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Hybrid Optimization Schemes for Opportunistic Routing and Localization in Wireless Network

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Abstract: The nodes in networks are constrained with limited power for their vital operations since the connectivity of the network will go down as soon as node energy gets exhausted. Node failures due to power constraints cause system failures and hence minimize end-to-end connectivity in the network. And also mobility and congestion of the nodes lead to frequent link failures and packet losses affecting the QoS performance of the protocol. In this work, we used an effective proposed scheme, named as Hybrid Optimization System (HOS), for efficient and routing and transmission for wireless networks. Our Hybrid scheme consist of many techniques such as, Dynamic Opportunistic Routing, Multipath Scheduling Scheme and Robust Transmission in networks to overcome above limitations in networks. Hybrid K-means PSO clustering approach, 'KPSO', that clusters the network into predefined number of clusters. K-means searches for the best number of clusters, and then groups the network into the selected clusters. PSO selects the best CH for each cluster. KPSO reduced the complexity on the way we are handling the problem and improved the network lifetime. It provides effective load balancing at the node and finds a stable path between the source and destination meeting the delay requirement. Simulation results show that the proposed protocol outperforms in terms of packet delivery ratio, throughput, routing overhead and average end to end delay.

Keywords: Wireless Network, Hybrid Optimization System (HOS), Internet of Things (IoT)

I. INTRODUCTION

1.1. WIRELESS NETWORKS:

Wireless network is a network set up by using radio signal frequency to communicate among computers and other network devices. Sometimes it's also referred to as WiFi network or WLAN. This network is getting popular nowadays due to easy to setup feature and no cabling involved.

You can connect computers anywhere in your home without the need for wires. It doesn't matter you are using broadband cable/DSL modem to access internet, both ways will work with wireless network.

If you heard about wireless hotspot that means that location is equipped with wireless devices for you and others to join the network. The two main components are wireless router or access point and wireless clients. Computers are very often connected to networks using wireless links, e.g. WLANs.

The proposed framework, we used an effective proposed scheme, named as Hybrid Optimization System (HOS), for efficient and routing and transmission for wireless networks. Our Hybrid scheme consist of many techniques such as, Dynamic Opportunistic Routing, Multipath Scheduling Scheme and Robust Transmission in networks to overcome above limitations in networks.

A novel idea is proposed for successful localization of the wireless network nodes using Distance detection and grouping using hybrid clustering algorithm. Hybrid K-means PSO clustering approach, 'KPSO', that clusters the network into predefined number of clusters. K-means searches for the best number of clusters, and then groups the network into the selected clusters. PSO selects the best CH for each cluster. KPSO reduced the complexity on the way we are handling the problem and improved the network lifetime.

II. LITERATURE REVIEW

Internet of Things (IoT) A Vision, Architectural Elements, and Security Issues:: The Internet of Things is an emerging technology across the world, which helps to connect sensors, vehicles, hospitals, industries and consumers through internet connectivity. Architecture of IoT is very complex because of the large number of devices, link layer technology and services that are involved in this system. However, security in IoT is the most important parameter. In this paper, we give an overview of the architecture of IoT with the help of Smart World. In the second phase of this paper, we discuss the security challenges in IoT followed by the security measures in IoT.

The Internet of Things: A survey: This paper addresses the Internet of Things. Main enabling factor of this promising paradigm is the integration of several technologies and communications solutions. Identification and tracking technologies, wired and wireless sensor and actuator networks, enhanced communication protocols (shared with the Next Generation Internet), and distributed intelligence for smart objects are just the most relevant. We discuss the security challenges in IoT followed by the security measures in IoT.

Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey:: The distributed nature and dynamic topology of Wireless Sensor Networks (WSNs) introduces very special requirements in routing protocols that should be met. The most important feature of a routing protocol, in order to be efficient for WSNs, is the energy consumption and the extension of the network's lifetime. During the recent years, many energy efficient routing protocols have been proposed for WSNs. In this paper, energy efficient routing protocols are classified into four main schemes: Network Structure, Communication Model, Topology Based and Reliable Routing. The routing protocols belonging to the first category can be further classified as flat or hierarchical.

Wireless Sensor Networks and Applications: a Survey:: In this research work, a survey on Wireless Sensor Networks (WSN) and their technologies, standards and applications was carried out. Wireless sensor networks consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture.

Recent Developments on Wireless Sensor Networks Technology for Bridge Health Monitoring: Structural health monitoring (SHM) systems have shown great potential to sense the responses of a bridge system, diagnose the current structural conditions, predict the expected future performance, provide information for maintenance, and validate design hypotheses. Wireless sensor networks (WSNs) that have the benefits of reducing implementation costs.

SensorScope: Application-Specific Sensor Network for Environmental Monitoring: SensorScope is a turnkey solution for environmental monitoring systems, based on a wireless sensor network and resulting from a collaboration between environmental and network researchers. Given the interest in climate change, environmental monitoring is a domain where sensor networks will have great impact by providing high resolution spatio-temporal data for long periods of time.

Localization algorithms of Wireless Sensor Networks: a survey: In Wireless Sensor Networks (WSNs), localization is one of the most important technologies since it plays a critical role in many applications, e.g., target tracking. If the users cannot obtain the accurate location information, the related applications cannot be accomplished. In general, the main localization algorithms are classified into two categories: range-based and range-free. In this paper, we reclassify the localization algorithms with a new perspective based on the mobility state of landmarks and unknown nodes, and present a detailed analysis of the representative localization algorithms.

Indoor tracking for mission critical scenarios: A survey: The availability of a reliable and precise tracking system for relief units operating in mission critical scenarios would drastically improve the situational awareness and thus facilitate the mission planning and accomplishment as well as increase the safety of human resources. Thus, the demand for such a system is very high both in the military and in the emergency and crisis intervention domain. While there are solutions like GPS for the localization in open areas, problems arise in urban scenarios and indoors due to insufficient or failed signal reception.

Quarter Sphere Based Distributed Anomaly Detection in Wireless Sensor Networks: Anomaly detection is an important challenge for tasks such as fault diagnosis and intrusion detection in energy constrained wireless sensor networks. A key problem is how to minimise the communication overhead in the network while performing in-network computation when detecting anomalies. Our approach to this problem is based on a formulation that uses distributed, one-class quarter-sphere support vector machines to identify anomalous measurements in the data.

CESVM: Centered hyper ellipsoidal Support Vector Machine Based Anomaly Detection: A challenge in using machine learning for tasks such as network intrusion detection and fault diagnosis is the difficulty in obtaining clean data for training in order to model the normal behavior of the system. Unsupervised anomaly detection techniques such as one class Support Vector Machines (SVMs) have been introduced to overcome this difficulty. One class support vector machines model the normal or target data using non-linear surfaces in the input space while ignoring the anomalous data.

III. PROPOSED METHODOLOGY

The proposed framework, we used an effective proposed scheme, named as Hybrid Optimization System (HOS), for efficient and routing and transmission for wireless networks. Our Hybrid scheme consist of many techniques such as, Dynamic Opportunistic Routing, Multipath Scheduling Scheme and Robust Transmission in networks to overcome above limitations in networks.

A novel idea is proposed for successful localization of the wireless network nodes using Distance detection and grouping using hybrid clustering algorithm.

Hybrid K-means PSO clustering approach, 'KPSO', that clusters the network into predefined number of clusters. K-means searches for the best number of clusters, and then groups the network into the selected clusters. PSO selects the best CH for each cluster. KPSO reduced the complexity on the way we are handling the problem and improved the network lifetime. It provides effective load balancing at the node and finds a stable path between the source and destination meeting the delay requirement. Simulation results show that the proposed protocol outperforms in terms of packet delivery ratio, throughput, routing overhead and average end to end delay.

Methodologies:

3.1 Neighbour selection:

We are presenting a novel approach to AODV against localization in WSN using neighbor node analysis. In our work, neighbor node analysis approach analyze the neighboring nodes so as to check the authenticity of the nodes for secure transmission of data over the network. According to this approach a node will request to its neighboring nodes and perform a request and response mechanism.

Step 1: As transmission initiates, source node search for the neighbor nodes and form a neighbor list.
Step 2: Source node then generates RREQ packet and encrypt it using the public keys of neighboring nodes and distribute it all around.
Step 3: If the neighboring node receiving RREQ packet, decrypt it using their private key then the node is authenticated otherwise, remove the node from neighbor list and report node as bad node.
Step 4: If node is authenticated it will send the RREP message to the source node.
Step 5: Source node will record the response time of RREP message.
Step 6: Compare the response time of RREP message with response time of actual message sent.
Step 7: The process is repeated for each node in the neighbor list till the destination is reached.

3.2 Energy Consumption Model: A wireless sensor node consists of: sensing unit, processing unit, transceiver and power supply. The power supply provides energy to all other sensor components. The sensed measurements are converted to a digital signal by means of the analog-to-digital converter (ADC) of the sensing unit.

EWsens = ESU + Eaggreg + ET rans
EWsens = ESU + Eaggreg + Esleep + Eidle + ET x + ET r where:

- EWsens is the total energy consumed by a wireless node,
- ESU is the energy consumed by the sensing unit,
- Eaggreg is the energy consumed in aggregating measured data,
- ET rans is the total energy consumed by the transceiver,
- Esleep is the energy consumed by the transceiver during sleep operation,
- Eidle is the energy consumed by the transceiver while in the idle state,
- ET x is the energy consumed by the transceiver to send a data message, and

EWsens ≈ Eaggreg + ET x + ET r

3.3 Optimized Clustering

In the clustering of Sensors, it is clear that enough number of SNs need to be deployed if every corner of the area of interest, need to sense for continuous monitoring and necessary action.

3.3.1 K-means Clustering: The K-means clustering algorithm is the algorithm which is used for clustering approach. It obtains the cluster's centre point by minimizing the distance between the points assigned to that cluster and the virtual center. The selection of cluster heads in K-means is given by the following steps-

$$K_{opt} = \sqrt{N}/\ 2\pi\ \sqrt{\epsilon f\ s}\ /\epsilon mp\ M\ /\ d^2_{\ to\ BS}$$

3.3.2 Clustering based PSO: Objective was to group the network into equal sized clusters using PSO. The clustering algorithm consists of two main phases. The first phase divides the network into equal clusters using a recursive PSO algorithm.

$$F = \sum_{j=1}^{k} \sum_{i=1}^{n_j} (d_{ij}^2 + \frac{D_j^2}{n_j}) \qquad F = \epsilon \times \frac{CHenergy}{ClusterEnergy} + (1-\epsilon) \times \frac{ClusterMemebersCount}{ClusterDistance}$$

The dataset are randomly deployed and the radio model is adopted. The simulation results outperformed LEACH protocol. However, applying PSO algorithm in the setup phase rather than applying it only when CH topology changes forces complexity in WSN operation.

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3.3.3 Hybrid K-Means PSO Clustering - 'KPSO'

• Phase 1: The first phase applies K-means to partition the network into k clusters.
• Phase 2: Next, the PSO searches for the best CH within each cluster obtained by Kmeans.
• Phase 3: Finally, the last stage evaluates the obtained cluster layout.

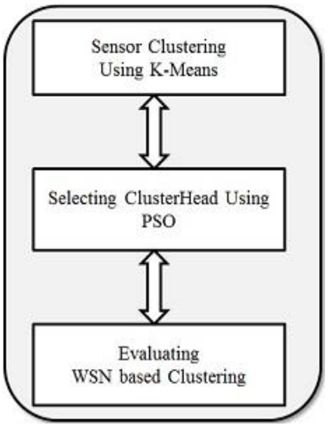

Fig 3.1 K-means PSO Hybrid clustering

Phase 1: Clustering based K-Means

K-means is a simple unsupervised clustering algorithm. It was successfully used to solve a variety of clustering problems.

$$D = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^j - \mu_j \right\|^2$$

Algorithm for selecting the best number of clusters

- 1 begin
- n = number of nodes
- For i=5 to 30
- k = i×n 100
- Form k clusters using K-means
- Calculate the computed clustered distance
- next i
- Find k for minimum computed distance
- End

Repeated until no new CH is selected. The distance between two nodes s1, s2is computed based on the following Euclidean distance calculation:

$$D(s_1, s_2) = \sqrt{(x_{s1} - x_{s2})^2 + (y_{s1} - y_{s2})^2}$$

Where x and y are the node's x-coordinate and y-coordinate, respectively. This phase will divide the network to disjoint clusters. The base station will save information about each cluster's sensor node ID, location and energy level. The steps of WSN K-means clustering is summarized as follows:

1. Arbitrarily choose k nodes to be CHs.
2. Join each node to the closest CH.
3. Calculate the new cluster center by calculating the mean distance between each CH and all sensors in its cluster.
4. If at least one new CH is changed then go to step 2, else stop the process.

Phase 2: Cluster Head Selection using PSO

PSO is then applied to select the optimal cluster head from each cluster obtained by the Kmeans phase. For instance, if the K-means partitioned z nodes to 3 clusters with l, m, and n nodes, respectively, then the PSO model will select three cluster heads; one from the l nodes, the second from the m nodes and the third from the n nodes.

CH_1	CH_2	......	CH_k

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Fitness Function

$$F = \begin{cases} \sum_{i=1}^{k} \frac{E_i}{d_i^2} & \text{for } d_i < d_0 \\ \\ \sum_{i=1}^{k} \frac{E_i}{d_i^4} & \text{for } d_i \geq d_0 \end{cases}$$

Where

• k represents the number of clusters,
• Ei represents the CH's actual energy,
• di is the Euclidean distance between the cluster head and the base station, and
• d o = 87m

3.4 Multipath Scheduling Scheme

The concept of proposed multipath feature is towards broadcasting the traffic load among the two or more routes.

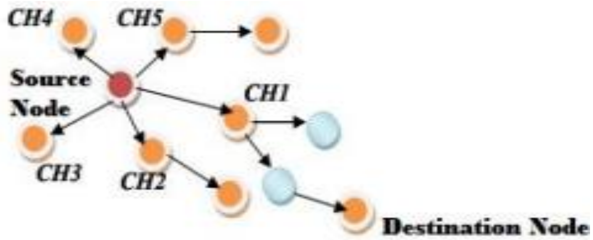

Fig.2.2 Multipath Routing Approach

Scheduling Scheme: The neighbouring nodes coordinate their listen and sleep schedules as such that they all listen at the same time and all sleep at the same time. To coordinate their sleeping and listening, each node selects a schedule and exchanges it with its neighbors during the synchronization period. Each node maintains a schedule table that contains the schedule of all its known neighbors.

3.5 Dynamic Opportunistic Routing

In WSNs, sensors typically operate on non-rechargeable batteries, so effective utilization of energy expenditure prolongs the lifespan of the sensor. In order to fulfill the QoS requirement, the sensor network should be able to maintain certain reliability and delay of the specific application. Therefore, developing new routing schemes for WSN to minimize the end-to-end delay and energy consumption is considered to be major performance criteria.

IV. EXPERIMENTAL RESULT AND DISCUSSION

Performance Analysis

For proper operation of our proposed approaches, some assumptions were made. We assumed a fixed number of static nodes that are randomly deployed in a two dimensional geographical area. The nodes are assumed to have an initial energy level. Within each cluster, each pair of sensor nodes is guaranteed to be within the effective transmission range. So each two nodes in the cluster can communicate with each other directly.

Parameter	Value
Field Size	$100 \times 100m^2$
Number of Sensor nodes	100
Energy of Sensor nodes	80% have 2J ; 20% have 5J
Base Station location	(0,0)
Size of message	4000 bits

Table 1.1 WSN simulation parameters

GRAPH SCREENS

Delay ratio: In this work compare previous and present process of delay ratio, here red line mention existing delay ratio and green line is proposed delay ratio, in our proposed work reduces the delay compared to existing process system.

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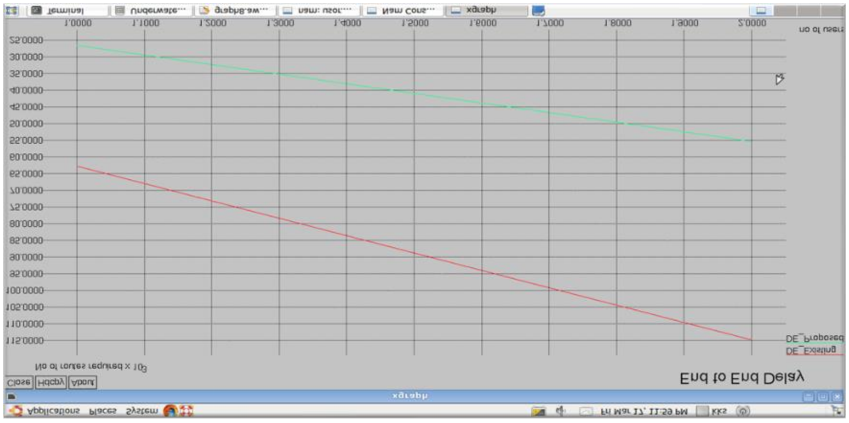

Fig 4.1 Delay ratio comparison

Energy Consumption rate:

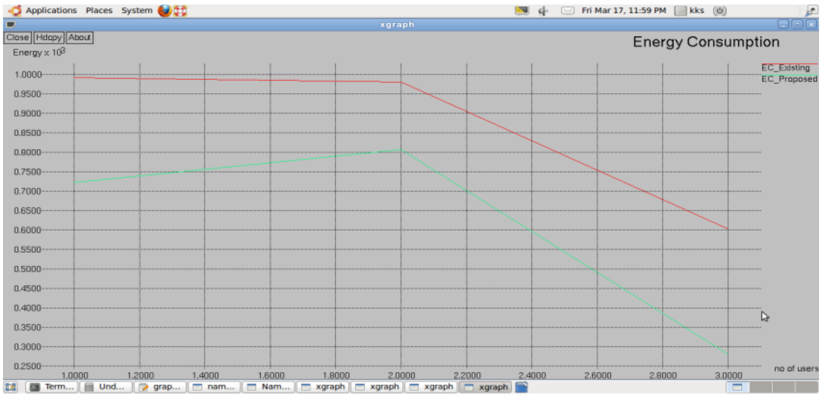

Fig 4.2 Energy consumption ratio comparison

In this work compare previous and present process of energy Consumption rate, here green line mention proposed energy ratio and red line is existing energy ratio. Our proposed work reduce consumption of energy compared to existing process.

Packet delivery ratio

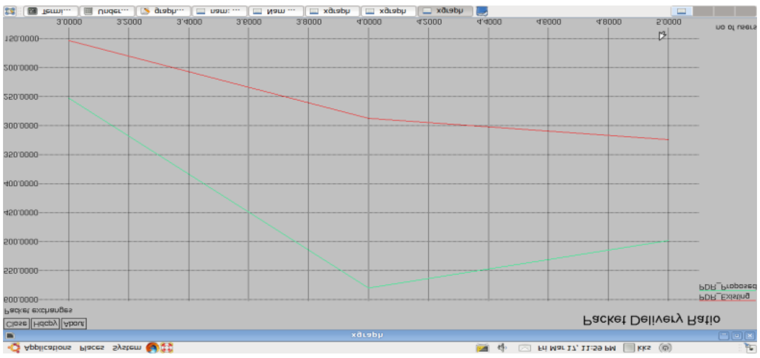

Fig 4.3 Packet delivery ratio comparison

In this work compare previous and present process of Packet delivery, here green line mention proposed ratio and red line is existing packet ratio. In our proposed work improves Packet delivery rate compared to existing process.

Average Throughput ratio:

In this work compare previous and present process of Throughput ratio, here green line mention proposed, red line is existing ratio, in our proposed work improved Throughput ratio compared to existing and previous process.

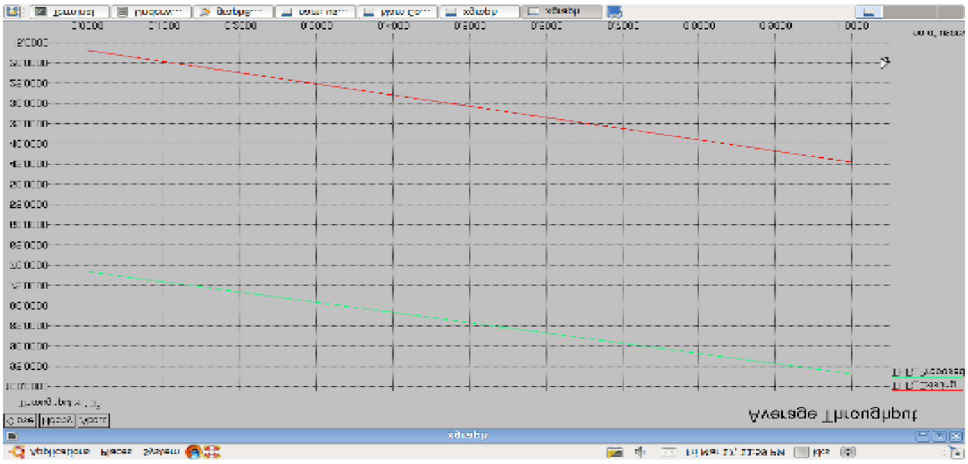

Fig 4.4 Throughput ratio comparison

V. CONCLUSION

In this work used used an effective proposed scheme, named as Hybrid Optimization System (HOS), for efficient and routing and transmission for wireless networks. Hybrid K-means PSO clustering approach, 'KPSO', that clusters the network into predefined number of clusters. K-means searches for the best number of clusters, and then groups the network into the selected clusters. PSO selects the best CH for each cluster. KPSO reduced the complexity on the way we are handling the problem and improved the network lifetime.

The performances of these protocols are evaluated with respect to the metrics such as network lifetime, total energy consumption, average residual energy, throughput, packet delivery ratio, normalized overhead and end to-end delay. The simulation results proved that the proposed protocol achieves better communication reliability with minimum delay while maintaining reasonable energy consumption and enhance lifetime of network. Hence, the principle of optimality holds.

VI. FUTURE WORK

We recommend the following ideas that can be used for future: In future, the proposed protocol can be employed for enhancing the efficiency of various applications like multimedia messaging, video calling, etc. The proposed protocol mostly deal with energy efficiency in routing protocol can be further extended to improving energy efficiency in MAC layer. Also the concepts of enhancing fault tolerance, security and mobility in communication will be performed.

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