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Data Gathering in Wireless Sensor and Actor Networks

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Abstract

Objective: To develop a command based active Actor node command which controls the WSAN network. Network areas of research is growing drastically in the field with the advancement of Wireless sensor network and Wireless sensor and actor network. **Methods/Analysis:** Data gathering method was used for collecting the information of sensor nodes in a network. Using this method, data gradients values of the nodes are stored efficiently in the cache of the actor node. Efficient path method is used to route the path from actor node to the destination node based on routing. Next load balancing method is used to balance the node efficiency in a WSAN, effectively. Lastly, we used recharge method which recharges the sensor nodes effectively using list available in actor nodes. **Findings:** Various experiments were conducted based on energy consumption, load balance, packet delivery, power consumption and compared with the WSN. It was shown that the entire command based Actor node gave better results in WSAN's. **Application/Improvement:** Hence, new commands can be written to merge different types of WSAN's based on topology structure and energy efficiency.

Keywords: Data Gathering, Gradient, Path and Routing, WSAN's

1. Introduction

Advancement in wireless technology has evolved in developing small devices, at low cost, low [=] power which are equipped with new wireless devices which has efficient communication mobility. To solve some complex scenarios we require integration of high capability devices with sensor called Actor nodes to execute the task efficiently at a specific time bound. The network using Actor nodes for execution are called WSAN's. It is the extension of WSN. Using WSAN's, various application programs can be executed dynamically. WSAN's is an integration of numerous sensor nodes and actors connected using wireless media, the actors and sensor co-operated each other in execution of the task effective and also distribute the task to the other sensor nodes when busy.

The WSN sensor nodes cannot recharge or configure the network based on energy efficient; to have effective communication between the sensors nodes networks can be overcome by advancing memory, processor speed, computational power and bandwidth which can increase the life span of the network. The architecture of WSAN's is shown in Figure 1.

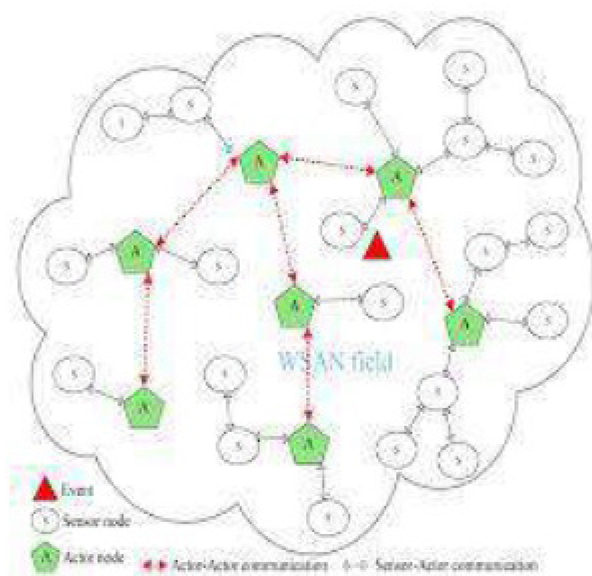

Figure 1. WSAN's network architecture.

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WSAN's has Actor nodes which have higher resources, such as computing capacity, transmission of power, recharge of power resource and lifetime of battery.

One of the prime requirements of a WSAN is that events have to be detected in a timely manner and communicated to the actor at the earliest possible time[1]. Since a centralized sink may not be present in a WSAN, coordination and communication between the Actors and between the sensors and the actors have to be managed. The coordination and communication problem has been studied and a hybrid location management scheme has been proposed to handle the mobility of Actors in[8]. This approach deals with a fully connected network and the actor moves following a variation of the random waypoint mobility model. Though the action and movement energy of the actor are assumed to be orders of magnitude higher than the energy required for communication purposes, this paper does not analyze the impact of random actor movement on the movement energy.

Research in WSAN uses Walk and Flooding models. In Walk model the actor nodes sends commands to move randomly to the destination at a varying speed, this process of walk continuous with varying of commands until it reaches the appropriate destination[1]. Random walk mobility model is evaluated on full network to assure a path between the actor nodes and sensors.

In[1] developed a Partitioning method for assigning the tasks on a mobile network in WSN.

In[2] explored data gathering technique on collection data on energy efficient in mobile sensor nodes.

In[3] proposed broadcasting method to broad caste packets on the neighbor nodes using this method he achieved high delivery ratio on packet transmission.

In[4] developed a central node to maintain and control the network, which identifies the failure of the neighbor nodes with high throughput and accuracy.

In[5] with mobile actors proposed a real-time coordination and routing framework for sensor-actor coordination to achieve energy-efficient and reliable communication.

In [6] proposed a mobile entities have also been used in Wireless Sensor Network (WSN) and Mobile Ad-Hoc Network (MANET) research. Data mules are mobile entities that collect data from sensors as they pass.

In[7] proposed mobile elements were also used for data collection in sparsely connected networks.

In[8] developed highly partitioned wireless ad-hoc networks where network connectivity can be maintained only when the nodes use their long range transmission radio.

2. Proposed Work

Our proposed work is divided into 4 parts:

- Data Gathering and gradient command.
- Energy efficient command.
- Load Balancing command.
- Re-charging command for sensor nodes.

2.1 Data Gathering and Gradient Command

Data gathering and dynamically routing in Wireless Sensor and actor's network, our work mainly deals with efficient time based data gathering routing for actor nodes in WSAN's. We focused on data gathering with minimum time delay or total number of packets delivered and the heals occurred due to:

- High energy may be required for routing path.
- Unordered or unbalanced nodes may arise in the path.
- The available routing may not be shortest.

These problems can be solved efficiently using dynamic data gathering method. In this data gathering is done by collects data from the senor nodes and sink, this data is stored in the actor node, actor node based on the data gathered, executes the program for dynamic routing path creation using flooding, walk based on BFS machine learning algorithms. Actor nodes are the key nodes, which broadcast commands to the neighbor nodes based on data gathered, in-term neighbor nodes broadcast the same to the nearest and so on.

Critical nodes are easily identified based on time bound or re-broadcasting. Following are the various steps proposed.

2.1.1 Propagation of Interest

The actor node executes a command, which floods the interest on the sensor nodes and sink, then each of the nodes again re-floods the command program to their neighbor nodes, at each time of flooding data is gathered and stored in the cache on the actor node based on Ggradient, updated on the gradient entry are done by removing duplicates in the actor node.

2.1.2 Command Response

In this phase we use data diffusion method, this method when stored in an ACTOR node of WSAN's gathers only the necessary data of the neighbor nodes available at various levels and stores the best path in cache storage.

Using this method, it is easy to identify the weak and critical node. Below are the gradient variable identifiers:

Command ID: Actor node: Destination: Time: Data request: Load resources.

Command ID: Actor node: Destination: Level count: Energy in total: Lowest energy.

The Actor node on Dynamic node creation will broad cast the command to the various levels of sensor nodes in gathering the data. This process is done by query command.

The Actor node will receive Request from multiple paths. Then the actor node process a Command based on the data gathered information, generate the efficient shortest path from source to destination.

2.2 Energy Efficiency Command

To calculate the path

PF S→ d = α(TE)* β(LE) /ϒ(HC) (1)

TE – Total Energy ratio of path.

LE - Low energy path level.

HC – Level count of Hop.

α and β are the data weight gathered from data gathering of each node.

Total Energy of the path is calculated as

TE = (Path s → Total Energy)/ Σ (from all the node path (total energy)) * 100 (2)

Path s→ d energy of total = $\Sigma_{\text{All nod path S}\rightarrow}$ d Energy of node level (3)

Low Energy is calculated as

Path s→ d = (Path s->d low energy)/ ($\Sigma_{\text{All nod path S}\rightarrow}$ d Low energy) * 100 (4)

Path s→d low energy = min(All path nodes s->d) (Energy node level) (5)

HC s→d = (path s→ d Level count) / ($\Sigma_{\text{All nod path S}\rightarrow}$ d Low energy) *100 (6)

2.3 Effective Load Balance Method

- Identification of independent nodes.
- Search for Node connectivity.
- Search the level of node from the Actor node.
- Derive the probability allocation mechanism for balancing.

The best path is tracked by the Actor node, which then enforces the command to the neighbor node for creating a dynamic shortest path from source to destination, is shown in Figure 2.

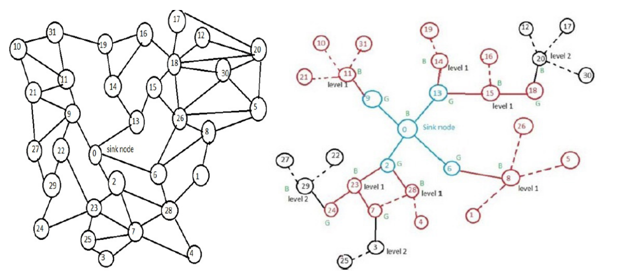


Figure 2. Load balance WSAN's level indicating actors node.

2.3.1 Propagation of Data

This method is used to identify their respective actor, neighboring nodes and Sink with each other for propagation data. It uses Data forward propagation method for identification of their respective neighbors and Actor node in a WSAN's

1. Begin
2. Actor node processes a set of command to the sensor neighboring nodes and sink, the command will generate a query packet and sends packet to the neighbors
3. If the Sensor node receives command the node get query packet
   Add query to table and set gradient towards source node then forward the command to the neighboring nodes
   SET-ON the Sensor node
4. If data matching is sense
   Generate query packet response
5. For each gradient associated with command, send query response packet
6. if command response packet receive
   add hop count
   add energy level to total energy
   check for minimum energy
7. for each gradient associated with command forward update
   Command response packet
8. if Actor node receive command response packet
   Calculate promising factor and find the optimal

path
send enforcing packet to neighbor on the best path
9. For Each node on the path will calculate the promising factor and enforce to the next node
10. end

2.4 Recharging of Sensor Nodes in WSAN

Actor node has commands to re-charge the sensor nodes whenever required, the commands uses Gradient for recharging the sensor nodes based on time. The Actor node has a charging list of all the sensor nodes, using this list the neighboring nodes are traversal and charged based on the request and sensitivity of the node power.

Sensor node-ID: Location: Request time: Energy Req: Energy consumption rate

The various steps used for recharging the sensor the nodes

- Prepare a Charging sequence function F.
  F= f= [e- v(tn -t)]log(d)
- Checking the threshold of each node , if the node energy is less than the required.
- Update the sensor using F function (re-charge from Actor node).
- After recharge of sensor , delete the entry of the node in charging list.
- Repeat the process from 2 to 5 by traversing the route from actor node to the sensors nodes.

3. Simulation Results

The performance evaluation is done Data gathering in WSN with WSAN's, Simulator Castalia is used to simulate WSNs and WSAN's. Castalia is an open source simulator, where user can implement his own protocols.

The performance of both the protocols is compared using parameters shown in Table 1.

Table 1. Simulation of various parameters

Parameter name	Value
Simulation Time	360 sec
X- axis	45- 185 meters
Y axis	45-185 meters
No of nodes	20
Sink node	Node 1
Radio Type	CC2421
MAC protocol	TMAC

We have conducted certain experiments on comparison of total energy consumption between Data gathered using in WSN's with Dynamic Data gathering in WSAN's. It is shown that WSAN's consumes less energy.

The second experiment was conducted to compare reliable of delivery of packets to the neighboring nodes in the network, it was shown that WSAN's method has high reliability compared to the existing of WSN's.

Next, the comparison is done on Life of a network; here also proposed WSAN's has better results.

The proposed method (Figure 3) shows that WSAN's consume less amount of energy compared to WSN's data gathering method.

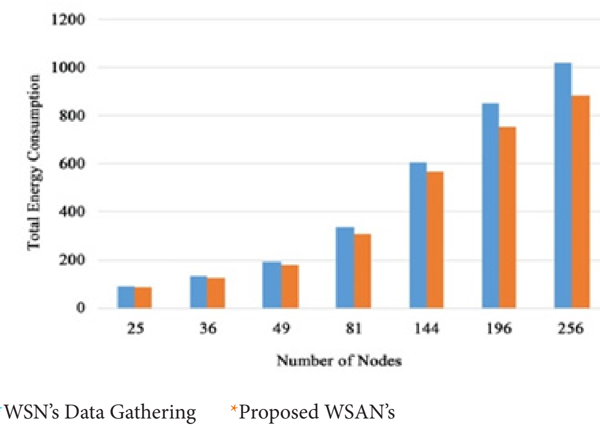


Figure 3. Total energy consumption vs difference.

The Figure 4, shows that the total energy consumption by WSAN's for the nodes is very less compared to the WSN network.

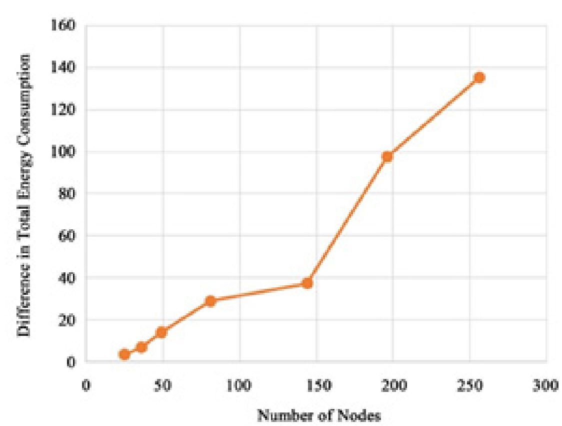
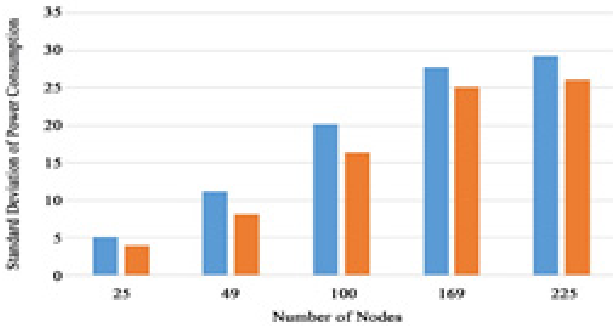


Figure 4. Total energy consumption difference.

Figure 5 shows that Actor node gives efficient consumption of energy and packet delivery rate w.r.t Sink node of WSN.



*WSN's Data Gathering *Proposed WSAN's

Figure 5. Block diagram of the proposed algorithm.

In Figure 6 shows a packet delivery difference of the difference in delivery of packets in WSN verses Proposed WSAN/s.

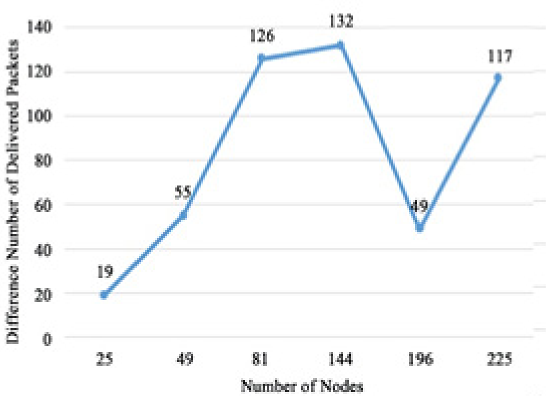
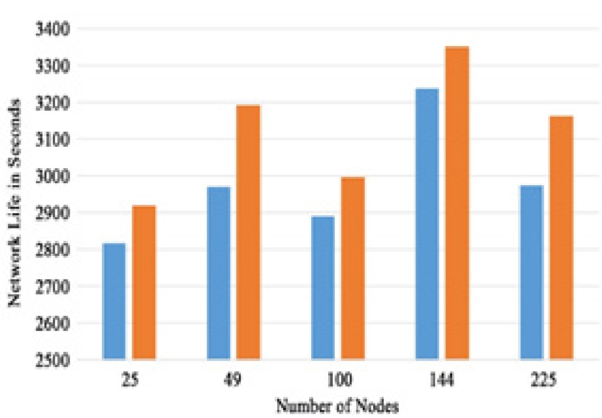


Figure 6. Packet delivery difference.

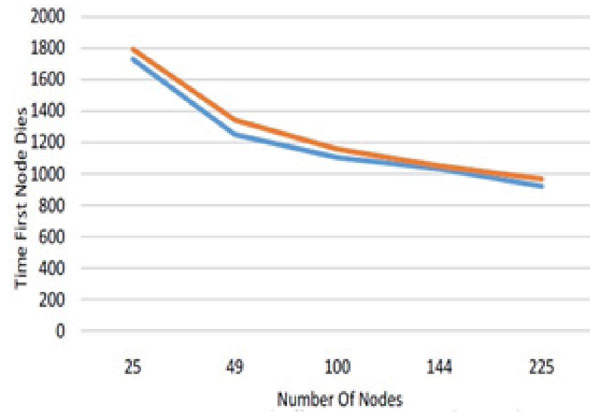
Figure 7 shows the life time of the network. It is observed that proposed WSAN's has higher life compared to WSN's.



*WSN's Data Gathering *Proposed WSAN's

Figure 7. Network life.

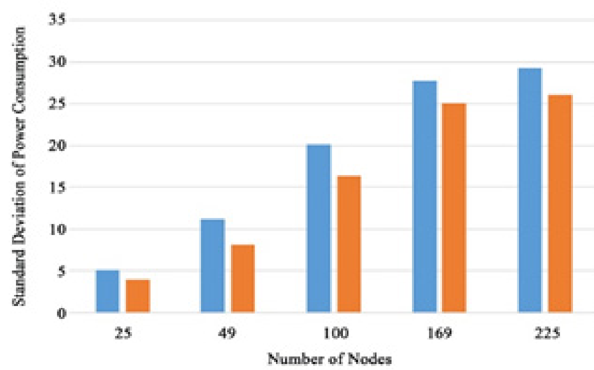
Figure 8 shows that WSAN's gives better results in load balance in a network of nodes.



*WSN's Data Gathering *Proposed WSAN's

Figure 8. Load balance.

According to Figure 9, the proposed WSAN's shows less power consumption compared to the two networks.

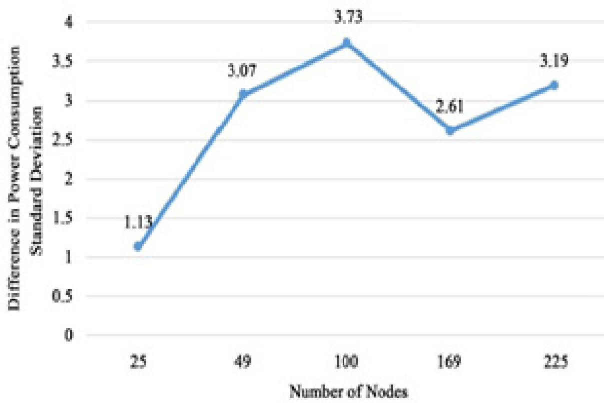


*WSN's Data Gathering *Proposed WSAN's

Figure 9. Power consumption deviation.

In Figure 10, the proposed network shows the level of power consumption of all the networks in a topological structure.

Regarding the balance of load and energy consumption distribution to the neighbor node, the proposed gives better results compared to WSN's.



*WSN's Data Gathering *Proposed WSAN's

Figure 10. Power consumption.

4. Conclusion

The proposed work shows as an efficient management of sensor nodes as done by the Actor nodes in a WSAN's. We use Data gathering method for collecting the information of sensor nodes in a network. Using this method, data gradients values of the nodes are stored efficiently in the cache of the actor node. Efficient path method is used to route the path from actor node to the destination node based on routing. Next Load balancing method is used to balance the node efficiency in a WSAN effectively. Lastly, we used recharge method to recharge the sensor nodes effectively using list available in Actor nodes. All these method are effective in WSAN's. Future enhancement can be done on clustering in WSAN's.

5. References

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