Design and implementation of weighted clustering algorithm

Basant Kumar Verma\textsuperscript{#1}, Dr. Binod Kumar\textsuperscript{\ast2}, Dr. Pratima Gautam\textsuperscript{#3}

\textsuperscript{#1}Research Scholar, AISECT University, Bhopal, India
\textsuperscript{#3}Professor & Dean, CSIT Department, AISECT University, Bhopal, India
\textsuperscript{\ast2}Professor & Director, JSPM, Pune, India

1 contact_basant@rediffmail.com
3 pratima_shkl@yahoo.com
2 binod.istar.1970@gmail.com

Abstract—The wireless communication leads effective solutions. But still there are a number of performance and security issues are remains to be fixed. In most of the wireless ad hoc infrastructures the problem of continuous connectivity and resources optimization issues are a major concern. In this context the experts are suggested to deploy the network in clustered organization for improving the network efficiency and the resource utilization. In this paper a weighted clustering algorithm is proposed for implementation and their performance evaluation. In addition of that the effect of the performance improvement is also noticed in comparison of the normal AODV routing technique. The obtained results show that the performance of the network is increases when the network nodes are functioning a clustered organization.

Keywords: wireless networks, WCA, performance improvement, traditional AODV, resource preservation

I. INTRODUCTION

In configuration point of view the networks can be wired or wireless. As compared to wired network technology the wireless networks are low cost and easy to maintain. Therefore the popularity of wireless networks are increases much rapidly as compared to wired networks. In addition of that setup and the binding up of these networks are also rapid and due to this a wide range of applications are supporting the use of wireless communication technology. Wireless networks not only support the communication it is also used for other critical computational task. Among them a much popular technology is wireless sensor network.

Wireless sensor networks are configured with the help of independent sensing nodes or devices which are capable to compute, sense the surroundings and communicate with other similar nodes. The ability of these nodes make it much expensive for various real world applications and the scientific applications. But the key constraint is their limited resources i.e. sensing range, battery or power source and the computational and storage limits. Therefore the resource utilization in efficient manner in such network is a key issue.

If the network nodes or devices are arranged in some specific manner then their performance can be scaled and the better performance can expected. One of such kind of organized network is termed as network clustering. In network clustering the network nodes are divided in three major roles first the cluster heads, cluster clients and the gateway nodes. The cluster heads are responsible for monitoring and serving the nodes which are belongs to the particular cluster. Additionally the route discovery is also a major role of the cluster head for efficient data delivery. The client nodes are the end devices which are participating in communication and become the member of a cluster. Finally the cluster members who are members of more than one cluster is known as the cluster gateways. These nodes are responsible to bridge the communication between two clusters.

In this context the cluster heads are the super nodes. Therefore the selection of super nodes in network is a effective task. A number of techniques for efficient, effective and stable cluster formation is available. Among them the node quality of service based cluster head selection technique is a most suitable and effective technique. In this manner in this work the weighted grouping calculation is shown for bunch head choice and group arrangement. This segment the diagram of the proposed work is given. In next segment the system of the proposed weighted grouping calculation is depicted.

II. PROPOSED WORK

A number of different kinds of wireless sensor network's routing protocols are available among them clustering is a most efficient technique for network. Therefore in this section includes a new weighted clustering algorithm.
A. Issues Addressed

The objective of proposed clustering algorithm is to find stable and efficient clusters. Thus optimum cluster head selection is required. Due to this the following parameters are considered.

1. **Cluster head must have sufficient energy**: energy of node affect network performance. Additionally low node not able to perform normal functioning therefore cluster head with low energy fails any time and existing routes become abandoned. Thus to serve better sufficient energy of nodes required.

2. **Cluster head much have fresh route information**: the cluster heads are responsible for route discovery process thus need to maintain recent routing information that helps to reduce time overhead introduced during route discovery.

3. **Cluster head communicate with maximum possible nodes**: connectivity of nodes shows ability to serve maximum nodes thus higher connective node is essential property of cluster head.

4. **Cluster head having less workload**: cluster head need to survive long time additional load on cluster head exhaust it therefore cluster head with enough processing workloads is not suitable for cluster.

5. **Stable cluster formation**: The mobility of nodes effect performance of network and can change cluster formation. Therefore need to include cluster heads with less mobility.

B. Parameter selection

Keeping in mind the end goal to locate the steady and effective system bunch head determination procedure the accompanying system obliges are proposed to incorporate for weighted grouping development.

1. **Energy**: the node with higher battery power able to participate in communication for long time. It is assumed at initial configuration entire nodes have full battery and can be denoted by $E_{in}$. Thus the energy is 100%. After a time interval $\Delta t$ node consumes a part of energy that is $\Delta e$. Therefore remain energy at sampling time $t_{sample}$ is:
   \[
   E_{\text{remain}} = E_{in} - \Delta e
   \]
   Where $\Delta e$ is consumed energy between time $\Delta t$ and $\Delta t = t_{\text{sample}} - t_{\text{initial}}$

2. **Lowest sequence number**: freshness of routing information is identified by lowest sequence number in AODV routing. That is a part of routing table information. To find most recent routing information the lowest sequence number is involved as decision indicator. The lowest sequence number is given as $L_s$.

3. **Connectivity**: The network is graph therefore nodes are connected with each other using links. In network usually links are known as connections. Thus degree of node connection is termed as connectivity of node. The figure 1 shows an example of connectivity. The maximum numbers of nodes connected through a node show higher serving ability. That is represented here using $C_{node}$.

4. **Buffer length**: The transmission and receive between nodes are usages a memory which is known as buffer. That is used to store, process and forward data. The buffer length of a node show work load on node. Thus highly used buffer show high workload on node. In this discussion node’s buffer is represented as $B$. The nodes are initialized with 100% free buffer, and when node samples are collectedit is filled by $M$ bytes thus $\Delta b$ amount of buffer is consumed. The remaining buffer size is used for weight computations. The remain buffer length is denoted by:
   \[
   B = B_{\text{initial}} - \Delta b
   \]
   Where $B_{\text{initial}}$ is initial buffer length assigned

5. **Mobility**: mobility of nodes impact on performance of networks thus less mobile nodes create stable clusters. Therefore less relative mobility based nodes are selected. To compute mobility let node with initial position at time $t_1$ is $(x_1, y_1)$ and after time interval $\Delta t$ it changes their position to $(x_2, y_2)$. The change in position between point $(x_1, y_1)$ and $(x_2, y_2)$ calculated as.
   \[
   D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}
   \]
Further the rate of change in a node position with respect to time is given by:

\[ M = \frac{D}{\Delta t} \]

C. Weight computation

The computed parameters which are derived in previous section are measured in different scale. Therefore to normalize these values a technique is required to convert into weight. Therefore some normalization factors are involved \( w_1, w_2, w_3 \) and \( w_4 \). The values of these factors are between 0-1 and regulated in such manner by which the combined weight values are also obtained between 0-1. The following formula is used for weight computation.

\[ W = w_1 \ast M + w_2 \ast B + w_3 \ast E + C \ast w_4 \]

Another factor is also involved named as \( L_s \) which is recent sequence number that is used when two nodes having same weight values to decide cluster head.

D. Proposed algorithm

The understanding about proposed algorithm’s steps for performing clustering operation in network is described in this section using table 1.

- **Info:** number of hubs N
- **Yield:** the bunched organize

**Process:**

1. A hub communicate the bunching demand
2. if demand got
   a. compute versatility M, connectivity C, buffer length B, energy consumption E and recent sequence number \( L_s \)
   b. work out weight of self
   \[ W = w_1 \ast M + w_2 \ast B + w_3 \ast E + C \ast w_4 \]
3. end if
4. switch over weight to neighbour
5. for \( i = 1; i \leq \text{neighbours}; i++ \)
   a. if self-weight > \( \text{weight}_i^{\text{node}} \)
      i. select self as cluster head
   b. elseif self-weight < \( \text{weight}_i^{\text{node}} \)
      i. select higher weighted node as cluster head
   c. else if self-weight = \( \text{weight}_i^{\text{node}} \)
      i. if \( \text{self}_{Ls} \geq \text{weight}_{Ls}^{\text{node}} \)
         1. select self as cluster head

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Type</td>
<td>Wireless Channel</td>
</tr>
<tr>
<td>Dimension</td>
<td>750 X 550</td>
</tr>
<tr>
<td>Antenna model</td>
<td>Omni Antenna</td>
</tr>
<tr>
<td>Radio-propagation</td>
<td>Two Ray Ground</td>
</tr>
<tr>
<td>No of Mobile Nodes</td>
<td>10, 20, 30, 40</td>
</tr>
<tr>
<td>Time of simulation</td>
<td>10 sec</td>
</tr>
<tr>
<td>Routing protocol</td>
<td>AODV with WCA</td>
</tr>
</tbody>
</table>

Table 1 proposed WCA algorithm.

III. EXPERIMENTAL SETUP

This section introduces details of simulation development. Therefore it includes network environment and configuration details additionally simulation scenarios are also discussed.

A. Simulation setup

The table 2 shows the parameters and simulation environments configuration for comparative analysis of clustered networks. That includes the network parameters and corresponding values for development.

B. Simulation Scenarios

Simulation scenario is sequence of processes involved in simulation configuration and communication performed. Using these scenarios the performance of simulated network is also approximated. For demonstrating proposed WCA algorithm and traditional WCA algorithm following simulation scenarios are proposed.

1. **Simulation of traditional WCA algorithm:** This simulation demonstrates previously available scheme of weighted clustering. Its implemented using network simulator 2. The simulation is performed with similar conditions as prepared for proposed
WCA algorithms. The network generated trace is used for performance analysis and comparative study.

2. Simulation of proposed WCA algorithm: The proposed WCA routing technique is configured in wireless sensor network environment. The simulation scenario of this technique is provided in figure 2. After simulation performance of proposed WCA algorithm is compared with previous scenario’s performance in same parameters.

IV. RESULTS ANALYSIS

This segment gives a point by point discourse about the system execution got by the near examination. In this manner distinctive execution factors are assessed utilizing the created organize follows and these follows are utilized for processing the system execution.

A. Throughput

The degree or rate of successful delivery of messages in a communication medium is known as network throughput. This data either travelled in physical or logical path ways, or it is passing through device to device.

![Figure 2 simulation screen](image)

![Figure 3 comparative throughput](image)

The measurement of throughputs given as far as bits every second (BPS) and here and there in information bundles per vacancy. Figure 3 shows similar throughput of both the weighted grouping calculations. Red line of graph indicates throughput of proposed system and green line show customary WCA execution. As per execution of proposed system, it devours higher transfer speed when contrasted with conventional WCA calculation. Moreover execution of both the system with expanding number of hubs is given in figure 4. The similar execution with expanding number of hubs demonstrates proposed weighted bunching calculation out performs as for customary WCA. In this way proposed strategy is productive and adequate for enhancing system execution in specially appointed systems.

B. Packet delivery ratio

The ratio of total packet transmitted and successfully delivered packets to target network node is called packet delivery ratio. The computation of PDR is provided using following formula in terms of percentage:

\[
PDR = \frac{\text{Total amount of delivered packets}}{\text{total sent packets}} \times 100
\]

![Figure 4 comparative throughputs](image)

![Figure 5 comparative PDR](image)

The comparative packet delivery ratio which is measured in percentage is defined in figure 5. In figure 5Y axis includes percentage PDR and X axis contains simulation time in seconds. To show performance green line shows PDR ratio of proposed WCA algorithm and red line describes traditional WCA algorithm’s performance. As indicated by trial comes about proposed procedure is productive when contrasted with
Conventional WCA directing convention. Furthermore, the examinations with expanding number of hubs are likewise performed for both WCA calculations that are shown in figure 6. As per assessed execution of both steering convention, the proposed system outperform concerning the customary WCA procedure. Consequently proposed procedure is proficient and satisfactory for security associations planned.

**C. End to End Delay**

Between sender and receiver communication leads a time difference for sending and receiving the data packets successfully. The amount of time to deliver a data packet to network device is termed as end to end delay. The end to end delay of routing protocols demonstrates communication cost of network. The comparative E2E delay of both WCA is given in figure 7 and 8. In first diagram figure 7 X axis contains simulation time and Y axis includes end to end delay with respect to simulation time. The measured delay of network is described here in terms of milliseconds. The red line in figure 7, shows E2E delay of traditional WCA routing and green line shows performance of proposed WCA algorithm.

![Figure 7 comparative End to end delay](image)

As indicated by exploratory outcomes conventional procedure's E2E delay is higher as for proposed WCA strategy. Besides it the execution with expanding number of hubs is additionally exhibited in figure 8. Acquired outcomes with expanding number of hubs as far as end to end postpone demonstrates that the proposed WCA steering produces less E2E delay when contrasted with conventional WCA approach.

![Figure 8 End to end delay (number of nodes)](image)

**V. CONCLUSION AND FUTURE WORK**

This paper provides a detailed study about routing protocols supported by wireless sensor networks and mobile ad hoc networks. Moreover, it cluster based routing is also explained in detailed with their advantage and limitations. In investigation it is found that the clustering of network enhances the performance of network. In this context a new weighted clustering is proposed. That technique includes the different network and node's properties for selection of efficient cluster head. This algorithm is implemented using NS2 network simulation. The main advantage of the presented weighted clustering algorithm is, it able to scale network performance. That is reflected on the evaluated performance parameters in comparison of the traditional AODV routing in wireless network scenarios. According to obtained results performance of proposed WCA technique it is efficient as compared with traditional WCA technique. The simulation performance demonstrates after implementation of the proposed clustering technique throughput of network, and packet delivery ratio of the network is improved. Additionally the end to end delay of network is reduced as compared to traditional WCA protocol. Thus the designed simulation based routing algorithm is able to improve network performance.

**REFERENCES**


RajuDutta, Shishir Gupta, Mukul K. Das, “Power Consumption and Maximizing Network Lifetime during Communication of Sensor Node in WSN”.

Basant Kumar Verma obtained his Master degree from Department of Computer Science, Guru Ghasidas University, Bilaspur, Chhattisgarh, India in 2003. He is currently a Ph. D. student under the supervision of Dr. Binod Kumar (Guide) & Dr. Pratima Gautam (Co-Guide). His research is centered on development of cluster-based intrusion detection system.

Dr. Binod Kumar is Professor & Director at Jayawant Institute of Computer Applications (JSPM's Group), affiliated to Savitribai Phule Pune University, India. He is having around 19.5 years of experience in various capacities in research, teaching and academic administration. He has obtained PhD (Computersc.) in 2010, MCA (NIT Jamshedpur) in 1998 and M.Sc.(BHU) in 1995. He worked as Associate Professor at School of Engineering and Computer Technology, Quest International University, Malaysia.

He has been an evaluator for Ph.D. dissertations of various Universities like Sardar Patel University (Gujarat), Bharathiar University (Coimbatore), Karpagam University (Coimbatore), Banasthali University (Rajasthan). He served as Conference Chairman Committee Member at QUAESTI 2015, The 3rd Virtual Multidisciplinary Conference, Slovakia. He is Advisory Board Member of RNB Global University, Rajasthan, India. He is reviewer of Journals like Elsevier, SpringerPlus and TPC of various IEEE sponsored conferences. He is Editorial Board member of nearly 45 International Journals. He has been associated with Technical Program Committee member (TPC) of nearly 60 International Conferences in India and abroad. He is Senior Member of IEEE Computer Society. He has published nearly 40 papers in International and National Journals. His areas of interest are Data Mining, Soft Computing and Machine Learning.

Dr. Pratima Gautam is Dean, department of computer science and application, affiliated to AISECT University, Bhopal, India. She has obtained PhD (Computer Application) in 2012 from MANIT, Bhopal and MCA from APS University in 2006. She worked as Associate Professor at Bansal Institute of Technology, Bhopal. She has published 30 papers in International and 15 National Journals. Her areas of interest are Data Mining, Image Mining and Networking.