Designing and Analysis of Energy Efficient Bacteria and Swarm Optimization Algorithm for Wireless Sensor Network

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Abstract—Wireless Sensor Network has the potentiality to link the physical world with the virtual world by forming a network of sensor nodes. Energy efficient object tracking is one of the main design issues for wireless sensor networks. Energy efficiency is required as the whole WSN is dependent on the power of batteries and the object tracking is required for checking the varying speed of target, target precision and missing target recovery. BOA and SOA works for providing the energy efficient clusters and cluster head selection and the task of object tracking is performed by prediction based clustering algorithm.

Keywords—WSN, BOA, SOA, Cluster Head, RSSI.

I. INTRODUCTION

In wireless sensor networks there are several wireless sensors which are capable of sensing a special phenomenon in the environment and send the data back to one or several base stations. The main feature of WSN that makes it unique is its flexibility in terms of the shape of the network and mobility of the sensors. Without any wires, WSN can be deployed in areas where regular sensor networks cannot operate. Also the self-shaping feature of WSN, along with the freedom of the wireless sensors movement makes it an ideal tool for the situations where the sensors are mobile. Having these features, WSN is used in medical applications, military purposes, disaster area monitoring etc [1, 2]. The flexibility of wireless sensor networks comes with a series of challenges. Since wireless sensors are not physically connected to any central source they are completely dependent on their battery to operate; also wireless sensors positions are not determined prior to the network deployment, thus sensors should be able to operate in a way that can automatically generate an optimum routing path and deliver the sensed information back to the base-station. Base-station integrates the received data and applies a process over it and sends the results to be viewed by a user or for further processing. Each wireless sensor node is not physically connected to any source of power, thus its own battery is the only reliable power supply for it. Sensor nodes are also constrained on bandwidth. Considering these two limitations, routing and sensing algorithms that use innovative methods to preserve the power of the sensors are required [3]. Since the lifetime of the network is highly dependent on the lifetime of the Sensors Sensing Environment Base-Station sensors’ batteries [4], preserving the energy in the sensors will increase the lifetime of the network.

II. OBJECT TRACKING:

Object tracking is one of the challenging and nontrivial applications for Wireless Sensor Network in which network of wireless sensors are involved in the task of tracking a moving object [5]. Object Tracking is widely used in many applications like military application, commercial applications, field of surveillance, intruder application and traffic applications. There are various metrics for analyzing object tracking such as cluster formation, tracking accuracy, cluster head life time, miss rate, total energy consumed, distance between the source and object, varying speed of the target, etc. The open issues in object tracking are detecting the moving object’s change in direction, varying speed of the target, target precision, prediction accuracy, fault tolerance and missing target recovery. The object tracking algorithm should be designed in such a way that it result in good quality tracking with low energy consumption. The good quality tracking extends the network lifetime and achieves a high accuracy. In order to obtain an energy efficient tracking with low energy consumption, an assumption is made that all the sensor nodes have same energy level [6]. Because, even if a sensor node fails, other sensor node can take the responsibility and carry out the tracking process.
III. BACTERIA AND SWARM OPTIMIZATION ALGORITHM

Bacteria and Swarm Optimization Algorithm (BOA and SOA) is a well-known computational methodology which is based on the study of the bacterial foraging behaviors. The complex but organized activities exhibited in bacterial foraging patterns could inspire a new solution for optimization problems. E. coli is a common type of bacteria. An E. coli bacterium alternates between running and tumbling. If it swims up nutrient gradient the E. coli will swim longer. If it swims down nutrient gradient the E. coli will search again to avoid unfavorable environments. Events can occur such that all the bacteria in a region are killed or a group is dispersed into a new part of the environment [7]. Elimination and dispersal events have the effect of possibly destroying chemotactic progress, but they also have the effect of assisting to place bacteria near good food sources. The goal is to find the minimization of [8]...

IV. ALGORITHM

The nodes are clustered using the Bacteria and Swarm Optimization Algorithm using the reproduction and elimination and dispersal processes of BOA and SOA in which events can occur such that all the bacteria in a region are killed or a group is dispersed into a new part of the environment [4]. During the process of reproduction, individual will reproduce themselves in appropriate conditions in a certain way. For bacterial, a reproduction step takes place after all chemotactic steps.

$$J_{\text{health}}^i = \sum_{j=1}^{N_c} J(i,j,k,l)$$

Where $J_i$ is the health of bacterium i. Sort bacteria and chemotactic parameters $C(i)$ in order of ascending cost $J_{\text{health}}$. Bacteria with the highest $J_{\text{health}}$ values die, the remaining bacteria reproduce.

Step 6 Reproduction: Computer the health of the bacterium $i$:

$$J_{\text{health}}^i = \sum_{j=1}^{N_c} J(i,j,k,l)$$

Sort bacteria and chemotactic parameters $C(i)$ in order of ascending cost $J_{\text{health}}$. Bacteria with the highest $J_{\text{health}}$ values die, the remaining bacteria reproduce.

Step 7 If ($k<N_{\text{re}}$), go to Step 3.

Step 8 Elimination-dispersal: Eliminate and disperse bacteria with probability $P_{\text{ed}}$.

Step 9 If ($l<N_{\text{ed}}$), go to Step 2.

V. METHODOLOGY

Input: Number of nodes
Output: Current location of the Moving Object

Steps 1: Initially the nodes are clustered and the cluster head selection is done using BOA AND SOA.

Steps 2: The moving object is detected by the sensor using RSSI and the CH which is close to moving object becomes the Active CH.
**Steps 3**: The Active CH uses the prediction mechanism and predict the next location of the moving object as \((x_{i+1}, y_{i+1})\).

**Steps 4**: If the predicted location is within the cluster members, then the active CH selects the three nodes to calculate the current location using trilateration algorithm.

**Steps 5**: Else if the predicted location is outside the current cluster, then the CH near to the predicted location becomes Active CH and Step 4 is followed.

**VI. RESULTS**

We are representing and displaying all the respective results of our proposed work. These all results are performed and analyzed on simulation tool MATLAB.

**Figure 5.1(a)**: shows total 50 nodes of the sensor

**Figure 5.1(b)**: shows the data transmission path between source and destination

**Figure 5.2**: screen shot of MATLAB code and output

There are 4 types of cluster heads as shown in fig 5.2, they are differentiated by their colors, red, blue, green and yellow.
Figure 5.3: This figure shows cluster formation in the wireless sensor network by Bacteria and Swarm Optimization Algorithm.

Figure 5.4 is representing the selection of cluster head, randomly generated source and destination nodes. Data transmission is also represented in this figure which is taking place in between source and destination node through cluster heads. In this figure, black triangle denotes base station of this network. Nodes in the shape of square or rectangle denotes source and destination node. And in all clusters the nodes having black in their center are cluster heads of the respective cluster. The figure is as follows: The triangle shows the cluster head of the selected path. The cluster head is which contain the information of the path.

Table 1: Table showing Source to Destination Path

<table>
<thead>
<tr>
<th>Source node</th>
<th>path nodes</th>
<th>destination node</th>
<th>energy consumed</th>
<th>time consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>29,50</td>
<td>25</td>
<td>0.0300</td>
<td>505.22</td>
</tr>
<tr>
<td>41</td>
<td>37,38</td>
<td>34</td>
<td>0.03</td>
<td>505.22</td>
</tr>
<tr>
<td>18</td>
<td>36</td>
<td>48</td>
<td>0.02</td>
<td>505.33</td>
</tr>
<tr>
<td>46</td>
<td>19</td>
<td>49</td>
<td>0.01</td>
<td>505.44</td>
</tr>
<tr>
<td>16</td>
<td>49</td>
<td>50</td>
<td>0.2</td>
<td>505.33</td>
</tr>
<tr>
<td>19</td>
<td>24</td>
<td>24</td>
<td>0.01</td>
<td>505.44</td>
</tr>
<tr>
<td>34</td>
<td>21,19</td>
<td>3</td>
<td>0.04</td>
<td>505.11</td>
</tr>
<tr>
<td>35</td>
<td>33,15,2</td>
<td>31</td>
<td>0.05</td>
<td>505</td>
</tr>
</tbody>
</table>

VII. CONCLUSIONS

The task of cluster formation and cluster head selection is performed using reproduction and elimination and dispersal steps of BOA AND SOA. Energy efficient data transmission is provided using prediction based clustering algorithm. Object tracking is done using RSSI (Reduced Signal Strength Indicator) by the base station by maintaining the details of path travelled by the object and by making the nearest CH active and keeping all others in sleeping mode provides energy efficient object tracking in WSN using BOA AND SOA.

REFERENCES