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TO PROPOSE A SMART ROUTING MODEL FOR MAXIMUM USE OF BANDWIDTH IN WIRELESS SENSOR & ACTUATOR NETWORKS

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ABSTRACT

Cooperation of sensors and actors is a vital analysis field in WSAN. This paper emphasizes on the sensible topology to manage period of network lifetime and load over WSAN. The wireless sensor and actuator networks (WSANs) are group of sensors and actuators distributed geographically. A smart energy efficient routing model is proposed in this paper. The proposed protocol or algorithm is cluster and hierarchical based. In this, simulation aims towards evaluating the performance of the wireless sensor networks (WSNs) and the wireless sensor and actuator networks (WSANs) within the planned simulation. The Neighbour Formation method was used for the WSN connectivity. Next, Localization Group Formation method is used for making the interconnections between the detector nodes. Lastly, the final step comes to the design topology using aggregation process. The proposed smart routing model is being evaluated for the execution time, energy consumption, overhead, load, delay and plenty of other network parameters. The WSN and WSAN are being enforced in very balanced topology together with an adequate diversity of device nodes. The device nodes are going to be evaluated beneath varied simulations in both the WSNs and WSANs to have energy efficient routing than the previously developed routing protocols.

Key words: Routing, Sensor Node, Bandwidth, Actuator Node, Wireless.

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1. INTRODUCTION

Wireless sensor and actor networks (WSANs) are group of sensors and actors which are joined by wireless medium to perform distributed sensing and different tasks. In such type of networks, sensors gather data according to the physical world, whereas actors take choices and perform the suitable actions on that physical area. The nodes in sensor networks are equipped with sensing and processing units to sense and

compute the required data, further send this data to base station (BS) or sink. The data can be send through single-hop or multi-hop communication.

1.1. Why Actors?

In this, the meaning of the term Actor differs from the notion of mechanism. Here the term Actor/Actuator suggests about the heterogeneous devices like robotic arms, water sprinklers, unmanned aerial vehicles etc. These actor nodes in WSANs having much higher capabilities like more computing power and wireless communication than the traditional sensor nodes in WSNs. The Actor nodes are one step ahead from the simple sensor nodes in WSNs. They can perform acting tasks on the physical world in accordance with sensing. Hence, due to the presence of Actors, WSANs have much more to provide than traditional WSNs. The CH selection architecture in WSAN is shown below in Figure 1.

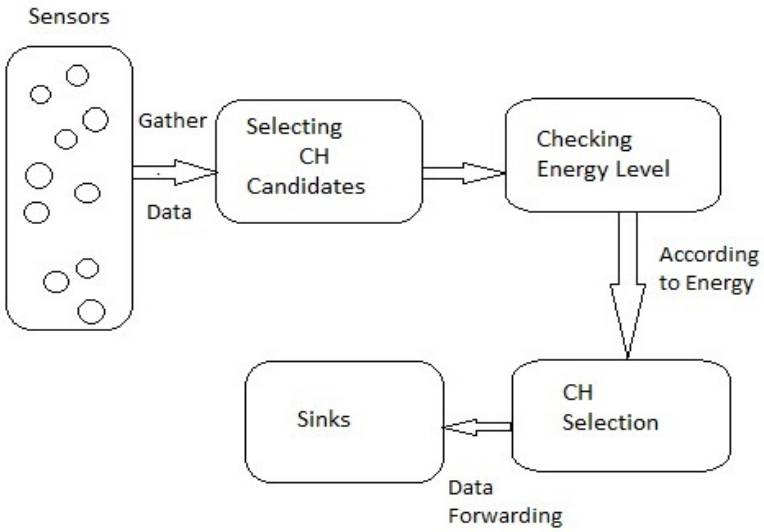

Figure 1 WSN Architecture

1.2. Peculiarities between WSNs and WSANs

Due to the presence of Actors, WSANs have some variations from WSNs, which are given below as:
In WSNs, sensor nodes can perform only the task of sensing at the physical area. Whereas in WSANs, the sensor nodes can perform both the sensing and acting tasks due to presence of actor/actuator nodes.

In WSNs, the sensor nodes are very tiny, low-cost devices with restricted sensing, computation power and wireless communication capabilities. On the other hand in WSANs, actor/actuator nodes are equipped with higher sensing, computation and communication capabilities than WSNs.

1.3. Communication in a Wireless Sensor Network

Depending on the network structure, routing in a wireless sensor network can be divided into three different types like Data based routing, Hierarchical routing or Cluster based routing, Location based routing. Sensor nodes can generate redundant data. Similar packets from multiple nodes can be combined so that number of transmissions is reduced. Further, the above given protocols can be divided into multipath based, query based, QoS based and negotiation based depends upon the protocol operation. In a WSN, sensors are connected to the atmosphere and their measurements are sent to the Base Station or sink through wired communication media.

1.4. Wireless Sensors

The wireless sensors are the standard measurement tools, which are equipped with transmitters to convert signals. The wireless sensors are used in locations which are difficult to access due to harsh conditions

such as pressure, high temperature, pH etc. We can also define a wireless sensor as a hardware object whose sole purpose is to detect changes in its surround areas. Range of wireless sensors can vary. The range is significantly less in the indoor areas as compared to open fields. A wireless sensor node can be comprises of the units like sensing unit, computing unit, transmitting unit and power unit.

1.5. Self Organized Routing

Overlay topologies are typically utilized in unstructured peer-to-peer networks so as to boost the overall performance. Numerous analysis works coping with communication challenges and issues associated with the dynamic networks gave abundant interest to overlay topologies to induce a far better network organization. In fact, the utilization of such structures aim to decrease the impact of network dynamics whereas enhancing its measurability. Moreover, overlays provide a more robust management of the networking and routing information flows over the network. Recently, some overlays giving scale-free and/or small-world properties are projected. However, most of the works especially for the structural aspects and don't provide abundant importance to the routing data and the associative information carried by peers. Figure 2 represents the self organized mechanism, in which nodes are connected with every possible path.

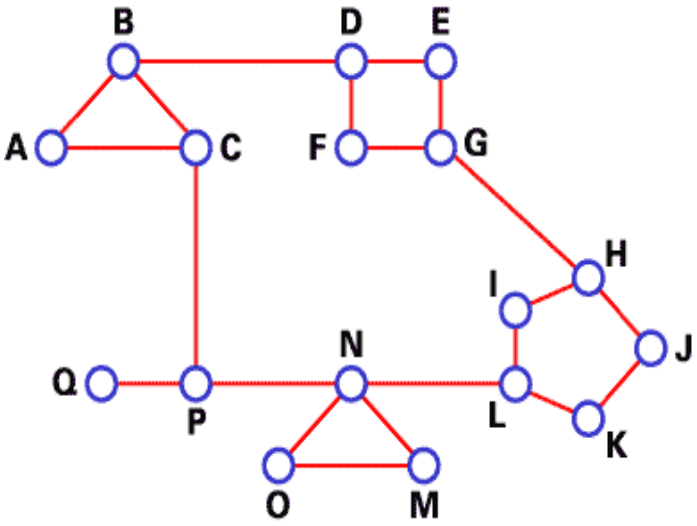

Figure 2 The self organized routing scenario with the nodes connected with every possible path

2. RELATED WORK

In paper [1] authors tend to propose associate economical cluster head choice methodology victimisation K-means algorithmic rule to maximise the energy potency of wireless sensing element network. It supported the thought of finding the cluster head minimizing the total of geometrician distances between the top and member nodes. Theoretical account shows that the planned approach permits higher performance than the prevailing hierarchic routing protocols similar to LEACH and HEED in terms of network period of time.

In paper [2] the authors planned an energy economical routing protocol, that is hierarchic and cluster based mostly. During this protocol, the Base Station selects the Cluster Heads (CH). The selection process is done out in two phases. Within the first phase, all candidate nodes for turning into CH area unit listed, supported the parameters like relative distance of the candidate node from Base Station. The CH generates two schedules for cluster members named Sleep and TDMA based transmit. The performance of the proposed protocol is compared with that of LEACH through simulation experiments. It is observed that the proposed protocol outperforms the LEACH under all circumstances.

In paper [3] authors introduced an energy consumption model to calculate the energy-factor of nodes. Then propose a protocol for energy-efficient routing. Experiments would be conducted to check the

planned protocol on the idea routing overhead, and will increase packet delivery magnitude relation by intense less energy with AODV and DSR, the popular existing routing protocols.

In paper [4] authors have propose a protocol named Hierarchical Adaptive Balanced energy economical Routing Protocol (HABRP) to decrease chance of failure nodes and to prolong the time interval before the death of the primary node (stability period) and increasing the period in heterogeneous WSNs, that is crucial for several applications.

In paper [5] authors proposed the principle and theoretical analysis of an algorithm. This algorithm can be used to find the connected key nodes in WSN. A path planning algorithm for mobile nodes is also proposed in order to prolong the network lifetime and reduce the influence of connected key nodes on the network lifetime. According to the theoretical analysis and simulation, this research has solved the problem about wireless sensor network topology division caused by connected key nodes and extended the network lifetime of WSNs.

3. PROBLEM FORMULATION

- Wireless sensor network consists of number of sensor nodes clustered together to collect various environmental or other physiological data like temperature, pressure, seismic graph, sound, location, etc.
- Wireless sensor and actor networks (WSANs) refer to a group of sensors and actors linked by wireless medium to perform distributed sensing and actuation tasks.
- In such a network, sensors gather information about the physical world, while actors take decisions and then perform appropriate actions upon the environment, which allows remote, automated interaction with the environment.
- In some situations, the choice has to be made between WSN and WSAN because of the adaptability of the both types of the networks for the particular situation. Hence there is a strong need to evaluate both of the networks (i.e. WSN and WSAN), in order to know their performance in various situations. The performance evaluation survey will be focused on the network parameters, merits and demerits.
- In this paper, to implement the simulations of WSN and WSAN using MATLAB simulator. The simulation is aimed at evaluating the performance of the wireless sensor networks (WSNs) and wireless sensor and actor networks (WSAN) in the proposed simulation.
- The proposed model is being evaluated for the execution time, energy consumption, overhead, load, delay and many other related network parameters. The WSN and WSAN are being implemented in a balanced topology along with an adequate number of sensor nodes. The sensor nodes will be evaluated under various scenarios.

4. PROPOSED MODEL & DESIGN

The simulation situation for this project relies upon the randomly deployed topology consisted of adequate range of nodes. The whole one hundred nodes are taken within the simulation situation. The nodes are manually positioned with the random coordinates to simulate the near-to-real situation. Within the near-to-real situations, the nodes are being deployed by the canons or through from the aerial mediums within the case of cragged areas or different areas with chanceful approaches. The quality node configuration has been chosen from the nodes within the topology. The simulation situation has been ready using the MATLAB machine. The MATLAB simulation is thought as Matrix Laboratory that has been written in C/C++ for the windows/MAC/LINUX platforms. In Figure 3, the whole peer to peer routing workflow is shown.

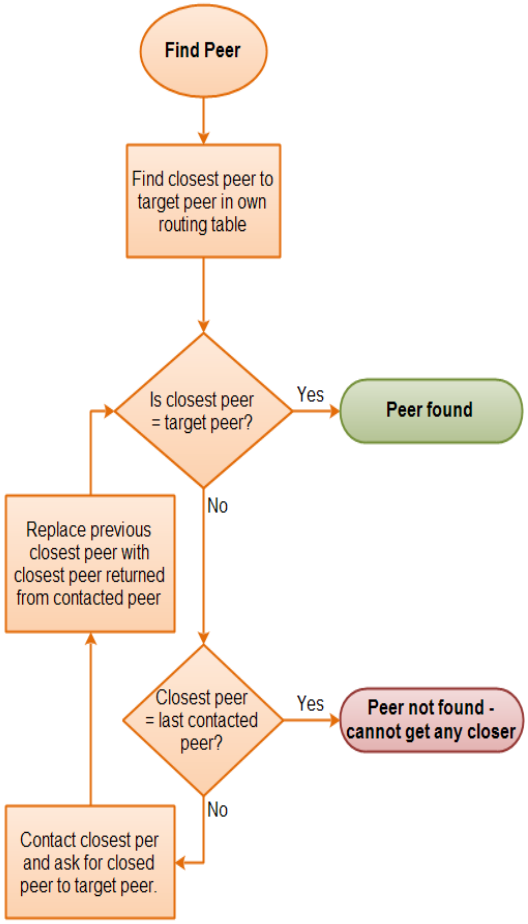

Figure 3 The peer-to-peer routing workflow

4.1. Neighbour Formation

The neighbour formation is the process of initial stage connectivity between the wireless sensor nodes. The neighbour formation process is based upon the coordinate information sharing and distance based calculation. The nodes within the one hop distance and transmission radius are marked as the immediate neighbour for the nodes. The Pythagorean formula has been used for the purpose of distance calculation in the three dimensional environment. The formula is as following:

$$\text{Di} = \left(x_i - x_j\right)^2 + \left(y_i - y_j\right)^2 + \left(z_i - z_j\right)^2$$

The neighbour formation is the fundamental process for the wireless sensor network connectivity. The neighbour formation process is the initial stage sensor node connectivity process initiated using the Hello sharing and then followed by sharing the node location coordinates. The following algorithm describes the neighbour formation process in more detail:

Algorithm: Neighbour Formation

Assumptions:

- The process of neighbour formation begins after initializing of sensor network. The sensor node form neighbor with the nodes that are present in direct transmission range.
- Further, all sensor nodes are deployed randomly in clustered network. All the nodes broadcast data to their neighboring nodes without any acknowledgement.

Algorithm Logic:

- Start up nodes N.

- All nodes will transmit their data in network to Sink, the neighboring nodes or the nodes that are in the direct range.
- Transmission Radius- R (=250m), which denotes the direct range.
- Node i out of Node N transmit neighbor formation message to all the other nodes that are present in the network.

$$\text{Di (i, j)} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (z_i - z_j)^2} \quad \textbf{(1)}$$

$$\int_0^N transmit(x, y) \rightarrow i \quad , \; if \; Di < R \quad \textbf{(2)}$$

- Node i will receive the j coordinate of all range and the nodes in the range of neighbors.
- Node i will build up coordinate array.
- Node i will compute the distance between every other nodes.

Compute Distance (i, j) using (1)

- Enable the process of Neighbor Formation for all the nodes with in the distance according to transmission range.

$$\text{Ni (j)} = \int_0^N \sum_{n=j}^{di<R} fn\,(\,x_j\,,\,y_j\,,\,d_{ij}\,) \quad \textbf{(3)}$$

Where, Ni (j) denotes Neighbor Table array for node i.

x_j denote x coordinate and y_j denote y coordinate.

- Neighbor formation will be established and information of all neighbors will be updated in the corresponding neighbor table.

4.2. Localization Group Formation

Wireless detector network Localization is that the method of making the inter-connections between the detector nodes. The detector node localization method connects the nodes with alternative nodes inside the transmission vary of every node. The nodes maintain the neighbour table for the shortlisted nodes. The neighbouring nodes are additional connected and sorted within the teams so as to facilitate the versatile and simple management of the nodes in close to connections. The localization method additional permits the routing method.

Algorithm: Localization Group Formation

- Once the neighbor information exchange is complete then selection of anchor node will be done randomly.
- Each anchor node will compute the distance of each node from itself.
- The node with minimum hop-count and average distance will be connected with the anchor node.
- In the final step, the anchor node will release and relay its role to other node with highest degree of connections on the distance of one –hop.

4.3. Topology for WSAN

After the completion of the localization process, the final step comes to design topology for WSAN in the network, which is implemented through small groups within in the WSN/WSAN. The nodes are capable of analysing the traffic coming from the slave nodes or from base station. The algorithm first analyses the ingress data then applies protocols of balanced topology. It analyses each group whether transmission is going on. If transmission is going on then it waits to complete the transmission for sending the group into acting network. It applies on every node of the group. Following method is implemented to change the mode awake to sleep and vice versa for each group.

Algorithm: Aggregation Process

- The algorithm analyzes the every node of each group in the network.
- The system checks the data transmission between base station and nodes or between anchor node and slave nodes.
- It tracks the nodes for their group.
- It checks if the communication is going on then it waits to complete it. After that it sends that particular group into sleep mode.
- Another group is on sleep mode if one group is awake.
- If there is no transmission then the mode will be changed for each group in a particular time slot.

5. EXPERIMENTAL RESULTS & DISCUSSION

The nodes are divided into three sorts of wireless network clusters. The nodes within the mobile network cluster are diagrammatical within the black, inexperienced and red colours. The network is representing the communications between the mobile network users and BTS's. The network is created of total a hundred nodes. The opposite cluster is Wi-Fi cluster or field cluster. The field cluster is created of half dozen nodes loco mote between nine and fourteen. The nodes are exploitation the traffic speeds loco mote between ten Kbps and a hundred Kbps whereas the Wi-Fi cluster (Campus Cluster) is exploitation the traffic speeds loco mote between 1 Mbps and 10 Mbps. The mobile nodes are exploitation AODV primarily based mobile communications. The mobile communications supply the long-range property to facilitate the inter-nodal career and net property between the mobile network users.

The projected model has been well tested beneath varied things within the sensing element network simulation. The projected energy primarily based sleep programming protocol on sensing element network has been well tested for the performance parameters of energy, latency, sleep rate and coverage rate. The nodes within the projected model simulation have performed well in terms of the entire on top of parameters. The energy, latency, sleep rate has been recorded lesser than and coverage is over the normal sleep programming sensing network elements with quality.

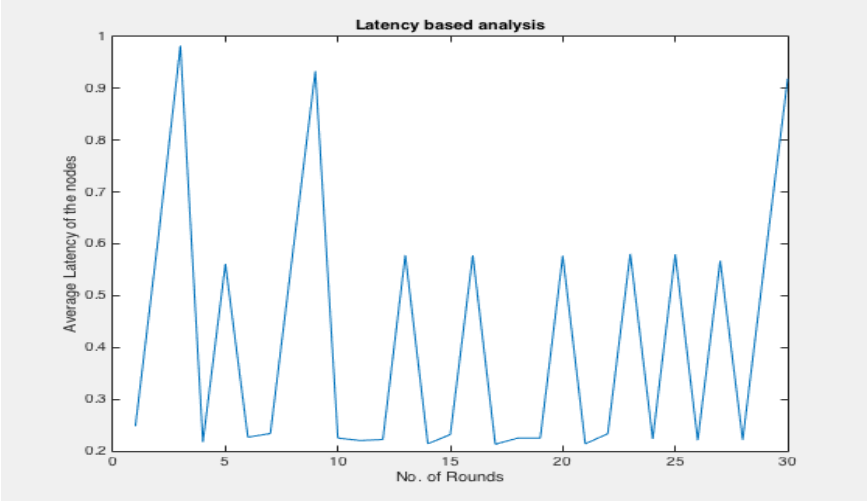

Figure 4 The Latency based analysis

In Figure 1, maximum delay recorded in the simulation is ranging between 0.25 and 0.95 milliseconds. The delay is the parameter represents latency of a packet when it was being sent between two nodes. The time taken for a packet to reach the destination from the source is called the total delay. The improvement of almost 40%-50% has been recorded in the proposed model in comparison with the existing model.

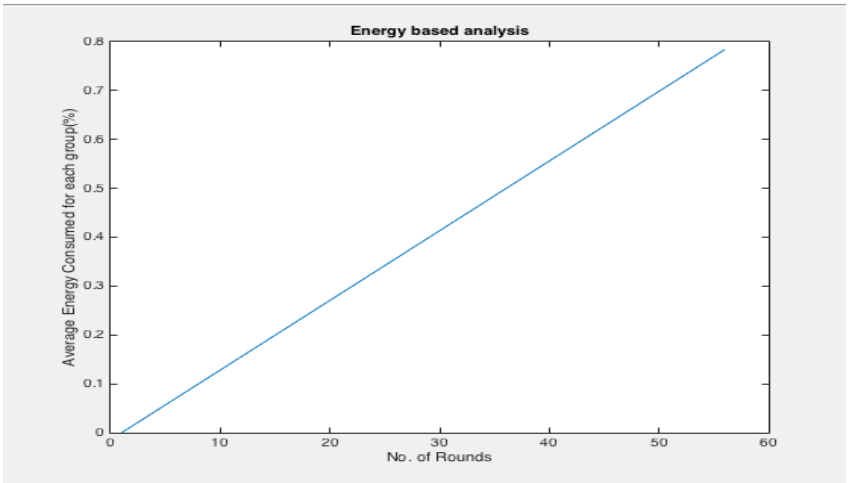

Figure 5 The Energy based analysis

In Figure 5, the parameter represents the consumed energy of a network in entire transmission. The sensor network using our proposed energy aware balanced topology based routing protocol has been recorded between 0and 0.8 joules in proposed system and 0 to 0.9 joules in the existing system. The 0 joules is the value recorded when no data is being sent between the nodes in the initial stages. Once the data transfers start, the energy starts going down.

Table 1 Sleep rate analysis

No of Nodes	Proposed	Existing
100	33	30
150	37	34
200	36	37
250	42	42
300	40	48

In Table 1, we have compared the values of sleep rate analysis between the existing and proposed system. The values are different for different no of nodes

6. CONCLUSION

In this proposed work, we give a brief discussion on the emergence of cluster based routing in wireless sensor actor/detector networks. In the proposed scheme, we develop k-medoids algorithm in variant of k-means algorithm that can further be utilized in other clustering routing protocols for better efficiency.
Proposed model enable the wireless sensors network to implement the algorithm to efficiently broadcast the collected information to ensure the energy efficient of the network and send the captured information to the BS or sink.

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