodes. By using these provided colors, nodes route the information in parallel till each node receives all its packets. For the broadcast operations the first protocol uses a single color and uses O (np +2) of memory space for every node. The second protocol uses multiple colors and faster for the broadcast operations and uses O (np + Δ) of memory space for every node.

P. Kavitha Rani and E. Kannan [13] studied Hybrid Routing Model for Multi Hop Heterogeneous Sensor Network. A robust methodology is introduced that uses hybrid routing model which combines FFA has an efficiency of fast retransmission, Straight line which is effective in energy optimization and branch & cut routing model in order to carry out optimal shortest path for data communication in heterogeneous multi hop sensor nodes and routing structure is developed for heterogeneous multi hop sensors. This robust model performs better results in terms of all influenced patterns. This can be applied in hybrid scheme even in case of node failure occurs. From the proposed work, it is observed that the hybrid routing model plays effective reliable transmission.

Ranjan Dasgupta [14] deals with congestion control and minimization of packet collision. The proposed work describes a network that uses congestion avoidance topology or CATopology where every wireless sensor is deterministically locate throughout the sensing area. And also a congestion avoidance data retrieval strategy is proposed by organizing an optimal congestion avoidance tree or CATree of sensor nodes using K-map and K-graph. It shows that network makes sure of congestion free multi-hop data routing and it greatly decreases packet collision and retransmission. It results in sink packet loss ratio and network end-to-end delay improves and increases energy efficiency and network lifetime.

Versha Sharma and Davinder S Saini [15] discussed the algorithm called Advanced-Multi-hop Low Energy Adaptive Clustering Hierarchy protocol with heterogeneous nodes. The proposed work tries to evaluate the performance of the network lifetime and path stability by presenting the concept of optimum number of clusters and also review the optimum number of hops in the heterogeneous nodes networks. It provides the algorithm for the avoidance of clusters overlapping and collisions in the network. The performance of advanced single-hop and multi-hop energy efficient LEACH protocols with heterogeneous nodes shows that advanced-multi-hop LEACH protocol outperforms the advanced single-hop LEACH protocol regarding energy efficiency, stability and network lifetime.

F. Smarra [16] deals with the aim of rendering the system robust with respect to packet losses, and utilizes network coding and data redundancy and it assumes that such data is re-integrated as a weighed linear combination. A network coding optimization Problem is set to maximize or constraining the robustness of a control-loop closed around a multi-hop network characterized by loss in packet. An approximation is proposed to make the computation of a sub-optimal network coding practical. From this approximation, it shows that packet loss probabilities are generally very small in real networks and it provides the potential results.

Luejun Xu [17] presented a Multi-radius Ring-based Multi-hop Clustering Routing Algorithm (MRMCRA) for agricultural monitoring system in wireless sensor networks. Concentric rings with different radius are created therefore the whole area is divided into different subareas. Each ring radius is selected to balance the power consumption. And in the inner sub area each cluster head (CH) is required to select its next hop. By considering the residual battery capacity, distance from next hop to the BS and distance from current cluster head to the next, a fuzzy logic system is applied to the decision making. The result shows that it optimizes the data transmission path, decreases the energy consumption.

Xiaohua Xu [18] studied real-time multicast scheduling in multi-hop wireless sensor networks. A routing strategy is designed and also packet scheduling protocol for periodic multicast tasks in multi-hop wireless sensor networks. Data produced by various source nodes need long time to be delivered to all target nodes. This approach is developed mainly to meet the delay requirements. From the conducted schedulability analysis it approximately optimizes the schedulable load. Schedulability test schemes are proposed for both necessary conditions and sufficient conditions for a set of real-time multicast tasks and achieve constant approximation.

Tae-Yoon Kim [19] proposed a multi-hop WBAN construction for healthcare IoT systems. This scheme contains four operations that include the clustered topology setup, mobility support, and transmission efficiency enhancement. This reduces number of overall control messages and it is more energy efficient. Bu using the virtual cluster and lower transmission range for network setup, it reduces potential interference not only from inner W-BAN node and also from outer W-BAN network. Further it helps to enhance transmission efficiency. The proposed method is well suited for mobility support and network failure tolerance features.

Evripidis Paraskevas and John S. Baras [20] proposed a method that designs routing protocol for resource-constrained wireless multi-hop networks that separates the protocol into different components, which define particular functionalities that allows modularity in protocol design and also reusability of existing components. Different QoS requirements can be guaranteed by effectively configuring distinct components. It also considers adversarial environments to mitigate network layer attacks by developing techniques. The design of decision-theoretic module is investigated for dynamic protocol configuration. The design in lightweight and the reusable techniques used configures misbehaving functionalities of protocol.

Xudong Zhu [21] studied the problem of decrease in network performance. This can be overcome by grouping WSN into various disjointed clusters, and each cluster has representative cluster head in charge of routing process. It is critical to detect a cluster partition with less number of clusters and distance between every node to its corresponding cluster head can be bounded by a constant number of hops and it is considered as d-hop cluster head set d-MCHS problem and it is NP-hard. The proposed addresses this d-MCHS problem and named as d^2-cluster and proved that the approximation ratio of d^2-cluster under unit disk graph is a constant factor λ that is related to d. The simulation shows that d^2-cluster have high efficiency. Sunil Kumar [22] introduced an enhanced energy efficient distributed protocol for heterogeneous WSN. It increases the lifetime of the network by considering energy heterogeneous Wireless sensor network. A flowchart is proposed based on different clustering equation that able to provide longer lifetime with improved QOS parameters. A test is made by using Raspberry Pi as BS, temperature sensors as node and xively.com as cloud. By using internet for decision or business purposes users can use data from xively.com.

Chinchu T Sony [23] studies that one of efficient protocol in WSN is LEACH (is Low Energy Adaptive Cluster Hierarchy) and improvements were done to make more energy efficient like election of Cluster Head, allocating Time division multiple access (TDMA) slot to cluster members multi hop for lengthy distance communication. Simulation results of proposed Modified LEACH protocol for small network areas and Modified Multi hop LEACH protocol for large network areas shows that the comparatively the protocol have better lifetime network than LEACH protocol.

3. OVERVIEW OF PROPOSED WORK

The number of nodes in sensor networks is very enormous and has to scale to several orders of magnitude and thus require distinct and more scalable results. The energy consumption in WSN is a significant metric to be examined. Our contribution is to evolve Sweeping Inclusive Connectivity based Routing Algorithm which effectively selects the best routing path. This makes available of high stability period and expand the lifetime of the network.

A. Secured multi-hop network

Multi-hop networks use two or more wireless hops to transfer information from a source to a base station. Communication between nodes is arranged as multiple hop relays, nodes in multi-hop networks are relatively deployed. It may introduce hierarchy network design, by using multi-hop network, more benefits can attain and also it provides rapid deployment, provides easy coverage for all areas and it enhances the throughput due to shorter hops. It extends the battery life because of lower power transmission and it extends the coverage due to multi-hop forwarding.

Multi-hop networks are often securely forwards the received packet. In proposed model, packet-absorb approach is used in order to provide security. Initially the source node sends the packet with the base station details. By using the packet-absorb approach, the packets are encrypted. So the intermediate nodes cannot view the original content, the intermediate nodes may or may not be malicious. Even the malicious nodes cannot decode the received packet. Only the base station can view the packet data.

Network density examines number of neighbour nodes have suspicious nodes are identified by malicious activities based in the information exchanges among neighbors. Packet-absorb approach needs some degree of coordination among the nodes in the network, so that they may together point the approximate location of the adversary. When a node collects a message and considers it as malicious, it may correlate with its neighbors try to find the origin of the message by using the signal strength identified by its own receiver and signal strength received by other nodes. The malicious nodes can also be identified by misbehaving activities, the malicious nodes are failed to convey the packet or drops the packet. The capacity of the nodes is not sufficient to forward the packets. In that case, those nodes are considered as malicious and seek to route another node. In such a case, the intermediate node cannot transmit the packets to the malicious nodes. Hence the network is planned as secured multi-hop routing network.

Figure-1 shows the work of proposed method. The network model is constructed with multi-hop routing including security. Packet absorb approach identifies the presence of malicious nodes; it estimates the node density and finds another route in case that the density of node is not sufficient. This also encrypts the original content of packet. Only the destination node can view the original content. Sweeping Inclusive Connectivity Based Routing Algorithm is introduced in order to find the shorter hop, better transmission coverage and connectivity. It identifies the total coverage and connectivity for the efficient transmission of data and the residual energy level is checked. It shows clearly, that the load in the network is balanced in short time with the help of multi-hop networks.

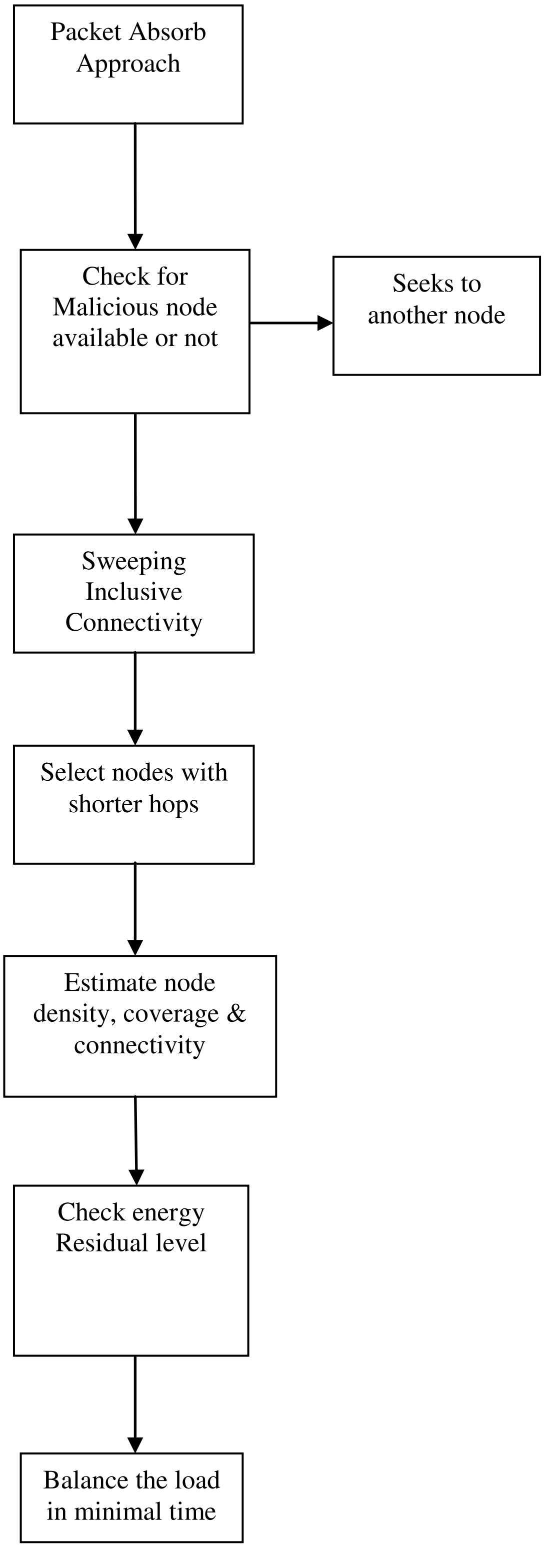

Figure-1. Block diagram of sweeping inclusive connectivity based routing.

B. Sweeping inclusive connectivity based routing

Nodes may combine with each other by forwarding or relaying each others' packets, possibly involves more intermediate nodes. This enables nodes that cannot get each other directly to communicate over in-between relays without increasing transmission power. Such multi-hop relaying is a very hopeful solution to increase throughput and provides coverage for a large physical area.

In proposed, sweeping inclusive connectivity based routing is proposed in order to find the best connectivity routing path. After checking for the malicious nodes, the proposed algorithm finds the shorter hops, coverage and connectivity. The main objective is to route the data from sensor to base station with strong connectivity. Coverage and connectivity are the two important metric to be considered.

Sweep coverage is used to move a number of sensor nodes across a sensing field, such that it labels a specified balance between increase detection rate and decrease number of missed detections per unit area. Depending on the sensing range, any particular node can be able to sense a part of the sensing field. Let us consider for the point P(a_i,b_i) the coverage of sensor is derived using the equation:

$$\mathrm{C}a_ib_i(s_i)=\begin{cases} 0, C_s + C_u \leq d(s_i, P) \\ e^{-\alpha x^{\beta}}, C_s - C_u < d(s_i\ P) < C_s + C_u \\ 1, C_s - C_u \geq d(s_i\ P) \end{cases} \quad (1)$$

From equation (1) a = $d(s_i, P)$ – $(C_s - C_u)$ and α *and* β are parameters that measures the probability detection when an object is within a definite distance from the sensor. All points that lie within a certain distance from the sensor. All points that lie within a distance of $(C_s - C_u)$ from the sensor are said to be 1-covered and all points lying within the interval $((C_s - C_u), (C_s + C_u))$ have a coverage value that exponentially reduces as the distance increases and is less than 1, Beyond the distance $(C_s + C_u)$ all the points have 0 coverage by this sensor. However, a point might be covered by multiple sensors and also each contributes a certain value of coverage.

Total Coverage

$$\mathrm{S} = \{s_{i,}\ i = 1,2, \ldots, k\} \quad (2)$$

Equation (2) denotes the set of nodes whose sensing ranges cover the point P (a_i,b_i). The total coverage of the point P as follows:

$$\mathrm{C}a_ib_i\ (\mathrm{S}) = 1 - \prod_{i=1}^{k}(1 - \mathrm{C}a_ib\ (s_i)) \quad (3)$$

In equation (3), $\mathrm{C}a_ib_i\ (s_i)$ is the probabilistic coverage of a point, the term $(1 - \mathrm{C}a_ib_i\ (s_i))$ is the probability that the point is not covered by sensor s_i. Now, since the probabilistic coverage of a point by one node is not dependent of another node, the product $\prod_{i=1}^{k}(1 - \mathrm{C}a_ib_i\ (s_i))$ of all such k terms will denote the joint probability that the point is not covered by any of the nodes. Hence, one minus this product would give the probability that point P is covered jointly by its neighbouring sensors, and is defined as its total coverage.

The overall coverage of a point lies in the interval one millisecond.

For good connectivity, consider an arbitrary multi-hop wireless network of m nodes. Let G = (N, L), be the graph of the topology where N is the set of nodes and L is the set of links. The graph G can be represented by the m x m adjacency matrix M(t) at time t.

$$M(t) = \begin{bmatrix} M11(t) & M12(t)\ldots & M1m(t) \\ M21(t) & M22(t)\ldots & M2m(t) \\ \vdots & \vdots & \vdots \\ Mm1(t) & Mm2(t)\ldots & Mmm(t) \end{bmatrix} \quad (4)$$

Where,

$$M_{ij}(t) = \begin{cases} 1, if\ link\ i\ to\ j\ exist \\ 0, otherwise \end{cases} \quad (5)$$

The link connectivity M_{ij}(t) between two nodes depends on their radio range and can be examined by nodes locally through the exchange of packets.

Sweeping Inclusive Connectivity based Routing Algorithm steps are given below:

Step 1: Establish the coverage with set of nodes S = $\{s_{i,}\ i = 1,2,\ldots,k\}$.

Step 2: Check the coverage for each nodes positions like (a_i,b_i), a_i- denotes x-axis position and b_i denotes y-axis position.

Step 3: Select the multi-hop routing path to transmit packets.

Step 4: Estimate probability for every connection based on the distance C$a_i b_i$ (s_i).

Step 5: In simulation Graph G = (N, L), where N is the set of nodes and L is the set of links.

Step 6: Connectivity M_{ij}(t) between two nodes is established depends on their radio range.

Step 7: Time Complexity is reduced with the packet absorb approach.

Step 8: Network overload is minimized in O(T(m + L logm)+m^2).

C. Load balancing with minimal time

For a network of m nodes and L links of which T are directed, it can be shown that the time complexity is O (T (m + L logm) +m^2). The algorithm can be implemented at any node of network having information of adjacency matrix.

Multi-hop networks consumes only less energy, as the Sweeping- Inclusive Connectivity algorithm provides the best routing path by satisfying both coverage and links of nodes. By using packet-absorb approach we can find malicious nodes so load can be balanced in very short time. Load balancing achieves highest throughput and minimize response time and it improves the lifetime of the network.

Proposed packet format

Packet ID: It contains each and every wireless node details. It contains a node's position and casual updates identification it fixed in network structure.

Source ID	Destination ID	Multi hop	Sweep inclusive	Time usage	Packet absorb
2	2	4	4	4	2

Figure-2. Proposed packet format.

In Figure-2: the proposed packet format is shown. Here the source and destination node ID field takes 2 bytes. Third one is Multi hop; nodes communicate each other in network that visits all hops in a path. In fourth field, the Sweep inclusive is denoted, evaluates multi hop path to get efficient transmission. In fifth, the Time usage in each transmission, check start time to end time for communication in multi hop path. The last field Packet absorbs encrypt the packet before send to receiver node.

4. PERFORMANCE ANALYSIS

Network Simulator NS-2.34 version is used to simulate present work SICRA algorithm. NS-2 is an object oriented tool command language. It supports to simulate network Technologies WSN, MANET, and VANET. NS-2.34 is based C++ language; ease of code, and to implements a lot of protocol designs.

In our simulation, 100 sensor nodes move around a 1000 meter x 1000 meter square region for 15 milliseconds simulation time. All nodes have the same coverage range of 250 meters. Mac address 802.11 is inbuilt to design, in that simulation setting and parameters are summarized in table.

Table-1. Simulation setup of proposed protocol.

No. of nodes	100
Area Size	1000 X 1000
Mac	802.11
Radio Range	250m
Simulation Time	15ms
Traffic Source	CBR
Packet Size	512 bytes
Mobility	Random Way Point
Protocol	LEACH protocol

Simulation result: Figure-3 show that the proposed method sweeping inclusive connectivity based routing is an efficient one compared with existing PLEACH [4] and MRMCRA [17]. It enhances security to detect malicious nodes occurred in network, and also reduce the load balance during transmission.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

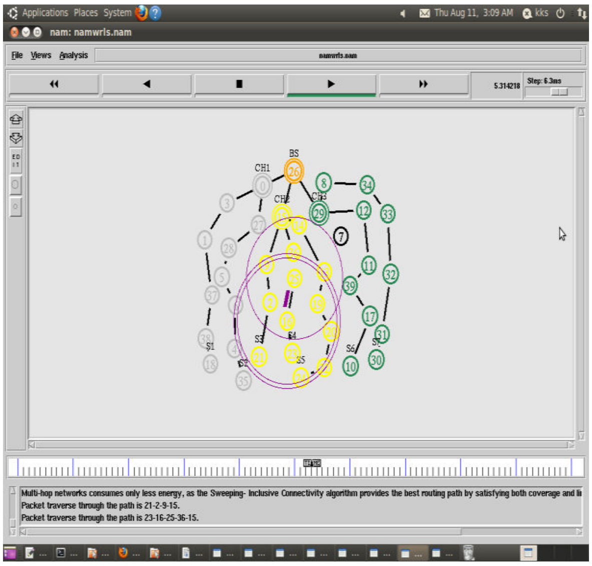

Figure-3. Proposed SICRA result.

Performance analysis

In simulation X-graph is used to analyze the following performance metrics in ns2.34.

Packet drop rate: Figure-4 shows packet loss ratio that occurs during transmission between sender nodes to route path when one or more packets failure to reach the receiver node based on capacity of node in a network. In proposed SICRA method Packet drop rate is minimized compared to existing methods HBRP, PLEACH, and MRMCRA.

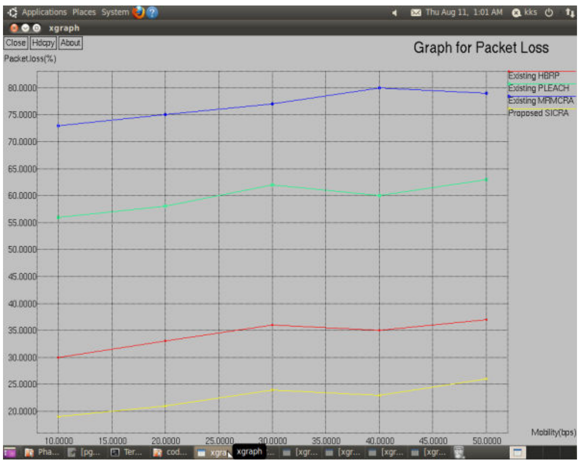

Figure-4. Graph for mobility vs. packet loss.

Energy consumption: Figure-5 shows energy consumption that is how long energy spend for particular packet transmission, calculates consumption of energy from initial energy level to final energy level. In proposed SICRA method energy consumption is reduced compared to existing methods HBRP, PLEACH, and MRMCRA.

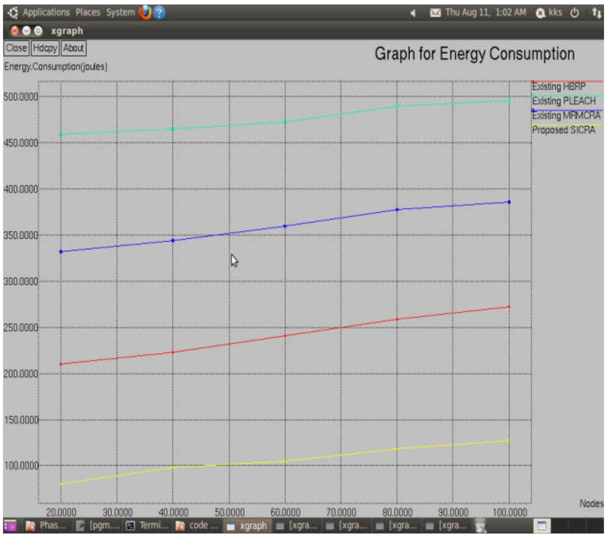

Figure-5. Graph for no. of nodes vs. energy consumption.

Packet delivery ratio: Figure-6 shows packet delivery ratio is measured by number of received packets from number of sent packets in particular speed. In simulation, fixed speed is 100(bps). In proposed SICRA method packet delivery ratio is increased compared to existing methods HBRP, PLEACH, and MRMCRA.

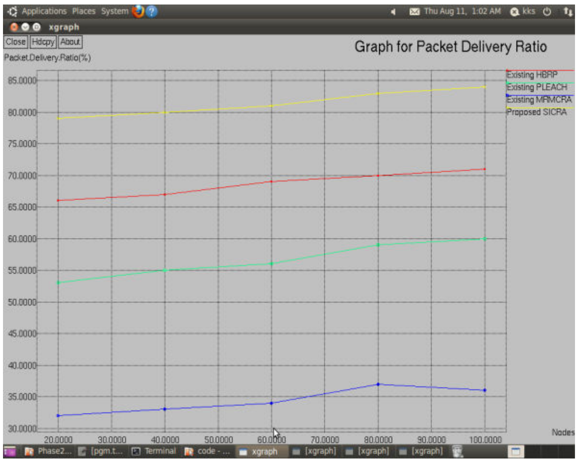

Figure-6. Graph for no. of nodes vs. packet delivery ratio.

Network overhead: Figure-7 shows network overhead, time taken for packet communication to complete the transmission from source node to root node. This shows how load is balanced in network. In proposed SICRA method network overhead is decreased compared to existing methods HBRP, PLEACH, and MRMCRA.

ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

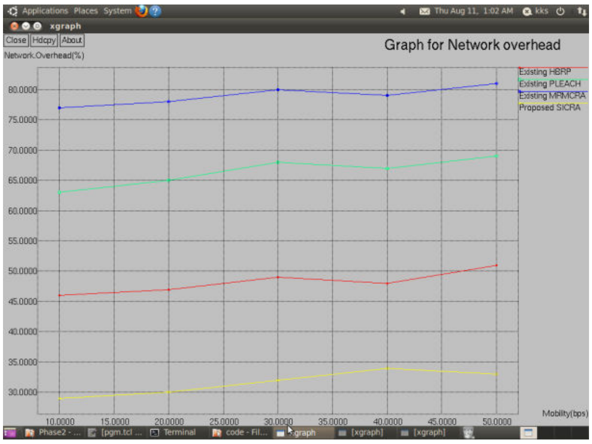

Figure-7. Graph for mobility vs. network overhead.

Transmission delay: Figure-8 shows Transmission delay is calculated by analyzing time taken to transmit packet from start point to end point, individual node is traced by IP address. In proposed SICRA method, transmission delay is reduced compared to existing methods HBRP, PLEACH, and MRMCRA.

Figure-8. Graph for no. of nodes vs. transmission delay.

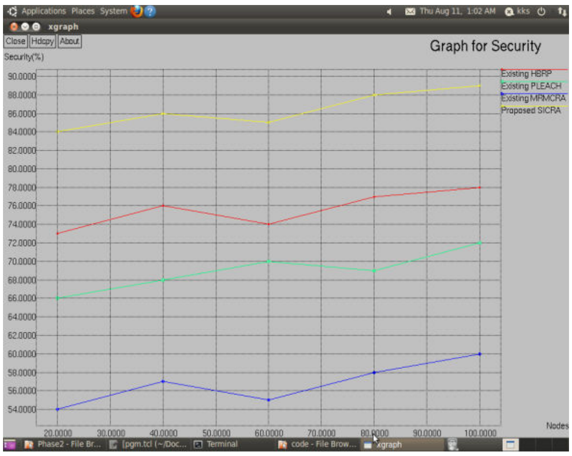

Figure-9. Graph for no. of nodes vs. security.

Security: Figure-9 shows security is calculated with success rate in number of packet sent. In proposed SICRA method, security is increased compared to existing methods HBRP, PLEACH, and MRMCRA.

5. CONCLUSIONS

In wireless sensor networks, producing low sensor, energy effective sensors are more challenged. In proposed Sweeping Inclusive Connectivity based routing algorithm that attains secured routing and load balancing by choosing shorter hops, effective coverage and connectivity. In first stage secured multi-hop routing is proposed by using the packet absorb approach. This provides security by identifying malicious nodes. In second stage, SICRA algorithm is implemented to choose the coverage and connectivity for effective data transmission. In third stage, it shows clearly that load balancing is reduced in minimal time with the use of packet absorb approach. By simulated in NS2, is a discrete event simulator, proposed method reduced packet loss in transmission, less energy consumption, minimized network overhead and transmission delay and increases packet delivery ratio and security.

REFERENCES

[1] Tolle Gilman, *et al*. 2005. A macroscope in the redwoods. Proceedings of the 3rd international conference on Embedded networked sensor systems. ACM, 2005.

[2] Fonseca Rodrigo, et al. 2004. Beacon vector routing: Scalable point-to-point in wireless sensornets. IRB-TR-04-012, Berkeley: Intel Research. 14.

[3] Cao Qing and Tarek Abdelzaher. 2006. Scalable logical coordinate’s framework for routing in wireless sensor networks. ACM Transactions on Sensor Networks (TOSN). 2(4): 557-593.

[4] Razaque Abdul, et al. 2016. P-LEACH: Energy efficient routing protocol for Wireless Sensor Networks. 2016 IEEE Long Island Systems, Applications and Technology Conference (LISAT). IEEE.

[5] Cota-Ruiz Juan, *et al.* 2016. A Recursive Shortest Path Routing Algorithm with Application for Wireless Sensor Network Localization. IEEE Sensors Journal 16(11): 4631-4637.

[6] Rabiaa Elkamel, et al. 2016. Efficient" MultiKG" Routing Protocol Based on Multi-Hop Transmission. 2016 30th International Conference on Advanced Information Networking and Applications Workshops (WAINA). IEEE.

[7] Kuhlmorgen, Sebastian, Andreas Festag, and Gerhard Fettweis. 2016. Exploiting Distributed Source Coding for Multi-hop Routing in Wireless Ad Hoc Networks. 2016 IEEE 83rd Vehicular Technology Conference (VTC Spring). IEEE.

[8] Siavoshi Saman, *et al*. 2016. Geographical multi-layered energy-efficient clustering scheme for ad hoc distributed wireless sensor networks." IET Wireless Sensor Systems. 6(1): 1-9.

[9] Chaibrassou Alami and Ahmed Mouhsen. 2016. A multi-channel cooperative MIMO routing protocol for clustered WSNs. 2016 International Conference on Electrical and Information Technologies (ICEIT). IEEE.

[10] Gaillard Guillaume, *et al.* 2016. Monitoring KPIs in synchronized FTDMA multi-hop wireless networks. 2016 Wireless Days (WD). IEEE.

[11] Kumar Prabhat, *et al*. 2015. Energy efficient multi-hop routing based on improved LEACH-CE for wireless sensor network. TENCON 2015-2015 IEEE Region 10 Conference. IEEE.

[12] Lakhlef Hicham, *et al.* 2015. Collision-Free Routing Protocol in Multi-hop Wireless Sensor Networks. Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), 2015 IEEE International Conference on. IEEE, 2015.

[13] Rani, P. Kavitha and E. Kannan. 2015. Hybrid routing model for multi hop heterogeneous sensor network. Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), 2015 International Conference on. IEEE.

[14] Dasgupta, Ranjan, Ritwick Mukherjee and Amitava Gupta. 2015. Congestion avoidance topology in wireless sensor network using Karnaugh map. Applications and Innovations in Mobile Computing (AIMoC), 2015. IEEE.

[15] Sharma Versha and Davinder S. Saini. 2015. Performance Investigation of Advanced Multi-Hop and Single-Hop Energy Efficient LEACH Protocol with Heterogeneous Nodes in Wireless Sensor Networks. Advances in Computing and Communication Engineering (ICACCE), 2015 Second International Conference on. IEEE.

[16] Smarra F., A. D'Innocenzo, and M. D. Di Benedetto. 2015. Approximation methods for optimal network coding in a multi-hop control network with packet losses. Control Conference (ECC), 2015 European. IEEE.

[17] Xu Luejun. 2015. A multi-radius ring-based multi-hop clustering routing algorithm for agricultural monitoring system. Electronics Information and Emergency Communication (ICEIEC), 2015 5th International Conference on. IEEE.

[18] Xu Xiaohua and Min Song. 2015. Delay Efficient Real-Time Multicast Scheduling in Multi-Hop Wireless Sensor Networks. 2015 IEEE Global Communications Conference (GLOBECOM). IEEE.

[19] Kim Tae-Yoon, *et al*. 2015. Multi-Hop WBAN Construction for Healthcare IoT Systems. Platform Technology and Service (PlatCon), 2015 International Conference on. IEEE.

[20] Paraskevas, Evripidis and John S. Baras. 2015. QoS Aware Component-Based Routing in Resource-Constrained Wireless Multi-hop Networks. 2015 IEEE 23rd International Conference on Network Protocols (ICNP). IEEE.

[21] Zhu Xudong, et al. 2015. A Distributed Approximation for Multi-Hop Clustering Problem in Wireless Sensor Networks. 2015 IEEE Global Communications Conference (GLOBECOM). IEEE.

[22] Kumar, Sunil, Priya Ranjan and R. Radhakrishnan. 2015. EMEEDP: Enhanced Multi-hop Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network. Communication Systems and Network Technologies (CSNT), 2015 Fifth International Conference on. IEEE.

[23] Sony, Chinchu T., C. P. Sangeetha and C. D. Suriyakala. 2015. Multi-hop LEACH protocol with modified cluster head selection and TDMA schedule for wireless sensor networks. Communication Technologies (GCCT), 2015 Global Conference on. IEEE.